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Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Grazing and Feeding Experiments with Pigs.

By J. F. DUGGAR.

BROWN PRINTING CO., PRINTERS & BINDERS.
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GRAZING AND FEEDING EXPERIMENTS WITH PIGS.

By J. F. Duggar.

Summary.

Pigs made a more economical growth just after weaning than did sow and pigs just before weaning time.

The following plants were tested as hog food, the hogs doing the harvesting; these plants are available for use in the months indicated:

Spanish peanuts, August to December.

Chufas, November to March.

Cowpeas, July to November.

Sweet potatoes, August to November.

Sorghum, July to November.

Vetch and oats, March, April and May.

Dwarf Essex rape (spring sown), May and June.

Dwarf Essex rape (fall sown), December, January, February, March, and part of April.

In most cases it was necessary to feed, in addition to the above crops, from one-fourth to one-half of the usual ration of grain. If we assume that of this grain 5 pounds was required to produce one pound of increase in live weight, we have left the following amount of growth of shoats attributable to one acre of each crop after deducting the gains due to the grain consumed.

Peanuts (with grain) in 7 tests averaged 333 pounds of growth, now worth $16.65.

Peanuts alone in 2 tests averaged 281 pounds, worth $14.05.

Chufas in 2 tests averaged 307 pounds, worth $15.35.

Cowpeas in 2 tests averaged 229 pounds, worth $11.45.

Essex rape in 2 tests averaged 452 pounds, worth $22.50.

Sorghum in 2 tests averaged 174 pounds, worth $8.70.

One acre of the best of these crops (peanuts, rape, and chufas) afforded pasturage for one month for at least 25 100-pound shoats, when a half ration of grain was fed.

The average amounts of grain required to make one pound of growth on shoats, consuming also the crops below, were as follows:

1.77 pounds of grain with peanuts;
2.30 pounds of grain with chufas;
3.07 pounds of grain with cowpeas;
2.68 pounds of grain with rape;
3.70 pounds of grain with sorghum;
3.13 pounds of grain with sweet potatoes.

Pigs grazing on sorghum, fully headed out, ate only 12 per cent less grain per pound of growth than those supported entirely on corn.

Shoats fed on a mixture of corn meal and of 20 or 25 per cent cotton seed meal in most experiments ate but little food and made very slow growth. In other experiments they required only 3.84 and 4.68 pounds of this mixture per pound of growth.

The feeding of cotton seed meal as part of the grain ration for 34 to 38 days in most cases had a poisonous effect on shoats weighing from 59 to 118 pounds each. No ill effect was noticed prior to the thirty-third day and some pigs showed no perceptible ill effects on the thirty-second day.

Cotton seed meal caused death or sickness of shoats when constituting one-fifth or one-fourth of the grain ration whether the cotton seed meal mixture was fed alone or in connection with a bountiful supply of green sorghum or peanuts.

Calculated on a basis of 100 pounds live weight, daily doses of .25, .40, .41 and .53 of a pound of cotton seed meal for 34 to 38 days caused sickness or death; .61 of a pound daily for 35 days fed in different years to shoats of practically the same size caused evident unthrift in one experiment, while in the other no immediate effects were discernible. Shoats averaging 143 pounds in weight were not hurt by eating for 31 days .73 of a pound of cotton seed meal daily per 100 pounds live weight. Evidently the younger the pig the more susceptible they are to cotton seed meal poisoning.

The health of shoats was injuriously affected or death resulted, where, in an exclusive mixed grain ration, the amount of cotton seed meal consumed per 100 pounds of live weight reached, with the smallest shoats 9.2 pounds, and with larger shoats, 21.4 pounds; while in a third experiment 21.5 pounds of cotton seed meal was consumed per hundred weight without immediate evidences of injury, and in a fourth experiment 22.6 pounds per 100 pounds of live weight was consumed without visible effects on the health of large shoats. Where a cotton seed meal mixture was fed in connection with grazed sorghum, cut sorghum, or grazed peanuts, toxic effects were manifested when respectively 21.6, 18.9 and 17.7 pounds of cotton seed meal per hundred weight had been consumed. We obtained highly satisfactory growth when some cotton seed meal was fed for short periods to shoats while grazing peanuts.

Peanuts fed up to the date of slaughter made a very soft lard. Chufas softened the lard to an almost equal degree.

The feeding of grain of any of the kinds tested to pigs whose flesh had previously been softened by feeding on peanuts greatly solidified the lard, but the exclusive feeding of grain for 26 to 35 days just before butchering failed to make the flesh and lard as firm as that of pigs which had never consumed peanuts.

When a mixture was fed containing 20 or 25 per cent of cotton seed meal and the remainder corn meal, the melting point of the lard was 3.4 degrees F. higher than when only corn meal was fed.

Rice bran was not relished by hogs and it did not afford rapid growth.

Rice polish in 5 experiments proved superior to corn meal. One pound of growth required only 3.73 pounds of rice polish as compared with 4.74 pounds of corn meal. Hence 78.6 pounds of polish were equal to 100 pounds of corn meal for shoats.

Corn hearts proved decidedly inferior to corn meal, and to cowpea meal.

Skim milk in moderate amount saved about half of the usual quantity of grain in the ration of shoats.

INTRODUCTORY.

Hogs are profitable property. Now that the prices of live hogs and of meat are unusually high this lesson is being brought home most forcefully. Hogs were profitable even when they sold on foot at 3 to $3\frac{1}{2}$ cents a pound as they did locally when our earlier experiments, published in Bulletins Nos. 82 and 93 of this station, were under way.

Whatever the price of hogs or of pork it is necessary to the maximum profit that we make sparing use of corn in most portions of the Gulf States. We need to economize in the use of corn, not by stinting the total amount of food offered, but by making use of other crops which can be grown on certain soils at less expense or which are more effective foods. To ascertain the relative pork-producing values of some of the special hog crops and their effect on the quality of flesh and lard has been the principal aim of most of the experiments in this bulletin.

These experiments herein recorded extend over a period of four years. During the first year of this period the details of feeding and weighing were in the hands of Mr. T. U. Culver. During the last three years this part of the work has been done by Mr. R. W. Clark, recently Assistant Agriculturist of this Station. To both of these acknowledgements are due for cordial co-operation and for faithful services.

The results of seven years' experiments in growing special hog crops enable us to suggest a succession of crops of proven value to be harveted by hogs, to which list we hope to be able to add a number of others when they have been further tested, among them being alfalfa, artichokes, pumpkins and soy beans.

Succession of hay crops.

Months when used.	Crops.
January and February...	Fall-sown rape and chufas.
March 1, to April 15....	Fall-sown rape, vetch and oats, rye, wheat, etc.
April	Vetch and oats, crimson clover, oats and wheat
May	Spring-sown rape, vetch and oats, wheat and the usual pastures.
June	Spring rape, stubble fields, turf oats and the usual pastures.
July and August.....	Sorghum, early varieties of cowpeas, and the usual pastures.
September, October and November..	Spanish peanuts, cowpeas, sweet potatoes and sorghum.
December .. .	Chufas and fall-sown rape.

Among these special hog crops attention is here directed to Dwarf Essex rape, because it is so little known, so palatable, so nutritious and because it can be so effectively used at once to relieve, to some extent, the present scarcity of corn. For the successful growth of rape the land must be as rich and as highly fertilized as for turnips, and preparation, sowing and cultivation are the same as with that crop, except that rape is not thinned. Sow 3 to 5 pounds of seed per acre in narrow drills between September 20 and October 20. Seed are cheap, 10 to 12 cents per pound, and they are sold by all seedsmen. We have also sown rape in March, getting hog pasturage in May and June.

In the summary the present local price of hogs, 5 cents per pound, has been used in estimating the value of one acre of each crop when converted into pork. However, in the body of the bulletin use has been made of the local price prevailing at the time when each experiment was made.

We can estimate the increase in live weight due to one acre of some special crop only by calculating the probable approximate amount of growth due to the grain fed. The amount of grain required, when fed alone, to produce one pound of growth varies of course with many conditions, but the average of many experiments is not very far from five pounds.

In assuming this figure we have sacrificed strict accuracy to uniformity and clear presentation. Those who prefer to use a different factor will find it possible from the date in the body of this bulletin to calculate the net gains per acre of hog crop, whatever factor they select.

Growth of Pigs Before and After Weaning.

On farms where dairying is an important industry and where there is an abundance of skim milk for sow and litter, it is not unusual for the brood sow to nurse a litter of pigs without herself losing weight. In the absence of skim milk we find that the sow generally loses in weight, however bountiful the supply of grain and green material.

For example in the period between farrowing, February 24, 1899, and the beginning of the experiment April 1, a sow lost 29.6 pounds, and her litter of 7 pigs gained 67.3 pounds. During this time sow and pigs were kept in a bare lot and fed a mixture of equal weights of ground cowpeas and a very coarse grade of rice meal, which in this case consisted largely of ground rice chaff. The amount of this mixture consumed in this time was 273 pounds.

This sow and her seven pigs were confined by means of hurdles or movable panels on a field where vetch and turf oats grew together. At the end of a five weeks' period, May 6, the sow was removed and the pigs, now 10 weeks old, were continued on the same character of pasture three weeks longer, or until May 27. The herbage was more tender and succulent in the earlier periods, though its weight per acre was greater in the later period. The grain fed to the sow and pigs while they grazed on vetch pasture was corn meal.

Gains made and food consumed before and after weaning.

	Before weaning.		After weaning.	
	5 weeks.	Per week.	3 weeks.	Per week.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Growth made by 7 pigs...........	113.60	22.70	55.40	18.5
Loss in weight of sow............	19.40	3.88	....	....
Net gain in weight of sow & pigs.	94.20	18.82	....	....
Meal consumed by sow* & pigs ..	554 20	110.8	244.00*	81.3*
Lbs. meal per lb. growth of pigs..	4.88	....	4.40	....
Lbs. meal per lb. *net* gain of sow and pigs......................	5.88	....	....	....
Area of pasture grazed; square ft.	(8550)	(1710)	(3858.)	(1286)
Total weight of sow and pigs at beginning of period............	350.30	....	....	....
Total weight of 7 pigs at the beginning of each period.........	118.60	....	322	....

*Only pigs during last 3 weeks.

A pound of growth was made with less meal, 4.40 pounds after weaning; before weaning it required 4.88 pounds of corn meal for each pound of growth ,or if we deduct' from the gains made by the pigs the decrease in the weight of the sow, we find that it required 5.88 pounds of meal to make one pound of growth of sow and pigs. This is a very unsatisfactory rate of growth and probably due, at least in part, to insufficient shade.

Growth of vetch and oats after grazing—As stated above, the pigs just after weaning were penned on a mixture of hairy vetch and turf oats, sown the previous October on poor upland soil. Both oats and vetch had been delayed in growth and otherwise injured by the unprecedented cold of February, 1899. Moreover, the vetch had been injured by root-knot.

While penned on the vetch and oats the weaned pigs required, as stated in a preceding table 4.4 pounds of corn meal to make one pound of growth, in addition to the pasturage.

It is interesting to note that on the areas grazed over prior to April 21 the vetch made, after the pigs were removed, sufficient second growth to afford about two-fifths of a normal crop of excellent hay, the average yield of second-growth hay on the plots grazed between these dates being 1,278 pounds per acre. The vetch should be credited with part of the growth made by the pigs, with the hay produced as a second growth, and with the improvement of the fertility of the land which was very marked as measured by the growth of silage corn planted in June of the same year.

Dwarf Essex Rape as Food for Shoats.

From May 27 to June 23 ,1899, these same seven shoats were maintained on drilled green rape and corn meal. During the first two weeks the rape was pulled and carried to the shoats, while during the latter period the rape was grazed. The four weeks of rape feeding will be treated as one period.

The seven shoats averaged in weight at the beginning of this period 41 pounds each. The area of drilled rape used was 4190 square feet; corn meal was fed each day, averaging 1.62 pounds per pig per day, or 317.6 pounds for the seven pigs in twenty-eight days. The increase in weight was 103 pounds. Hence to make one pound of growth required 3.1 pounds of corn meal and 40.5 square feet of rape pasture. This is at the rate of 1078 pounds of growth for one acre of rape and 3324 pounds of corn meal.

If we assume that for shoats of this size fed on corn meal alone 5 pounds of this grain would have been required for each pound of growth, the acre of rape would be credited with producing alone 413 pounds of growth, worth, at 4 cents per pound, $16.52.

In addition, the rape which had been grazed made a second growth which was ready for pasturing within a month after the removal of the shoats, but which was ruined by the Harlequin cabbage bugs, or "calico backs," before it could be utilized.

The soil in which this patch of rape grew would be classed as sandy bottom land of medium grade.

Let us turn aside here from the history of this litter of pigs, which we may call litter M, to describe some tests of rape made in 1900 and 1901.

Rape as Winter Pasturage for Pigs.

Dwarf Essex Rape sown in drills on sandy upland, October 13, 1900, was ready for pasturage January 6, 1901, when four pigs from litter O, weaned three weeks before, were confined on it with hurdles which were moved about once a week. The first growth of rape afforded pasturage until March 28. The second growth, on land previously grazed over, afforded pasturage from March 28 to April 18.

Throughout the whole period that the pigs were on rape they received also about a half ration of corn meal.

Less rapid and more expensive gains were made in March, when the plants had become tough and ready to seed, than during January and February. The most rapid and economical growth was made during the brief period while the succulent second growth was being consumed.

Weight of 4 pigs January 6	130 lbs.
Weight of 4 pigs March 28	311 lbs.
Gain in 81 days	181 lbs.
Corn meal consumed in 81 days	524 lbs.
Pounds meal per pound growth	2.9 lbs.
Area of 1st growth rape grazed	13,912 sq. ft.

This is at the rate of 570 pounds of growth in live weight afforded by one acre of first-growth rape assisted by 1641 pounds of corn meal. If we assume that 5 pounds of corn meal made one pound of growth we have left 242 pounds of live weight, worth $9.68, to be credited to one acre of first-growth rape.

March 28, the rape having begun to blossom and having become relatively unpalatable, the hurdles were placed about the rape grazed in January and part of February, on which the second growth was by this time in good condition for pasturage, though small.

On this second growth the pigs remained three weeks, meantine consuming the crop on one-sixth acre and eating 168 pounds of corn meal.

The growth made during these three weeks was 82 pounds, or one pound of growth for only 2.05 pounds of meal, which figure indicates that the pigs must have derived about half their sustenance from the green crop.

One acre of second growth rape assisted by 1008 pounds of corn meal resulted in a growth of 492 pounds. If we again assume a normal requirement of five pounds of grain for one of growth we have 290 pounds of increase in live weight, worth $11.60, as the value of an acre of second crop rape when converted into pork.

It is fair to add together the gains made on an acre each of first growth and of second growth, since part of the area was grazed twice. This gives a growth of 512 pounds of pork then worth $20.48, as attributable to an acre of rape grazed twice. This is on the assumption that it would require 5 pounds of an exclusive grain ration to produce a pound of growth.

GRAZING SORGHUM, FIRST EXPERIMENT.

Let us now return to the history of litter M, which had grazed on rape until June 23, 1899.

This litter of seven shoats was grazed on sorghum from June 24 to September 2, 1899, meantime receiving daily a very small amount, about $1\frac{1}{2}$ pounds per day per shoat of a mixture of equal weights of cowpea meal and corn meal.

During this time the seven shoats made an aggregate gain of 22.44 pounds and utilized 15,374 square feet of drilled and cultivated sorghum, and also grazed the second growth on 8380 square feet, or about half of this same plot. The grain meantime consumed was 812 pounds by the lot of seven shoats, or 3.6 pounds of grain for each pound of increase in live weight.

This is equal to a gain of 635 pounds of live weight per acre of sorghum, assisted by 2298 pounds of grain. Assuming that if the grain had been fed alone 5 pounds would have been required to produce one pound of growth, we have left 195 pounds of growth attributable to one acre of first growth sorghum and to about half of the second growth on the same.

At 4 cents per pound 195 pounds of growth gives a return of $7.80 per acre of sorghum.

Doubtless the value of an acre of sorghum would have been considerably greater if the second growth on the entire area, instead of on half of it, had been utilized. It was noticed that the shoats required per week about twice as large an area of second growth as of first growth sorghum.

During a small portion of the time covered by this experiment sorghum was cut and carried to the pigs and when this was done a given area lasted much longer than when hogs were turned in to graze, in which case the waste of green food, bitten down and not consumed, was excessive.

Where labor is abundant and cheap or where the use of a corn harvester is possible it is believed that it will pay to cut and carry the sorghum to the pigs rather than to graze it.

When shoats averaging about 80 pounds received only one and one-half pounds of grain a day per head and were required to make growth chiefly on sorghum, the rate of gain was slow, being a little more than half a pound per day.

The sorghum when grazed was at the stages of growth between early bloom and complete maturity and most of it was about five feet high. The yield was rather light, the land being poor, sandy upland, moderately fertilized. The sorghum used in all our grazing experiments has been drilled and cultivated.

THE VALUE OF SPANISH PEANUTS AS PASTURAGE FOR PIGS.

In Bulletin No. 93 of this Station the writer has recorded the very satisfactory results of several experiments in grazing pigs on peanuts in 1897. The results below confirm the conclusions which we have heretofore expressed as to the great value of peanuts as food for hogs.

Peanuts and corn meal.—A litter of pigs farrowed September 1, 1899, was penned on Spanish peanuts November 4, after weaning. There was only about two-thirds of a stand of peanuts.

The total increase of live weight up to December 23 was 298 pounds, during which time 482 pounds of corn meal was consumed or 1.62 pounds of grain per pound of growth. The area grazed over was 34,944 square feet, or nearly five-sixths of an acre.

This is equal to a gain of 371.4 pounds of live weight from one acre of peanuts assisted by 601 pounds of corn meal. If we assume that it required 5 pounds of grain to produce one pound of growth and subtract this amount of pork we have left 251 pounds of increase in live weight attributable exclusively to a poor crop of peanuts on one acre. With pork worth 4 cents per pound gross this gives a value of $10.04 to an acre of peanuts converted into pork.

Peanuts, corn meal and milk.—From September 30 to November 4, 1899, account was kept of the food consumed by a sow and litter of 9 pigs farrowed September 2. The food consumed during these five weeks was as follows:

355 pounds corn meal at 1 cent	$3.55
921 pounds skim milk at $\frac{1}{4}$ cent	2.30
Total	$5.85

In addition to the above food, Spanish peanuts from one-fourth acre of land were also fed.

During this time the sow made a gain of 9 pounds, showing that on a sufficiently nutritious and palatable diet the weight of the nursing sow can be maintained. The pigs made a gain of 226.5 pounds. The total gain of sow and pigs was 235.5 pounds, making the cost of grain and skim milk for one pound of growth 2.5 cents.

Assuming that one pound of growth of sow and pigs requires 5 pounds of grain in a ration like this, and that, as in certain Wisconsin experiments, $3\frac{1}{4}$ pounds of skim milk are equal to one pound of corn, we find that per acre of peanuts, assisted by 2552 pounds of grain or its equivalent there was made an increase of 942 pounds in live weight. Deducting the amount attributable to the grain, 510 pounds, we have a balance of 432 pounds of pork as the equivalent of one acre of peanuts, then worth, at 4 cents per pound, $17.28.

Peanuts and corn meal for shoats in 1902.—Another litter of 7 shoats was penned on Spanish peanuts from October 11, 1902 to November 2, 1902. Their average weight at the beginning was nearly 100 pounds each. They made a growth of 224.5 pounds while consuming 286 pounds of corn meal and the peanuts on .47 of an acre. To produce a pound of growth required only 1.3 pounds of corn meal. This gain is at the rate of 486 pounds of live pork per acre of peanuts assisted by 632 pounds of corn meal. Assuming that five pounds of grain would make one pound of growth we have left 360.5 pounds of growth which we may attribute to one acre of peanuts alone. These shoats were sold after further experimental feeding and brought five cents on foot, making the acre of peanuts worth $18.02.

Gains made by very small pigs on peanuts alone.

A litter of seven Poland China pigs was weaned September 4, 1901, and immediately hurdled on Spanish peanuts.

After a week allowed for them to become accustomed to their new food, the experiment proper began, and continued for six weeks, during which time no grain was fed. The initial weight averaged 28.1 pounds. The gains in six weeks aggregated 156.5 pounds, which is at the rate of a little more than half a pound per day per pig. The area grazed was 13, 887 square feet. This is equivalent to a gain of 503 pounds of live pork per acre of peanuts, worth, with pork at 4 cents, $20.12.

When taken from peanuts October 31, 1901, one of these pigs, No. 12, was butchered and the melting point of the lard determined.

Peanuts and corn meal in 1899.—On September 2, 1899, a lot of seven shoats previously supported on sorghum and on a diet of corn and cowpeas (see p. 14) was transferred from sorghum to Spanish peanuts, and to make a properly balanced ration the grain was changed to corn meal.

During the next four weeks the lot of seven pigs made gains of 120.7 pounds while consuming 333 pounds of corn meal and the peanuts on 10,593 square feet. This is at the rate of 496 pounds of growth produced by an acre of peanuts assisted by 1356 pounds of corn meal. If 5 pounds of grain alone would have produced one pound of growth there remains 225 pounds of pork, worth $9.00, as the value of an acre of peanuts converted into pork. Besides the peanuts there was required 2.73 pounds of corn meal to produce a pound of growth.

A week after the close of this period these seven pigs, all of one litter, were divided into several lots, one lot continuing to graze on peanuts, a second lot grazing on chufas with grain as stated further on, a third lot being penned and fed on a mixture of cotton seed meal and corn meal, and the remaining pig together with one of a different litter being fed in a pen on corn meal alone.

..*Peanuts and corn meal in* 1899, *second period.*—For five weeks certain of these pigs were hurdled on a field of Spanish peanuts. During the last three weeks of this grazing period they gained in weight at the rate of 293 pounds per acre of peanuts, assisted by 274 pounds of corn meal, or one pound of growth for .94 of a pound of corn meal. Crediting the corn meal as before we have left 247 pounds of pork, then worth $9.88, as apparently attributable to one acre of peanuts.

GAINS MADE BY YOUNG PIGS ON CHUFAS.

From November 19 to December 17, 1898, nine Berkshire pigs were hurdled on a field of chufas where there was only a poor stand of plants. They were also fed a little grain, mixed corn and cowpea meal, of which only 262 pounds was fed during the four weeks. The increase in weight was 121.1 pounds and the area grazed over was 7986 square feet. This is at the rate of 660 pounds of live pork per acre of chufas assisted by 1429 pounds of grain or one pound of growth for 2.17 pounds of grain. Attributing one pound of growth to five pounds of grain we have left 374 pounds of increase in live weight as apparently due to one acre of peanuts alone. Hogs were then selling at 3½ cents per pound on foot, so that the acre of chufas when converted into pork was worth $13.09.

PEANUTS VERSUS CHUFAS VERSUS MIXED GRAIN.

Four lots of pigs (from litters N and P.) were fed for twenty-five days, October 19 to November 13, 1900, as follows:

Lot A.—Spanish peanuts, grazed, and a half ration of mixed grain.

Lot B.—Spanish peanuts grazed, without grain.

Lot C.—Chufas grazed and a half ration of mixed grain.

Lot D.—Mixed grain alone, fed in bare lot, as much grain as shoats would clean up.

The grain fed to Lots A. C. and D., consisted of one-third by weight of ground cowpeas and two-thirds ground corn.

The table below gives the data for the last 18 days of the experiment, the preceding week being regarded as preliminary and as needed to fully accustom all lots to their food. At the beginning of the experiment proper lots A, B, C, and D, weighed respectively 363, 256, 318 and 392 pounds.

Growth made by each lot of 3 pigs and food consumed in 18 days.

Lot.	Area grazed.	FOOD.	Grain eaten.	Incr'ase in live weight.	Lbs. grain for 1 lb. growth.
	Square ft.		*Lbs.*	*Lbs.*	*Lbs.*
A	8,344	Spanish peanuts, grazed Mixed grain, ½ ration..	152	81	1.88
B	12,448	Spanish peanuts, grazed	....	22	....
C	7,937	Chufas, grazed .... Mixed grain, ½ ration..	152	79	1.92
D	....	Mixed grain, full ration	304	70 5	4.31

Chufas and peanuts in this test were nearly on an equality, and when half a ration of grain was fed with either there was required only 1.92 or 1.88 pounds of grain to produce one pound of groth. As compared with the exclusive grain ration this represents a saving of 56 per cent of the grain by the use of either chufas or peanuts.

Spanish peanuts without grain afforded a very slow growth, and the increase in live weight was only 76¾ pounds for each acre of peanuts. This is an abnormally poor return and due in part to the poor growth and poor stand of peanuts.

With live pork at 4 cents per pound this gives only $3.03 as the returns per acre when no grain was fed, a result entirely unsatisfactory.

A much larger return was made when peanuts were supplemented with a half ration of grain. With lot A, the gain due jointly to one acre of peanuts and to 791 pounds of corn was 423 pounds of live pork. Dividing the amount of grain fed to this lot by 4.31, the amount required per pound of growth when nothing but grain was fed, we have 184 pounds of live weight as apparently due to the grain fed; subtracting this from the total increase in live weight we have left 239 pounds as the amount of growth that we may credit to one acre of peanuts. With pork at 4 cents per pound this gives $9.56 as the value of an acre of peanuts converted into pork.

An acre of chufas supplemented by 832 pounds of grain produced 433.5 pounds of live pork and by the same process as above we calculate that one acre of chufas should be credited with 240½ pounds of pork, or $9.62.

This experiment agrees with a previous one, reported in Alabama Station Bulletin No. 83, p. 118, in showing that it is more profitable to feed some grain to small shoats grazing on peanuts than to require them to make their entire growth from the nuts.

The following table shows the daily gain per pig, the grain consumed daily per 100 pounds of live weight and the number of days of pasturage afforded by one acre of peanuts or chufas. In calculating the last two columns the average of the live weight at the beginning and end of the experiment has been used.

Peanuts and chufas as pasturage.

Lot.	Food.	Daily gain per pig	Grain consumed daily per 100 lb. live weight.	Pasturage on 1 acre for a 100 lb. shoat.
		Lbs.		*Days.*
A	Peanuts, and ½ grain ration..	1.50	2.58	850
B	Peanuts, alone...............	.41	....	463
C	Chufas and ½ grain ration....	1.46	2 99	827
D	Full grain ration............	1.31	4.67	....

The rate of gain, nearly one and one-half pounds per day per head, was satisfactory except for the lot receiving no grain, with which the daily growth was only .41 of a pound per head.

The second column shows that when shoats were "hogging off" peanuts or chufas they made good use of 2.58 pounds and 2.99 pounds respectively of grain daily for every hundred pounds of live weight.

The third column shows that an acre of peanuts, without grain, afforded pasturage at the rate of 463 days for a hundred pound shoat, which is equal to 15 such shoats for one month. In 1899 when receiving about one-fourth of a normal grain ration pigs grazing on inferior peanuts made moderate gains when the field was stocked at the rate of 13 100-pound shoats for one month. When a half ration of grain was fed the peanuts or chufas lasted nearly twice as long, the rate of pasturing per acre for every 100 pounds of live weight being 850 days for peanuts and 827 days for chufas, equal to the support for one month of 28 100-pound shoats on an acre of peanuts and of 27 on an acre of chufas.

EFFECTS OF PEANUTS, CHUFAS AND COWPEAS ON FIRMNESS OF LARD.

At the conclusion of the two experiments just described one barrow from each of the four lots was killed, November 14, 1900, and lard rendered from the fat taken from the jowl of each. The melting points of these samples of lard were determined by Prof. C. L. Hare of the Chemical Department.

Effect of peanuts and chufas on melting point of lard.

Lot.	Food during 26 days before butchering.	Food fed prior to 26 days before butchering.	Melting point of fat. Deg's C.	Melting point of fat. Deg's F.	Increased hardness over lot B Deg. F.
A	Peanuts, ground cowpeas and corn.	Sorghum grazed Ground cowp's & corn	28.0	82.4	10.8
B	Peanuts, alone	Sorg'm graz'd; pean'ts	22 0	71.6	....
C	Chufas and ground cowpeas and corn..	Cowpeas grazed......	27 5	81.5	9.9
D	Ground cowpeas and corn.....	Ground cowpeas and corn	30.0	87.0	15.6

The half ration of one-third cowpeas and two-thirds corn meal fed to lot A, for several months immediately before butchering raised the melting point 10.8 F. for the lard of pigs fed partly on peanuts as compared with pigs that had received no grain, but only peanuts for several months. This grain ration fed alone to lot D afforded a lard which was firmer by 15.6 degrees F. than that from pigs which up to the day when killed had consumed peanuts.

In this test sorghum shows no marked tendency to soften the lard, at least when its use was discontinued nearly a month before the hogs were killed. Additional tests are required to determine its effect, if any, in this respect when fed up to the last day.

The cowpea evidently afforded a rather firm lard, but our tests do not show exactly how it compared with corn in this respect.

GRAZING SORGHUM AND COWPEAS.

September 14th, 1900 twelve pigs recently weaned (litters N and P.) were divided into four lots of three pigs each. The different lots were quite evenly matched in all essential respects and weighed respectively 175.5, 176.5, 170.5 and 193 pounds per lot. The experiment lasted five weeks in addition to the preliminary period.

Lot A was confined by means of movable hurdles on drilled sorghum, in dough and ripening stages, and was supplied with what was regarded as a half ration of a mixture of two-thirds corn meal and one-third cowpea meal by weight.

Lot B was penned on sorghum alongside of lot A; no grain was furnished to this lot, but instead ripe Spanish peanuts were pulled and thrown in the pen daily in quantities estimated as furnishing about a half ration of peanuts.

Lot C was hurdled on drilled Whippoorwill cowpeas on which the pods were ripe, and this lot received no other grain.

Lot D was confined in a small bare pen and furnished with as much as the pigs would consume of the same grain mixture as that supplied to lot A.

Grain eaten, area of sorghum, cowpeas, and peanuts grazed, and growth made in five weeks by three pigs in each lot.

Lot.	FOOD.	Grain eaten.	Increase in live weight.	Lbs. grain for 1 lb. growth.
		Lbs.	*Lbs.*	*Lbs.*
A	Corn and cowpea mixture...	244	74.5	3.28
	4872 sq. ft. of sorg'm, grazed	....	....	....
B	4872 sq. ft. of sorg'm, grazed	....	53 5	....
	29905 sq. ft. of Sp. peanuts.	....	....	....
C	17964 sq. ft. ripe cowpeas...	....	50 5	....
D	Corn and cowpea mixture ..	464	124	3 74

Evidently sorghum was in this case of very slight value; for with lot A sorghum saved only 12 per cent of the grain required by lot D to make a pound of growth. Equally unsatisfactory was the growth of lot B, which was made to subsist entirely on sorghum supplemented by peanuts grown without fertilizer between corn rows on very poor sandy land.

Lot C grew at the rate of 122.5 pounds of live weight per acre of cowpeas, which, at 4 cents per pound, gives $4.90 as the value of an acre of a moderate crop of ripe cowpeas when converted into pork.

The waste was very great, the peas falling on the ground and sprouting before being consumed. In a former experiment (Bulletin No. 93) in which some corn was furnished to shoats grazing on nearly ripe cowpeas the results were far more satisfactory, one acre of cowpeas assisted by 1578 pounds of corn making 730 pounds of live pork. If we assume that each five pounds of grain formed one pounds of growth, we have 336 pounds of live pork, worth at 4 cents $13.44, as the value of an acre of cowpeas alone converted into pork in that test, while in this one an acre of cowpeas alone made much less.

Lot D made a very satisfactory growth on the mixture of one-third cowpea and two-thirds corn meal, only 3.74 pounds of this mixture being required to make one pound of growth. The rate of growth was several times more rapid than with the pigs dependent entirely upon cowpeas or upon sorghum and peanuts, and considerably more rapid than with lot A, which received a limited ration of grain and an unlimited supply of sorghum.

The average daily gain per shoat was 1.18 pounds when a full ration of mixed cowpea and corn meal was fed. The average daily consumption of this grain *per 100 pound of live* weight was 5.19 pounds.

COTTON SEED MEAL IN THE GRAIN RATION.

November 13, 1900, after the conclusion of the experiment just described, one pig from each of lots B, C, and D was kept for five weeks on an exclusive grain diet made up of one-fourth by weight of cotton seed meal and three-fourths corn meal. They were given all they would eat but did not relish the food.

During the five weeks they gained 67.5 pounds, requiring 4.68 pounds of food per pound of growth. This is an average daily gain of .64 of a pound per head. Near the end of the fifth week the attendant noted the unthrifty appearance of the pigs, but no death occurred.

The amount of cotton seed meal which had produced sickness but not immediate death, was 25.5 pounds per shoat of an average weight of 117.6 pounds. Hence the toxic dose of cotton seed meal was here, per 100 pounds of live weight, 21.4 pounds, of .61 of a pound per day for 35 days.

After eating this grain, containing 25 per cent of cotton seed meal, for five weeks the pigs were slaughtered and a sample of lard from the fat of the body was examined by Prof. C. L. Hare, who found the melting points to be as follows:

Melting point of lard from cotton seed meal ration.

Lot.	Food during last 5 weeks of life.	Food second month before butchering.	Melting point of lard Deg. F.
B	{ ¼ cotton seed meal.. ¾ corn meal......	Peanuts, alone	87.4
C	do.............	Chufas, &c. { ⅓ cowpea meal ⅔ corn meal..	82.8
D	do.............	Full ration { ⅓ cowpea meal ⅔ corn meal...	84.9

The lard from some pigs in lot B had melted at 71.6° F., immediately after the pigs were taken from a peanut pasture; now, after five weeks feeding of a ration containing 25 per cent of cotton seed meal, the melting point has risen to 87.4 degrees, a hardening effect of 15.8 degrees attributable to this food. This cotton seed meal and corn meal mixture did not very greatly increase the hardness of the lard of the lots which had been receiving a partial or exclusive grain ration for a number of weeks before the cotton seed meal feeding was begun.

COTTON SEED MEAL (25 PER CENT) IN THE RATION OF PIGS.

In the fall of 1899 three Poland China shoats from the same litter, previously maintained on peanuts with a light ration of corn meal, and an Essex pig previously consuming ordinary pasturage and corn, were penned. Two of the Poland Chinas were fed all they would eat of a mixture of one-fourth cotton seed meal and three-fourths corn meal. The third Poland China and the Essex shoat were fed in separate pens on corn meal alone.

A mixture of cotton seed meal and corn meal versus corn meal alone.

Lot No.	Food.	Average weight per pig during experiment.	Growth per pig.	Grain eaten per pig.	Lbs grain per lb. growth	Daily ration per 100 lbs. live weight.	Daily growth per pig.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
3 (P. C.)	¼ cotton s. meal, ¾ corn meal. . .	113 1	14.3	97.7	7 11	2.46	.41
4 (P. C.)	Corn meal	121 5	21	128 8	6.13	3 02	.60
5 (Es.)	Corn meal.	97.5	58.5	200.0	3.43	5.86	1.67
Av. 4 & 5	Corn meal	109.5	39.7	164.4	4 13	4.28	1 13

None of the Poland China pigs (lots 3 and 4) ate sufficient grain for rapid growth when changed from peanuts to an exclusive grain diet. As a result of the small daily consumption of food slow growth was made by lots 3 and 4, with the almost inevitable result that the increase in live weight was made at a financial loss. It required 7.11 pounds of the mixture containing cotton seed meal or 6.13 pounds of corn meal alone to make one pound of growth, both figures showing unsatisfactory rates of growth.

The cotton seed meal mixture was decidedly unprofitable, but up to five weeks it was not preceptibly injurious to health. During these 35 days the amount of cotton seed meal consumed per 100 pounds live weight was .61 of a pound daily or a total of 21.5 pounds.

EFFECT OF PEANUTS, CHUFAS, CORN MEAL AND COTTON SEED MEAL ON QUALITY OF LARD.

After the conclusion of certain experiments previously described, (grazing peanuts and feeding cotton seed meal in comparison with corn meal) the pigs thus fed were butchered.

Samples of the lard made from the bodies of these pigs and from others which had subsisted for some months on chufas, supplemented by a light ration of grain, were tested by Prof. C. L. Hare of the Chemical Department to learn the temperature necessary to melt the lard.

Melting point of lard from various foods.

Pig No.	Food during 5 weeks just before butchering.	Food fed prior to 5 weeks before butchering.	Melting point of fat.	Average melting point of fat
			Degrees F.	*Degrees F.*
84	Peanuts...........	Peanuts	73 5	....
86	Peanuts...........	Peanuts......	75.7	....
Av. 84 & 86	Peanuts...........	Peanuts......	....	74.6
87	Chufas	Peanuts......	75.2	....
89	Chufas	Peanuts......	74.6	....
Av 87 & 89	Chufas	Peanuts......	....	74.9
88	¾ corn meal, ¼ cotton seed meal	Peanuts......	84.2	....
90	¾ corn meal, ¼ cotton seed meal....	Peanuts......	84	....
Av. 88 & 90	¾ corn meal, ¼ cotton seed meal....	Peanuts......	....	84.
85*	Corn meal..........	Peanuts......	80.7	80.7
E.	Corn meal (Essex)..	Corn and grass pasturage..	86.0	....

*This pig was from same litter as Nos. 84 ,86, 87, 88, 89 and 90.

It is well known that peanuts produce a soft lard. When the feeding of peanuts was continued uninterruptedly up to the date of slaughter the resulting lard melted at the low temperature of 74.6 degrees Fahrenheit, or at the temperature of an ordinary living room in spring. It has been claimed that by feeding entirely on corn for a few weeks before the date of butchering, the flesh and lard can be brought to the normal degree of hardness. This was not the case in this experiment. By discontinuing the peanuts five weeks before the hogs were killed and feeding thenceforward exclusively on corn meal we succeeded in raising the melting point to 80.7 degrees Fahrenheit, an increase of 6.1 degrees Fahrenheit. This lard, however, was still much softer than that from hogs never fed on peanuts. In a similar experiment in 1897-'98 (see Bulletin No. 93) the feeding of corn during the four weeks immediately preceding the time of butchering effected a considerably greater increase in the melting point of lard from the pigs previously fed on peanuts, but in that test as in the present one, the feeding of corn during a short period did not make the resulting lard equal in firmness to that made by continued feeding of corn.

In this experiment the lard produced by feeding chufas was practically as soft as that obtained from peanut-fed pigs.

After ascertaining in a previous experiment that the melting point of lard from peanut-fed pigs could not be raised to the normal degree of firmness by feeding exclusively on corn during the month immediately preceding death, search was made for some food which might have a greater effect in solidifying the flesh and lard. Cotton seed meal seemed worthy of a trial for this purpose as it has been shown to increase the firmness of butter, and as a few determinations appear to indicate that it produces tallow and suet with a high melting point. Unfortunately no safe method of feeding to hogs for a long period any considerable proportion of cotton seed meal has yet been entirely demonstrated. In small amounts it may be fed for four weeks, or even a little longer without causing death.

In this experiment a mixture of one pound of cotton seed meal to three pounds of corn meal was fed during the five weeks before the date of butchering to pigs which prior to this time had grazed on peanuts. The effects of the food containing cotton seed meal was to raise the melting point of the resulting fat to 84.1 degrees Fahrenhiet. This is a gain of 9.5 degrees as compared with an uninterrupted diet of peanuts. The cotton seed meal mixture afforded lard which required for melting a temperature of 3.4 degrees Fahrenheit higher than that necessary with fat produced by feeding corn meal alone during the same length of time.

The result of this experiment is encouraging as indicating the superior hardening power of a mixture of cotton seed meal and corn meal over corn meal alone. The lard from the pigs fed for six weeks on this mixture was practically as firm as that obtained in this experiment from an Essex pig that had never eaten peanuts, but it was not so firm as the lard produced in the corresponding experiment of 1897-'98 from pigs fed uninterruptedly on corn. (See Alabama Station Bulletin No. 93, p. 30.)

Cotton seed meal as food for hogs in connection with corn meal and sorghum or peanuts.

On September 14, 1901, a litter of six thoroughbred Poland China pigs, farrowed April 2, was divided into three lots and these were fed as follows:

Lot I,grazed on drilled sorghum, (blooming to ripe stage), and a half ration of grain, as below.

Lot II, in dry lot, fed sorghum from same field, cut into lenghts of 1 to 2 inches, and also fed grain like lot 1.

Lot III, grazed on Spanish peanuts and given same grain as other lots.

All three lots received in addition to sorghum or peanuts a mixture of one-fifth cotton seed meal and four-fifths corn meal, which was not greatly relished and of which the pigs in a dry lot could not be induced to eat as much as was desirable. This lot also ate far less sorghum than was desired.

After a week of preliminary feeding the experiment began September 20 and continued until the last week in October.

Sorghum, grazed and soiled, versus peanuts grazed.

Lot.	Pig No.	Weight Sept. 20 Each.	Weight Sept. 20 Total.	FOOD.	Daily gro'th per pig.	Total growth.	Grain consumed.	Lbs. gr'n per lb. growth.
					Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
I	1	61.	135.5	Sorghum grazed; cotton seed meal & corn meal.	.53	36	140	3.80
	2	74 5						
II	3	67	124.5	Sorghum in pen; cotton seed meal and corn meal	.11	8.5	94	11.05
	4	57.5						
III	5	71	135.5	Peanuts grazed; cotton seed meal & corn meal.	.94	72.5	134	1.85
	6	64.5						

During the experiment lot I grazed over (with great waste) 2203 square feet of sorghum and lot 3 consumed the peanuts on 3880 square feet; 782 pounds of green, cut sorghum were offered to lot II but only 372 pounds were consumed. Reducing these results to the basis of one acre we have the

Growth made on one acre of sorghum or peanuts.

	Pasture Crops.	Growth per acre of green food.	Grain per acre of green food.	*Growth attributable to 1 acre green food.
		Lbs.	*Lbs*	*Lbs.*
Lot I.	Sorghum grazed; and grain..	707	2768	153
Lot II.	Sorghum fed; and grain.....	210	2323	loss
Lot III.	Peanuts grazed; and grain..	814	1504	513

* On the assumption that 5 lbs. of grain made 1 pound of growth.

To produce one pound of growth, there was required 3.8 pounds of grain in connection with sorghum pasturage, only 1.85 pounds of grain in connection with peanuts and 11.05 pounds of grain when cut sorghum was fed in a dry lot.

The financial results are quite satisfactory for peanuts, one acre of which is estimated as producing 513 pounds of live pork, worth at 4 cents per pound, $20.52. An acreof sorghum grazed is estimated as affording 153 pounds of live pork worth $6.12, while sorghum fed to pigs in a pen was consumed in quantities too small to give any measureable financial results.

Effect of a 20 *per cent. cotton seed meal mixture on health of pigs.*—A mixture of one-fifth cotton seed meal and four-fifths corn meal was fed as just stated, in connection with sorghum or peanuts continuously from September 14. All went well until October 24, when pig No. 1 in lot II died suddenly. Three days later the other pig in lot 1 died and also both pigs in lot II. October 28 the use of cotton seed meal was discontinued with lot III, which had thus far shown no symptoms or sickness or unthriftiness, but which, as the subsequent history of one of these pigs shows, had been injured by the use of cotton seed meal. One of these pigs, No. 6, from the lot grazing on peanuts was used in a subsequent experiment, in which he died, though not given any more cotton seed meal. The other one was butchered October 28 and samples of fat were taken from this one, as well as from one of the pigs that died in each of the other two lots.

Let us calculate the amounts of cotton seed meal which constituted a dangerous ration when fed for about six weeks.

Amounts of cotton seed meal causing death of shoats when fed with corn and sorghum or peanuts.

	Lot I. Mixed grain and sorghum (grazed.)	Lot II. Mixed grain and sorghum (fed.)	Lot III. Mixed grain and peanuts (grazed.)
	Lbs.	*Lbs.*	*Lbs.*
Total grain per head daily............	2 06	1 27	1 76
Total grain per 100 lbs. av. live weight	2.67	2 00	2 05
Cotton seed meal per head daily......	.41	.25	.35
Cotton seed meal daily per 100 lbs. av. live weight.....................	.53	.40	.41
Total amount cotton seed meal (incl'g preliminary week)................	16.60	12 20	15.20
Total amount cotton seed meal per 100 lbs. av. live weight................	21.60	18.90	17.70

From this table it may be seen that a daily ration containing one-fourth pound or more of cotton seed meal per 100 pounds of average live weight was fatal when continued for about six weeks. No deaths occurred until the small shoats (averaging about 64 pounds) had each consumed 12.2 pounds of cotton seed meal. Per 100 pounds of liveweight the minimum fatal quantity was 18.9 pounds.

EFFECTS OF A 20 PER CENT COTTON SEED MEAL MIXTURE AND OF SORGHUM AND PEANUTS ON MELTING POINT OF LARD.

Lard was rendered from samples of fat taken from the neck and also from around the kidneys of one pig in each of the lots just referred to. The melting points of the lard were as follows:

Effect of cotton seed meal on melting point of lard.

Food.		Lard from kidneys	Lard from jowl
		Deg. F.	Deg. F.
Sorghum grazed; ½ ration of	{ $\frac{1}{5}$ cotton seed meal.. { $\frac{4}{5}$ corn meal........	115.2	87.4
Sorghum fed,	do	115.2	85.3
Peanuts grazed,	do	99.7	80.6

It is evident that peanuts afforded a much softer lard than did sorghum, even when each constituted only about half the ration. The feeding of somewhat less than a half ration of mixed cotton seed meal and corn meal (1 to 4) for five weeks while peanuts were being grazed, failed to overcome the softening effects of peanuts.

In two experiments already recorded in this bulletin the body lard from pigs getting only peanuts melted at temperatures of 74.6 and 71.6 degrees Fahrenheit; the feeding of a small amount of a mixture of cotton seed meal and corn meal for five consecutive weeks while peanuts were being eaten in this test raised the melting point to 87.4 degrees, a gain of 12.8 and 15.8 degrees.

This increase of 12.8 to 15.8 degrees in hardness is somewhat greater than had previously resulted from feeding a stronger cotton seed meal mixture for six weeks after the peanuts were discontined (see Experiment on p. 29.)

On the whole these experiments viewed together indicate that greater hardening effect results from the grain when fed with the softening food (as peanuts or chufas) than from that fed as the exclusive ration in the six weeks just before the date of butchering. This is also practically the conclusion reached by Bennett in Arkansas Bulletin No. 65.

COTTON SEED MEAL VERSUS COWPEA MEAL AND VERSUS CORN MEAL AS A FINISHING FOOD.

Six pigs from one litter which had subsisted for six weeks after weaning on a field of Spanish peanuts without any grain, were later divided into three lots and fed for 37 days (including the preliminary period of 7 days) as much as they would eat of the rations mentioned below:

Food consumed and growth made in 30 days.

	FOOD.	Grain eaten.	Growth made.	Lbs. grain per lb. growth.
		Lbs.	*Lbs.*	
Lot III	$\frac{1}{3}$ cowpea meal, $\frac{2}{3}$ corn meal....	95.3	19	5.00
Lot IV.	Corn meal	140 0	29	4.82
Lot V.	$\frac{1}{5}$ cotton seed meal, $\frac{4}{5}$ corn meal ...	92.0	16.5	5.57

All three lots made but slow growth, which we may attribute in the case of lots III and V to the relative unpalatability of the mixture containing either cowpeas or cotton seed meal. Corn meal was more relished and hence in this brief experiment more satisfactory, though in previous experiments a mixture of cowpeas and corn has been superior to either alone, and especially so when the feeding period has been a long one.

EFFECTS ON HEALTH.

After 37 days' feeding of the 20 per cent. cotton seed meal mixture, No. 13, one of the pigs in Lot V, died, after having appeared gaunt and weak for two days. This death and the unthrifty appearance of the other pig receiving cotton seed meal notified us that it was time for the experiment to close. The pigs in the other pens remained healthy. All were butchered as soon as the experiment was stopped, and samples of fat were taken and rendered into lard.

Up to the time of the death of one pig and the evident unthriftiness of another, the pigs in Lot V, averaging at the middle of the period 59.4 pounds per head in weight, had each consumed since the seventh of November 5.4 pounds of cotton seed meal. This is equivalent to saying that toxic effects were evident when for each 100 pounds of average live weight 9.2 of cotton seed meal had been consumed. During the experiment proper the average daily consumption of cotton seed meal was .25 of a pounds per 100 pounds of live weight. It will be recalled that when the same mixture was fed in an earlier experiment to somewhat larger, but young shoats, the daily consumption of .41 of a pound per 100 pounds live weight resulted fatally. In a still earlier experiment with still larger shoats, cotton seed meal was consumed at the rate of .61 of a pound daily per 100 pounds of live weight, for 35 days; no immediate conspicuous injury resulted, and observations on subsequent effects were prevented by the disposition made of the pigs.

Effects on quality of lard of small shoats fed on cowpea meal and cotton seed meal.

Lot.	Pig No.	Food for last 37 days of life.	Food from Sept. 14 to Oct. 31.	Lard from kidneys Degrees F.	Lard from jowl. Degrees F.
......	12	Peanuts alone......	Peanuts [kil'd Oct.31]	**82.6**	**68.2**
III.	11	{ 1/8 cowpea meal... 2/3 corn meal.....	Peanuts....	81.5	72 0
III.	8	do	do	79 9	72.5
III.	**Av.**	do	do	**80.7**	**72.3**
IV.	10	Corn meal.	do	88.3	78.8
IV.	9	do	do	77 2	72.4
IV.	**Av.**	do	do	**82.7**	**75.6**
V.	7	{ 1/5 cotton seed meal 4/5 corn meal......	do	90.0	70.3
V.	13	do (died.)	do	83.3	64.4
V.	Av.	do	do	86.7	67.4

The lard from all lots had a very low melting point for grain fed animals, probably due in part to small size and extreme immaturity of the pigs as well as to the softening effects of peanuts in an earlier period. We may safely discard the melting point of the jowl lard fat of Lot V, as probably being influenced by accidental conditions, possibly by variations in the percentage of moisture or other impurities left after rendering. Shutt has observed that unthrifty pigs have soft pork, which condition may constitute the explanation of the low melting points in Lot V.

The kidney lard was firmest when the cotton seed meal mixture was fed, the advantage in favor of this food being 4 degrees F. as compared with corn meal.

Corn meal afforded a slightly firmer lard, both from kidneys and jowl, than did a mixture of cowpeas and corn meal.

As compared with the lard obtained from No. 12 (immediately after feeding peanuts), the cowpea mixture and cornmeal scarcely affected the melting point of the kidney lard, but increased that of the jowl lard by 4.1 and 7.4 degrees F. respectively.

The cotton seed meal mixture raised the melting point of kidney lard 4.1 degrees F. above that of pure peanut lard from kidney fat.

Apparently 37 days was too short a period for any of the grain foods to thoroughly harden pork once softened by peanuts. The tendency of our experiments and of those made by Bennett, in Arkansas, is to show the need for a longer hardening period than is generally regarded as necessary, or else the feeding of some grain while the peanuts are being consumed.

COTTON SEED MEAL MIXTURE VERSUS CORN MEAL—FOURTH EXPERIMENT.

Shoats which had grazed for 23 days on peanuts in October, 1902, were then penned and divided into two lots. One lot was fed on corn meal alone, the other on a mixture of three-fourths corn meal and one-fourth cotton seed meal. The average weight per shoat during the experiment was 136.3 pounds for those getting corn meal, and 142.8 ponuds for those on the cotton seed meal diet. The amounts of food consumed by the two lots were practically identical. Omitting the preliminary period, the results for the next 28 days were as follows:

Food.	*Daily growth per pig.* *Lbs.*	*Grain, per lb. growth* *Lbs.*
Corn meal	1 1	5 31
¼ cotton seed meal, ¾ corn meal	.8	3 .84

In this experiment the rations containing 25 per cent. of cotton seed meal caused much more rapid and economical growth than corn meal alone.

Throughout the 31 days during which cotton seed meal was fed the health of the shoats was good. The shoats getting the mixed rations consumed daily, per 100 pounds of mean live weights, .73 of a pound of cotton seed meal. Their total consumption of cotton seed meal in 31 days, including the preliminary period, was 22.6 pounds per 100 pounds of live weight.

Comparing this result with those previously recorded let us note the increasing amount of cotton seed meal per 100 pounds of live weight which may be safely fed as the pigs increase in size.

EFFECT OF COTTON SEED MEAL, CORN MEAL, AND RICE POLISH ON LARD.

In the following table are recorded the results of determinations, made by Mr. A. McB. Ransom of the Chemical Department, of the melting point of lard from the jowls.

The pigs were Poland Chinas from the same litter, but were not butchered on the same date.

Melting point of lard.

		Food during 31 days before slaughtering.	Food from 55th to 32d day before slaughtering.	Melting point of body lard. Deg. F
Lot F.	No. 101	Corn meal............	Peanuts & corn meal.	76.1
"	No. 102	do	do	79.9
"	Average	do	do	**78.0**
Lot G.	No. 103	{¼ cotton seed meal, ¾ corn meal.......	do	80 1
"	No. 104	do	do	82 6
"	Average	do	do	**81.4**
	105	Rice polish [last 8 weeks]	Peanuts and corn meal [23 days]]	**74.2**
	106	Rice polish [8 weeks]	Grain ration	78.3
	107	Corn meal [8 weeks]..	Grain ration..........	85.1
	108	Corn and skim milk *	Peanuts & corn meal, [23 days]...........	76.1

*Only small amounts of skim milk were used and for only 19 days.

In this test the feeding for 31 days of corn meal raised the melting point of lard (previously softened by peanuts) by only 3.8 degrees F.The feeding for the same time of a mixture containing 25 per cent. of cotton seed meal raised the melting point by 7.2 degrees F. The lard afforded by the cotton seed meal ration was firmer than that from corn meal, the melting point of the former (81.4 degrees F.) being 3.4 higher.

This last result, together with other experiments described in previous pages, indicates that cotton seed meal has an appreciable value for hardening the lard and doubtless also the flesh of pigs raised on peanuts, chufas, and most other softening foods. This will be an important point in its favor when hog raising for sale, as well as for home consumption, becomes an important industry in Alabama; for the buyer for a packing house will not knowingly buy hogs with soft flesh.

There is every reason why those sections of Alabama where peanuts thrive should at no distant date ship carloads of hogs to packing houses in Birmingham, Atlanta, New Orleans, or other markets, provided the flesh can be hardened. In many counties the sale of hogs and of hog products could easily be made to bring in as much money as the cotton crop. Cholera is not an insuperable obstacle. Keeping hogs off the public range, away from flowing streams of cholera-infected water, an understanding of the nature and means of spreading of this disease, and judicious feeding and care, will greatly reduce this danger.

Hog raising requires little capital and brings its returns quickly. Improved blood, food, care, and knowledge are capable of making the Alabama hog, as well as his relative in the corn belt, a "mortgage lifter."

SWEET POTATOES FOR HOGS.

From November 13 to December 18, 1900, a period of 35 days, two shoats were penned on sweet potatoes growing on poor sandy soil, and furnished daily per head with 2 pounds ground corn and 1 pound ground cowpeas, which was regarded as a half ration. The total weight at the beginning of the test was 231 pounds, and during the five weeks the two shoats made a total gain of 67 pounds, requiring besides sweet potatoes, 3.13 pounds of grain per pound of growth.

The potatoes were not eaten with much relish, and after being rooted up they were left on the surface, some of them remaining there until they decayed. Probably the waste would have been less if less grain had been fed. The composition of the sweet potato leads us to expect that it would be advisable not at any time to confine shoats to sweet potatoes alone, but to give them while on the potato field a little nitrogenous food, such as cowpeas, peanuts, etc.

CORN HEARTS VERSUS COWPEA MEAL VERSUS CORN MEAL.

For a period of seven weeks, in addition to a week of preliminary feeding, in January and February, 1899, these food stuffs were compared, each being fed in connection with an equal weight of rice bran obtained from Ernst & Co., New Orleans. There were three lots of recently weaned pigs, each lot containing three pigs. All the pigs except one were from the same litter, and were crossbred Berkshire—Poland Chinas.

The unusually cold weather of this time, inadequate pig pens, and the rather unpalatable nature of all the rations, due to the admixture of rice bran, made the rates of growth slow and unsatisfactory.

Growth and food eaten in seven weeks.

Food.	Total growth, lbs.	Food eaten, lbs.	Lbs. food per lb. growth.
Pen 4—50% corn hearts and 50% rice bran..	65	479.5	7.38
Pen 5—50% cowpea meal and 50% rice bran.	80.6	478.5	5.95
Pen 6—50% corn meal and 50% rice bran....	98.1	540.0	5.50

The ration containing corn meal was the most effective one, probably because of its greater palatability, hence the larger amount consumed.

According to partial analyses made in the chemical laboratory here the rice bran used contained 9 per cent. of protein, and the corn hearts 8.9 per cent. of protein.

RICE POLISH AS A FOOD FOR PIGS.

The high price of corn during 1902 made it desirable to look for some substitute in addition to such materials as can be grown on the farm. Hence rice polish was employed in a number of experiments and was tested in comparison with corn meal. In different experiments these two foods were used alone or each combined with corresponding proportions of other foods. Each lot consisted of three pigs, usually recently weaned. In all cases the food was fed dry.

Rice polish versus corn meal in connection with skim milk.—In the first experiment, made in the spring of 1902, skim milk was fed in connection with either corn meal or rice polish. The results were as follows:

Food.	Growth, 3 pigs, in 5 weeks.	Lbs. grain per lb. growth.	Lbs. skim milk per lb. growth.
Corn meal and skim milk............	89.5	2.1	4.65
Rice polish and skim milk...........	109.0	1.7	3.67

It will be seen that in connection with skim milk, rice polish was more effective, pound for pound, than corn meal.

Rice polish versus corn meal alone, first experiment. At the end of the fifth week the skim milk was dropped from the ration of both lots and the rate and economy of growth were immediately greatly decreased, as shown below.

It then required to make one pound of growth 6.7 pounds of corn meal or 6.7 pounds of rice polish. In this test, in which the conditions were unfavorable to rapid gains, the rice polish and corn meal were of equal value.

Rice polish versus mixed grain.—The following test was made with a different litter of pigs just after weaning. The experiment covered, in addition to the preliminary period, five weeks, terminating June 11, 1902. There were three pigs in each lot.

The mixed grain consisted of one-half cowpea meal, one fourth corn meal, and one-fourth rice polish. This was fed in comparison with a grain ration of rice polish, the pigs of both lots receiving in addition a nearly equal amount of skim milk.

	Lbs. grain per lbs. growth.	Lbs. milk per lb. growth.
Lot B—Mixed grain and skim milk..	1.78	4.13
Lot C—Rice polish and skim milk....	1.93	4.74

It will be noticed that mixed grain consisting partly of cowpea meal, and hence very rich in nitrogenous material, proved superior to rice polish.

Rice polish in different proportions.—During the next five weeks the grain mixture for lot B remained the same, namely 50 per cent. cowpea meal, 25 per cent. corn meal and 25 per cent. rice polish.

The grain of lot C, was so changed as to consist of equal parts of corn meal and rice polish.

Exclusive of the preliminary period the results were as follows:

		Lbs. grain per lbs. growth.
Lot B	½ cowpea meal .... ¼ corn meal .... ¼ rice polish	5.0
Lot C	½ corn meal .... ½ rice polish	4.2

This test was made during mid summer and the pigs, confined in small, bare yards and deprived of green food, did not make as rapid or as economical growth as they would doubtless have done under more natural conditions. Ordinarily we should expect that for young pigs the more nitrogenous mixture fed to lot B, would prove superior, as it did in the test described immediately above.

Rice polish versus corn meal alone.

During a third period of five weeks terminating August 20, 1902, these same lots of shoats were used in a comparison of rice polish with corn meal, both foods being fed alone. The amounts of grain fed to the two lots were identical.

	Lbs. growth 3 pigs in 4 weeks.	Lbs. grain per lb. of growth.
Lot B—Corn meal	53.5	5.01
Lot C—Rice polish	79	3.40

The daily rate of growth was much more rapid for the pigs eating polish and these also required considerably less food to make one pound of increase in live weight.

Rice polish versus corn meal in mixed grain ration.

A litter of six Poland China pigs, dropped April 29, 1902, were divided into two lots and fed for five weeks on two lots of grain that were exactly similar except that rice polish in one was substituted for an equal percentage of corn meal in the other. The results of the last four weeks of the period follow:

		Lbs. growth.	Lbs. food per lb. growth.
Lot D	40% corn meal		
	40% cowpea meal	56	3.7
	20% wheat bran		
Lot E	40% rice polish		
	40% cowpea meal	65.5	3.1
	20% wheat bran		

Both of the above mixtures afforded satisfactory rates of growth, but the one containing rice polish was decidedly more effective than the mixture into which corn meal entered.

Rice polish versus corn meal alone, third experiment.

This experiment was made with two lots of three shoats each and extended over eight weeks, terminating October 1, 1902. The shoats used were the same as those employed in the last mentioned experiment.

	Lbs. growth in 8 weeks.	Total food in 8 weeks.	Lbs food per lb growth.
Lot D—Corn meal	68	422.2	6.21
Lot E—Rice polish	131.5	492.9	3.75

The rate of growth was almost twice as rapid with the pigs fed on polish as for those consuming corn meal.

To make one pound of increase in live weight required in this experiment 39 per cent. less of polish than of corn meal.

Average results with rice polish.

In most of the direct comparisons of rice polish with corn meal the polish proved decidedly superior.

Taking the average of all five of these direct comparisons we find that to produce one pound of increase in live weight of pigs required only 3.73 pounds of rice polish and 4.74 pounds of corn meal. At this rate 78.6

pounds of rice polish was equal to 100 pounds of corn meal, a saving of 21.4 per cent of the grain by the substitution of polish for corn meal.

The differences in composition are not such as to explain the superiority of the polish, but this may possibly have been partly due to the fact that the rice meal, a flour-like powder, was in a finer state of division than the corn meal.

Composition of rice polish, rice meal and corn meal. Figures from Henry's Feeds and Feeding.

	Nitrogenous Matter.	Starch. etc.	Fiber.	Fat, etc.
Rice polish	11.7	58.0	6.3	7.3
Rice meal	12.0	51.0	5.4	13.1
Rice bran	12.1	49.9	9.5	8.8
Corn meal	9.2	68.7	1.9	3.8

We have had some difficulty in obtaining rice polish from states east of us, it being more profitable for the mills to mix it with other less valuable by-products and to sell the mixture of polish, rice, bran, etc., under the name of rice meal. Rice meal is of variable quality, according to the amounts of each by-product mixed in. Hence the figures quoted above need not be regarded as showing the composition of an average grade of rice meal.

As stated in a previous page we employed in one experiment rice bran mixed with an equal weight of several other foods. We found the rice bran mixtures unpalatable and the growth of pigs fed on it slow. At the South Carolina station rice meal, in connection with large amounts of skim milk, in a brief feeding period produced pork at less cost than when corn meal and skim milk were fed.

In November, 1902, rice meal was quoted to us by Planter's Rice Mills, Savannah, Ga., at $17.90 delivered at Auburn, Ala., in less than carload lots. Rice polish bought from the same firm two years ago cost about $26 per ton delivered at this station. It is of interest to note that a part of this rice polish kept in good condition for more than a year.

According to our experiments rice polish could with great profit be substituted for corn, meal selling at the same price.

APPENDIX.

Percentages of internal organs, etc., as affected by food.

	FOOD. 25 per cent cotton seed meal, 75 per cent corn meal.						FOOD. Corn meal alone.					
	No. 88.		No. 90, female.		Av. Nos. 88 & 90.		No. 85, female.		Essex Barrow.		Av. Nos. 85 & Essex.	
	Weight lbs.	% in terms of live weight.	Weight lbs.	% in terms of live weight.	Weight lbs.	% in terms of live weight.	Weight lbs.	% in terms of live weight.	Weight lbs.	% in terms of live weight.	Weight lbs.	% in terms of live wght.
Date of butchering	Nov. 16.		Nov. 16.				Nov. 20.		Nov. 16.			
Live weight	127	......	117.00	......	122.	......	135	......	127.00	......	131.00	......
Blood	......	......	2.00	1 71	......	......	3	2 22	3 00	2.36	3.00	2 29
Dressed carcass, including head & feet.	103 5	81.4	93 00	79 5	98 3	80.55	111.5	82.65	96 40	76 10	103 95	79.37
Lungs	.52	.41	49	.42	.51	.42	.73	.50	.60	.47	.66	49
Liver	1 80	1.42	1.60	1.37	1.70	1.40	1 91	1.41	3.10	2 44	2 50	1.92
Heart	29	.23	.26	.22	.28	.23	.26	.19	.24	.19	.25	.19
Kidneys	.38	.30	.46	.40	.42	.35	.35	.26	.33	.26	34	.26
Spleen	.09	07	.10	.09	.10	.08	12	.09	.12	.09	.12	09

The most significant differences attributable to the foods is the greater weight of kidneys and heart of the pigs receiving the more nitrogenous ration, and the greater weight of lungs (as in our former experiments) when the ration was highly carbonaceous.

W. A. Orton

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Legume

ALABAMA.

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Vetch, Cowpea, and Soy Bean Hay as Substitutes for Wheat Bran.

By J. F. DUGGAR.

BROWN PRINTING CO., PRINTERS & BINDERS,
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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

VETCH, COWPEA AND SOY BEAN HAY AS SUBSTITUTES FOR WHEAT BRAN.

BY J. F. DUGGAR.

SUMMARY.

The object of the feeding experiments herein described was to ascertain whether hay made from hairy vetch, cowpeas and soy beans could be advantageously substituted for most of the wheat bran in the ration of dairy cows.

The following values per ton were used in calculating the cost of food:

Wheat bran, $20.00; vetch hay, $10.00; cowpea hay, $10.00; cotton seed $12.00; cotton seed meal, $20.00; cotton seed hulls, $5.00.

Vetch hay proved fully equal in feeding value to a similar weight of wheat bran. By this substitution the cost of the food required to make a pound of butter was reduced 25 per cent., which is equivalent to a monthly saving of $22.20 in a herd of twenty cows.

With the vetch ration the cost of food for one pound of butter averaged 10 cents in contract with 13.4 cents when wheat bran was fed.

The waste in feeding vetch hay was, with most cows, about 6 per cent. of the amount offered and with cowpea hay about 16 per cent.; the latter residue, being unless, is charged as a part of the ration.

That portion of the cowpea hay actually eaten proved fully equal in feeding value to a similar weight of wheat bran. Charging the cows with all the cowpea hay offered them, we find that cowpea hay had 86 per

cent. of the feeding value of wheat bran, one ton of this hay being equal to 1720 pounds of wheat bran.

When wheat bran was worth $20.00 per ton cowpea hay was worth $17.20 and vetch hay $20.00.

The monthly profits per cow were $4.65 on the vetch ration and $4.35 on the cowpea ration.

One of the Jersey cows used in this test produced butter at a cost for food of only 8 1-3 cents per pound, when fed on the vetch ration.

Running cowpea hay through a feed cutter did not decrease the waste in feeding this food.

Four and a half per cent more butter was produced with soybean hay than with cowpea hay, if we take account of the portion of each actually eaten; however a larger proportion of the coarse stems of the soybean hay was left uneaten.

When corn hearts was substituted for wheat bran the yield of butter was increased by 8 per cent.

The following combinations of food stuffs made satisfactory daily rations for Jersey cows weighing between 700 and 800 pounds and producing a little more than a pound of butter per day:

(a) 4 lbs. cotton seed.
2 lbs. wheat bran.
11.8 lbs. vetch hay.
Total 17.8 lbs.

(b) 6.5 lbs. cowpea hay.
9.6 lbs. cotton seed hulls.
4.8 lbs. cotton seed.
2.4 lbs. cotton seed meal.
2.4 lbs. wheat bran.
Total 25.7 lbs.

(c) 6.6 lbs. soybean hay.
8.6 lbs. cotton seed hulls.
4.3 lbs. cotton seed.

2.2 lbs. cotton seed meal.
2.2 lbs. wheat bran.

Total 23.7 lbs.

Account was kept of the manure produced during certain periods, and it was found that this was produced at the rate of 1,749 pounds per month, or 3 1-2 tons per cow during a stabling period of four months.

Almost exactly half of the manure was left in the barn during the stabling period of 16 hours and an almost exactly equal amount was deposited during the 8 hours while the cows were in the lots.

The General Plan of the Experiments.

The chief aim of the experimental feeding of dairy cows as conducted by the Agricultural Department of this Station during the past four years has been to ascertain the means by which the dairymen might reduce his expenditures for purchased food.

The chief profits in live stock consist in using them as the means of improving the soil and of advantageously marketing the crops grown on the farm. Hence the larger the proportion of farm-grown food and the smaller the proportion of purchased material in the ration of an animal the greater the profit.

The proximity of cotton seed oil mills, the relative cheapness of cotton seed meal and hulls, and the convenience with which these by-products can be fed, have had the effect of making many southern farmers too dependent upon purchased foods. In Bulletin No. 114, issued in 1901 by this department, it was shown that at prices then prevailing a home-grown ration of cotton seed meal and sorghem hay afforded less butter, but at a lower cost per pound, than a diet of cotton seed meal and hulls.

The southern dairyman incurs considerable expense in the purchase of wheat bran. The experimental feeding of dairy cows during the past two winters has had for its object to learn whether the dairyman could advantageously reduce the amount of wheat bran often fed. Instead of wheat bran, we fed in 1901-2 vetch hay and the past winter cowpea hay. In composition these two hays are quite similar to wheat bran, as may be seen in the table of composition below, giving the composition of the foods used as determined by the Chemical Department of this station.

	In 100 pounds of food are:					
	Water.	Ash.	Protein Lbs.	Starch sugar etc. Lbs.	Fat. Lbs.	Fiber. Lbs.
Wheat bran ..	9.21	7.17	15.19	51.84	4.59	12.00
Cowpea hay ..	9.84	12.18	13.62	34.66	4.08	25.62
Vetch hay	**20.30	5.79	17.15	32.12	2.14	22.50
Soy bean hay..	9.25	6.01	12.19	34.26	2.35	35.12
Corn hearts ..	10.21	2.49	10.75	58.95	7.76	9.84
Rice meal	8.54	9.14	10.56	49.97	8.30	13.55

*Starchy matter, etc. **Vetch hay, when analyzed, (Ala. Bul. No. 105), contained more water than when fed.

In each experiment six thoroughbred Jersey cows have been employed, carefully divided into two nearly similar lots. Each lot has been fed (in addition to a basal ration which was the same for all) for half of the time on wheat bran and during the other portion of the experiment on either vetch or cowpea hay instead. The effort has been to make each lot of cows consume as nearly as practicable as many pounds of wheat bran during one period as of hay during the other period of each experiment. In other words hay of hairy vetch or of cowpea has been substituted almost pound for pound for wheat bran. Each cow in each lot did not receive exactly the same amount of food, but so far as practicable it was the aim to make the total amount of food of one lot equal, or nearly equal, to that of the other lot.

While the results have a very positive value for the dairyman they should also convey to the grower of beef cattle suggestions of almost equal value.

The details of the first experiment recorded below were under the immediate care of Prof. R. W. Clark. In the later experiments the writer was assisted by Mr. J. M. Jones and by students. To the intelligent care and interest of all of these are largely due the satisfactory results obtained.

Hairy Vetch Versus Wheat Bran.

This experiment extended over a period of eight weeks during the winter of 1901-2. The rations were reversed at the end of four weeks, so that the cows which at first received an extra quantity of wheat bran later had an extra amount of vetch hay. The first week of each period was regarded as a preliminary period and, as usual, excluded from the record.

Every cow received daily a basal ration which averaged as follows:

4 lbs. uncooked cotton seed.
2 lbs. wheat bran.
5.2 lbs. vetch hay (average.)
11.2 lbs. total basal ration.

Besides the above, each cow in one lot received an additional amount of vetch hay, which varied with the appetite of the individual cow, and which averaged 6.6 pounds per cow daily, excluding the small amount which was offered but not eaten.

The other lot of cows was fed, besides the basal ration, an additional amount of wheat bran, which extra allowance averaged 7 pounds per head daily. The rations of the two lots of cows were in time reversed so as to eliminate any possible inequality due to the individuality of the cows. For the sake of simplicity we shall hereafter speak of the one as the vetch ration and of the other as the bran ration.

The vetch ration consisted of a daily allowance of 17.8 pounds of food per day and the bran ration of 18.2 pounds. This gives slight advantage in the amount of food to the cows on the bran ration.

The following prices for food stuffs are assumed as average local prices on the farm for the last two winters:

Cotton seed, $12.00 per ton.

Wheat bran, $20.00 per ton.

Vetch hay, $10.00 per ton.

Cowpea hay, $10.00 per ton. The actual prices for a small portion of the food varied from this average; for example, the supply of home-grown peavine hay becoming exhausted before the conclusion of this experiment, it was necessary to buy a few bales at one dollar per hundred weight.

The vetch hay was of good quality, though it contained a small amount of coarse oat hay, it being necessary to sow oats or other grain with vetch to hold the slender vetch plant off the ground.

The cows used were as follows:

Lot.		Breed.	Age—Years.	Days since calving.	Weight when test began.
I	Ida	Jersey	6	143	831
I	Hazena*	do	3*	65	653
I	Hypatia	do	6	44	813
Av. I	Average			**84**	**766**
II	Lukie*	do	3*	108	699
II	Susan	do	4	68	672
II	Ada	do	10	99	831
II	Average			**92**	**734**

*Heifers with first calves.

Composite samples of the milk were tested weekly by the Babcock test and the amount of fat thus found was converted into butter by the usual method of multiplying by one and one-sixth.

From the table below it will be seen that the basal ration was the same for every cow, whatever the extra food consumed at the same time.

Period (each 21 days.)	Cows.	Pounds food in 21 days.					
		Vetch Hay Extra.	Wheat Bran Extra.	In basal ration.			
				Cotton Seed.	Wheat bran.	Vetch hay.	Total basal ration.
I	Dec. 19 to Jan. 9.						
I	Ida	157.6		84	42	108.4	234.4
I	Hazena	61.1		84	42	108-4	234.4
I	Hypatia	195.6		84	42	108.4	234.4
II	Jan. 16 to Feb. 6						
II	Lukie	74.6		84	42	108.4	234.4
II	Susan	166.1		84	42	108.4	234.4
II	Ada	179.6		84	42	108.4	234.4
Total.	6 cows	**834.6**		504	252	650.4	**1406.4**
II	Ida		159.6	84	42	129	255
II	Hazena		92.4	84	42	63	189
II	Hypatia		176.4	84	42	126	252
I	Lukie		126.0	84	42	84	210
I	Susan		168.0	84	42	122.5	245.5
I	Ada		168.0	84	42	126.0	252
Total.	6 cows		**890.4**	504	252	650.5	**1406.5**

The average daily cost of food per cow was 10.3 cents for the vetch ration and 14 cents for the wheat bran ration at the price assumed as an average for wheat bran, namely $20.00 per ton.

Hence the vetch ration was the cheaper by 3.7 cents per cow per day or $1.11 per month per cow. At this rate the saving through the substitution of vetch hay for wheat bran in a herd of 20 cows would be $22.20 per month.

Only the vetch hay actually consumed is charged, for the reason that with most cows the amount of vetch hay left uneaten was very small. The percentages rejected by five of these cows during the time when large amounts of vetch hay were fed were respectively 1, 3, 7, 9, and 9 per cent. of the amount offered. Hazena and Lukie, however, could not be induced to eat the desired amount of hay and hence were on rather "short rations" (with corresponding shrinkage in yield) during the time that they were receiving the vetch ration.

The greater part of the waste consisted in the case of most cows of the coarser part of the oat plant, which was mixed with the vetch.

If the average proportion rejected by five cows, 6 per cent., be regarded as the usual waste and charged to the cows, it would change the relative results only by a small fraction of a cent per day.

The amount of milk and of butter produced by each cow on both rations are recorded for periods of 3 weeks in the following table:

Milk and butter in 21 days from nearly equal amounts of vetch and wheat bran.

Vetch Hay Ration.				Wheat Bran Ration.			
Period.	Cow.	Milk lbs.	Butter lbs.	Period.	Cow.	Milk lbs	Butter lbs.
I	Ida. . . .	266.4	16.15	II	Ida. . . .	245.6	15.08
I	Hazena . .	280.3	17.92	II	Hazena . .	262.8	18.50
I	Hypatia .	430.9	27.15	II	Hypatia .	373 2	25.06
II	Lukie. . .	298.2	20.63	I	Lukie. . .	338.5	22.39
II	Susan. . .	381.4	27.74	I	Susan. . .	398.8	29.00
II	Ada	356.5	20.12	I	Ada	377.8	21.76
Total.	6 cows, 21 days.	2013.7	129.71	Total.	6 cows, 21 days,	1996.7	131.79
	Per cow per day	**16.0**	**1.03**		Per cow per day	**15.8**	**1.05**

The two rations were practically of equal value, whether judged by the amount of milk or of butter produced. During the entire period covered by the experiment and on both rations the average daily yield of butter exceeded one pound per cow.

Assuming that manure and skim milk balance the labor of caring for the cows and that butter is worth 25 cents per pound we have the following financial statement:

Financial statement.

	With vetch ration.	With bran ration.
Value of butter from 6 cows, 21 days	$32.43	$32.95
Cost of feed, 6 cows, 21 days	12.96	17.69
Cost of food per pound of butter, cents	.100	.134
Daily profit per cow, cents	.155	.121
Profit per pound of butter cents	.15	.116

By substituting vetch hay for wheat bran there was a saving of 2.4 cents, or 26 per cent on the cost of each pound of butter.

Not only does the vetch hay pay a profit when fed, as compared with wheat bran, but it affords an additional profit if produced at a lower cost than $10 per ton.

To sum up the whole comparison: Practically as much butter and milk was afforded by 834.6 pounds of vetch hay actually consumed as by 890.4 pounds of wheat bran. Hence each pound of vetch hay consumed was slightly more effective than a pound of wheat bran.

If we charge the cows also with the small amount of vetch hay that was fed, but not consumed, we find that *a ton of vetch hay was equal to a ton of wheat bran when* *fed to dairy cows in the proportion employed in this experiment.* Stated differently, vetch hay was worth $20 per ton when wheat bran cost $20 per ton.

Every one of the six cows produced butter at much less cost on the vetch than on the wheat bran ration.

The cost of food for one pound of butter was as follows:

	On vetch ration.	On bran ration,
	Cents.	*Cents.*
Susan	8.3	11.1
Lukie	8.9	11.6
Hypatia	9.0	13.2
Hazena	9.9	11.6
Ada	11.6	14.8
Ida	13.9	21.0

Cowpea Hay versus Wheat Bran.

This experiment extended from December 19, 1902, to March 6, 1903. In addition to the usual preparatory feeding there were two periods of 30 days each. The rations were at the proper time reversed, so that during one part of the experiment each lot of cows received cowpea hay and during another portion of the test each lot received wheat bran. The general plan was similar to that of the preceding experiment, but on account of the larger amount of cowpea hay rejected (averaging about one-sixth of that offered) it was considered necessary to supply larger amounts of cowpea hay than of wheat bran.

Foodstuffs were valued at the same price as the previous winter. Cotton seed hulls were priced at $5 per ton and a fair quality of cowpea hay at $10 per ton.

A basal ration was made up by weight as below and fed to every cow during the entire experiment:

$\frac{1}{4}$ cotton seed (raw).

$\frac{1}{8}$ wheat bran.

$\frac{1}{8}$ cotton seed meal.
$\frac{1}{2}$ cotton seed hulls.

Of this mixture each lot of cows received practically equal amounts. The average quantity of this basal ration consumed daily per cow while eating cowpea hay was 19.18 pounds, and when eating an extra amount of wheat bran 19.35 pounds of the basal ration was consumed. This amount contained practically 9.6 pounds of concentrated food and an equal amount of hulls.

In addition to the above, each cow received during one period of the experiment cowpea hay, the average daily consumption of which was 6.5 pounds per cow.

During another period each cow received wheat bran, the average daily consumption of which was 6.1 pounds per cow.

Summary of daily ration per cow.

	Cowpea hay ration.	Wheat bran ration.
Cowpea hay	6.5**	
Wheat bran		6.1
Concentrated food in basal ration	9.6	9.6*
Cotton seed hulls	9.6	9.6*
Total daily ration, average..........	25.7	25.3

*Approximate. **7.84 pounds cowpea hay offered.

The cows used were as follows:

Lot.		Breed.	Age years.	Days since calving.	Weight when test began.
I	Lukie	Jersey	4	95	752
I	Susan	Jersey	5	115	696
I	*Neura	Jersey	3	72	691
I	Average			**94**	**713**
II	Ada	Jersey	11	73	887
II	Hazena	Jersey	4	72	734
II	Hypatia	Jersey	7	56	848
II	Average			**67**	**806**

*Heifer with first calf.

The amount of the basal ration, common to every cow, averaged practically the same for each lot, whether the additional food was cowpea hay or wheat bran.

Incidentally it was ascertained in this test that running the cowpea hay through a feed cutter, so as to chop it into lengths of about two inches did not decrease the proportion of hay rejected.

Amount, kind, and cost of food eaten.

Period (each 30 days)	Cow.	Pounds food in 30 days. Wheat bran.	Cowpea hay eaten.	Basal.
1	Dec. 26 to Jan. 25:			
I	Lukie	....	166.2	642
I	Susan	....	197.5	642
I	Neura	....	149.5	604
II	Feb. 4 to March 6:			
II	Ada	....	223.5	542
II	Hazena	....	219.3	482.5
II	Hypatia	....	220	540.5
Total.	6 cows	....	*1176.0	3453.0
II	Lukie	202	....	560
II	Susan	202	....	559
II	Neura	202	....	482
I	Ada	164.5	....	643
I	Hazena	162	....	606
I	Hypatia	164.5	....	634.5
Total.	6 cows	1097	....	3484.5

*1411 pounds of cowpea hay offered and charged against the cows.

The amount of wheat bran consumed by six cows in 30 days, in addition to the basal ration, was 1,176 pounds. Adding also the portion of the hay which was unused, and which consisted of nearly worthless coarse stems, we must charge the cows with 1,411 pounds of cowpea hay. This has been done in the following table in calculating the cost of food required to make a pound of butter.

Including this wasted material, the average cost of food for one pound of butter were 12.3 cents with the cowpea ration, and 15.9 cents with the wheat bran ration. This is a difference of 3.58 cents per pound of butter, or a saving of 23 per cent. in the cost of food required to make a pound of butter due to the substitution of the cheaper cowpea hay for wheat bran costing $20 per ton.

Milk and butter in 30 days from nearly equal amounts of cowpea hay and wheat bran.

Cowpea Ration.				Wheat Bran Ration.			
Period.	Cow.	Milk lbs.	Butter lbs.	Period.	Cow.	Milk lbs.	Butter lbs
I	Lukie. ..	529.7	35.01	II	Lukie. ..	462.6	31.41
I	Susan. ..	611.7	43.87	II	Susan. ..	514.7	37.01
I	Neura. ..	399.1	28.11	II	Neura. ..	349.7	25.26
II	Ada	585.6	33.95	I	Ada	563.4	29.72
II	Hazena ..	471.1	32.61	I	Hazena ..	479.2	31.70
II	Hypatia .	511.9	31.27	II	Hypatia .	509.8	29.27
Total.	6 cows, 30 days.	3109.1	204.82	Total.	6 cows, 30 days.	2879.4	184.37
	Per cow per day	**17.3**	**1.13**		Per cow per day	**16.0**	**1.02**

In the yield of both milk and butter the cowpea ration was slightly superior.

In brief, the cows on the cowpea ration *consumed* 7 per cent. more of cowpea hay than the other lot did of wheat bran, but in return the former afforded 11 per cent. more butter than did the cows that received wheat bran. So that the portion of the cowpea hay that was actually eaten was slightly more valuable than an equal weight of wheat bran. However, including the sixth of the cowpea hay that was wasted, we find that a ton of wheat bran was equal in feeding value to 2,327 pounds of cowpea hay; a ton of cowpea hay was equal to 86 per cent. of a ton of wheat bran, or to 1,720 pounds of wheat bran.

In other words, when wheat bran cost $20 per ton, cowpea hay in the barn was worth 86 per cent. of this amount, or $17.20 per ton.

Financial statement.

	With cow-pea ration.	With bran ration.
Value of butter from 6 cows, 30 days	$51.21	$46.09
Cost of food (6 cows, 30 days), eaten	25.18	29.29
Profit from 6 cows, 30 days	26.03	16.80
Cost of food per pound of butter	0.123	0.159
Daily profit, per cow	0.145	0.090
Profit per pound of butter	0.127	0.091

Assuming that the value of the manure will pay for labor and that skim milk and the production of a calf will meet other charges, we have a monthly net profit per cow of $4.35 per month when a cowpea ration was fed.

The substitution of cowpea hay for wheat bran effected a saving of 23 per cent. in the cost of producing a pound of butter when wheat bran was rated at twice the price of cowpea hay.

In this experiment, as in the one made the previous winter, every cow produced butter at much cheaper cost when consuming large amounts of nitrogenous hay. Susan again afforded the cheapest butter, costing for food per pound of butter 10.4 cents when hay was fed.

The cost of food per pound of butter was as follows:

	With cowpea ration.	With bran ration.
Susan	10.4	13.3
Hazena	11.8	15.1
Lukie	12.2	15.8
Ada	12.3	17.0
Hypatia	13.3	17.0
Neura	14.5	18.0

LIMITAIONS TO THE SUBSTITUTION OF HAY FOR WHEAT BRAN.

Viewing the results of the two preceding experiments together it is evident that the hay of hairy vetch is quite as valuable as an equal weight of wheat bran, and that a good quality of cowpea hay is worth 86 per cent. as much as wheat bran.

This would probably not be true if we endeavored to support a cow in full flow of milk on hay alone, or almost entirely on hay. These tests showed that in rations containing 6 to 10 pounds of concentrated food (cotton seed, wheat bran, etc.,) about 6.5 pounds of hay of vetch or cowpea was practically as effective as, and muct more economical than, wheat bran. In future tests we hope to ascertain whether still larger amounts of leguminous hay can be substituted for corresponding quantities of wheat bran.

Readers are cautioned against assuming that equally favorable results would be obtained by the substitution of limited amounts of grass hay for wheat bran. The hay of vetch, cowpeas, crimson cover, red clover, and alfalfa is quite similar in composition to wheat bran and much richer in nitrogenous material than hay made from the grasses. These leguminous plants just mentioned, being rich in nitrogen, make not only rich food, but rich manure.

Not least among the considerations which should impel the dairyman to displace wheat bran as far as practicable with foods grown on the form is the possibility that the wheat bran which he buys may be adulterated, even to the extent of being made up of 30 per cent. ground corn cobs.

Still stronger reasons for supplanting wheat bran by leguminous hay are the reduced cost of butter and the improvement in the soil where even the stubble of cowpeas, vetch, or other leguminous plants have grown.

Amount of Food per pound of Butter.

Since the cost of food fluctuates so widely from year to year, we may with profit reduce the data obtained in both the preceding experiments to a more stable basis by calculating the amount of air-dry food required per pound of butter produced.

Air dry food per pound of butter.

	Hay ration. Lbs.	Bran ration. Lbs.
1901-2.		
Vetch hay eaten and wasted.......	6.82	
Vetch hay or bran consumed	6.43	6.76
Basal ration	10.84	10.67
Total food consumed	17.27	17.43
1902-3.		
Cowpea hay eaten and (16 per cent.) wasted	6.88	
Cowpea hay or wheat bran consumed	5.74	5.95
Basal ration (½ concentrated food..	16.86	18.19
Total food consumed	22.60	24.14

Five of the cows were used in the experiments of both winters. Each of them required a larger total amount of food for the second winter, chiefly because the basal ration at that time contained a large amount of cotton seed hulls, a material having very low nutritive value.

The effects of the rations on the live weights of the cows.

On vetch hay the cows remained practically stationary in weight, while under the same conditions the average gain per cow per period was 13 pounds when wheat bran was fed.

The next winter the cows on cowpea hay gained only 1 pound per head per period, while those getting wheat bran grew heavier by 16½ pounds per head.

This suggests a slightly greater tendency of wheat bran than of hay of vetch or cowpeas to increase the live weight, a doubtful advantage in the case of the milch cow.

MINOR TESTS.

At the conclusion of the experiments just described the feeding season was too nearly past and the cows too far advanced in lactation to permit any further experiments requiring long periods. Hence in the two experiments described below it was necessary to adopt the short period sometimes employed, dividing each experiment into three periods and using the data only for the last ten days of each period, the earier part of the period being considered as preparatory. The natural shrinkage in the flow of milk was counterbalanced by averaging the results of the first and third periods, during which the same food was fed, and comparing this average with the yield of milk and butter obtained during the second or intermediate period.

The ration fed during the first and third period of this experiment was the same as that fed to the corresponding lot of cows during the second period of the experiment previousy described. The same six cows were employed. The basal ration was the same as in the experiment comparing cowpeas with wheat bran.

Corn Hearts Compared with Wheat Bran.

For 7 pounds of wheat bran per head daily was substituted 6.8 pounds of corn hearts, a by-product from corn obtained in the manufacture of grits or hominy. Our supply came from the Western Grain Company, Birmingham, Ala., and cost, in Birmingham, $24.00 per ton in February, 1903.

One cow failed to eat the corn hearts as freely as wheat bran.

Corn hearts vs. wheat bran.

Perioe.	Ration.	Milk lbs. 3 cows, 10 days.	Butter lbs. 3 cows, 10 days.
I	Wheat bran	474.2	31.9
III	Wheat bran	449.5	28.9
	Average	461.8	30.4
II	Corn hearts	495.6	33.0
	Difference in favor of corn hearts..	33.8	2.6

Evidently corn hearts was a better food than wheat bran. The increase with the corn hearts ration as compared with the bran ration was 8 per cent. in butter, and 7 per cent. in milk.

The basal ration consisted of the same materials as in earlier experiments,—cotton seed and cotton seed hulls, with a small proportion of both cotton seed meal and wheat bran.

In these tests corn hearts was worth as a food for production of butter $21.60 per ton, when wheat bran was worth $20.

Soy Bean Hay Compared with Cowpea Hay.

In addition to the basal ration, which was the same for both lots, soy bean hay was consumed at the rate of 6.6 pounds per cow daily, or cowpea hay at the rate of 7 pounds daily.

In addition to the above amount actually consumed, 32 per cent. of the soy bean hay that was offered was rejected. This rejected portion consisted of the coarse stalks and some of the larger limbs. The corresponding waste with cowpea hay in this test was 22 per cent. of that offered.

Soy bean hay vs. cowpea hay.

Period.	Ration.	Milk lbs.	Butter lbs.
I	Cowpea hay	545.7	34.60
III	Cowpea hay	487.2	30.11
	Average	516.4	31.85
II	Soy bean hay	535.3	33.25
	Difference in favor of soy bean hay	18.9	1.4

From the above table we see that the soy beans afforded 4½ per cent. more butter and 3½ per cent. more milk than an equal weight of cowpea hay actually ocnsumed. However, the greater waste or greater residue with the soy bean fully counterbalances this, reducing the hay of these two valuable leguminous plants to a practical equality in feeding value. Soy beans are worthy of more extensive cultivation in the South. Their principal advantage over cowpeas consists in their easier curing, erect growth, and freedom from tangling. In our experiments they seem to require slightly richer soil than cowpeas.

DIGESTIBLE MATTER IN RATIONS FED.

In the following table are given the amounts in the daily rations fed of digestible dry matter; protein, or "muscle formers"; carbohydrates (chiefly starchy material); and fat. For comparison, the table also includes the figures showing what is generally regarded as the normal nutritive requirement of a cow in full flow of milk.

Digestible nutriments in rations fed.

Ration.	Dry matter.	Digestible nutrients. Protein.	Carbohydrates.	Fat.	Nutritine ratio.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Wolff-Lehmann Standard	29	2.5	13	.5	1:5.7
11.8 lbs. vetch hay 4.0 lbs. cotton seed 2.0 lbs. wheat bran 17.8 lbs. total	15.80	2.26	7.58	.91	1:41
9.0 lbs. wheat bran 4.0 lbs. cotton seed hulls 5.2 lbs. vetch hay 18.2 lbs. total	16.119	2.277	7.009	.998	1:40
6.5 lbs. cowpea hay 9.6 lbs. cotton seed hulls 4.8 lbs. cottonseed 2.4 lbs. cottonseed meal 2.4 lbs. wheat bran 25.7 lbs. total	22.92	2.51	8.47	1.42	1:4.6
6.1 lbs. wheat bran 2.4 lbs. wheat bran 9.6 lbs. cottonseed hulls 4.8 lbs. cottonseed 2.4 lbs. cottonseed meal 25.3 lbs. total	22.51	2.55	8.35	1.51	1:4.6
9.2 lbs. wheat bran 8.6 lbs. cottonseed hulls 4.3 lbs. cottonseed 2.2 lbs. cottonseed meal 24.3 lbs. total	21.59	2.50	8.11	1.40	1:4.5
6.8 lbs. corn hearts 2.1 lbs. wheat bran 8.2 lbs. cottonseed hulls 4.1 lbs. cottonseed 2.0 lbs. cottonseed meal 23.2 lbs. total	20.62	2.35	7.77	1.33	1:4.3

Ration.	Dry matter.	Digestible nutrients. Protein.	Carbohydrates.	Fat.	Nutritine ratio.
7 lbs. cowpea hay......... 2.2 lbs. wheat bran .... 8.6 lbs. cottonseed hulls.... 4.3 lbs. cottonseed .... 2.2 lbs. cottonseed meal.... 24.3 lbs. total	21.69	2.40	8.07	1.27	1:4.4
6.6 lbs. soy bean hay...... 2.2 lbs. wheat bran......... 8.6 lbs. cottonseed hulls.... 4.3 lbs. cottonseed .... 2.2 lbs. cottonseed meal.... 23.9 lbs. total	21.28	2.36	7.92	1.31	1:4.6

All of these rations fall far below the German standard in carbohydrates, and greatly exceed it in fat. In the Gulf States, by reason of the high price of corn, it is customary to feed rations which present much the same departures as above from the standard considered desirable in countries where carbohydrates are cheap. In spite of the large amount of fat, no digestive disorders resulted.

Amount of Manure Produced by Dairy Cows.

The manure dropped in the barn during ten nights by three cows was weighed for the perriod from January 17 to 26th, 1903. At this time this lot of cows was getting the cowpea ration. They were in the stable about 16 hours per night.

During this time the average amount of solid and liquid manure per cow per night was 36.1 pounds, exclusive of rye straw bedding, which was 4 pounds per night. Hence the total amount of manure was 40.1 pounds per night for cows averaging 713 pounds in live weight. This is at the rate of 1,203 pounds of manure dropped in the barn per month for each Jersey cow milked.

Again the manure collected by stabling the cows at night, March 26th to 30th, was weighed, one lot of cows then getting the cowpea ration, the other the wheat bran ration. The average daily production of liquid and solid manure, free from bedding, was 28.3 pounds, or, including fine straw bedding, 29.6 pounds, or 888 pounds per cow per month.

During the next five days the six cows were kept in the stable continuously, except for the few minutes required twice daily for watering, at which time they were watched to see that no manure was lost. The ration was the same as during the preceding five days, three cows receiving the cowpea hay ration and three the wheat bran ration.

Under these conditions of continuous stabling the average daily production of manure was 56.8, exclusive of bedding; the total, including pine straw bedding, was 58.3 pounds. Comparing these amounts, we find that 50 per cent. of the net manure was dropped during eight hours out of doors and an equal amount during sixteen hours in the barn. This is in close agreement with previous tests made at this station and recorded in Bulletin No. 114:

"This is important because the manure dropped on the lots or pastures usually suffers greater losses, and hence is worth less than that collected while the cows are in the stable. However, the high value of manure from grain fed cows should prompt every dairyman to gather and protect the manure from the lot as well as that from the barn."

This is equivalent to a production of 1,749 pounds of manure per cow per month, including bedding, or to three and one-half tons during a stabling period of four months, half of which (dropped in the barn), and a part of that dropped in the lot, would be saved.

It is of interest to note that during the time covered by these tests each pound of dry food consumed resulted in the production of about two and one-half pounds of manure.

BULLETIN No. 124. MAY, 1903.

ALABAMA.

Agricultural Experiment Station

OF THE

Agricultural and Mechanical College,

AUBURN.

The Horticultural Law.

Notes on Some of the Insects and Fungous Diseases Affecting Horticultural Crops.

R. S. MACKINTOSH.

MONTGOMERY, ALA.,
THE BROWN PRINTING CO., PRINTERS AND BINDERS.
1903.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

THE HORTICULTURAL LAW AND RULES ADOPTED BY THE BOARD OF HORTICULTURE.

INTRODUCTION.

For years the horticultural interests in Alabama have suffered very much from the injury done by various insect and fungous pests. Most of the seriously injurious pests are distributed upon nursery stock from infested sections. The nursery trade is a legitimate one, and one that should be encouraged when honestly conducted. Since the introduction of the notorious San José scale the people have awakened to the fact that it is necessary to protect the planter from stock from infested nurseries. The method commonly adopted is to consider nursery stock infested with pests, as dangerous to the public welfare, and order such stock destroyed. To do this all nurseries have to be examined one or more times each year, to see if there are no pests on the stock growing therein. If all the stock is healthy a certificate of health is given, stating that the stock is apparently free from all such pests. Even with all this precaution the planter should ever be on the lookout for insects and fungous pests which may have escaped the eye of the inspector, or which may have gotten upon the trees or plants after the time he made the examination.

The many wide-awake fruit growers of Alabama have for years been trying to get adequate laws to aid them in protecting the industry in this State. This past winter the newly-organized State Horticultural Society took the matter up, and with the aid of others interested in the work, succeeded in getting the Legislature to pass the following law:

No. 121. Code of 1903.

AN ACT

To Further Protect Horticulture, Fruit Growing, and Truck Gardening, and to Exclude Crop Pests of all Kinds in the State of Alabama.

SECTION 1.—*Be it Enacted by the Legislature of Alabama*. That from and after the passage of this act, the Commissioner of Agriculture and Industries of the State of Alabama, the President of the Alabama State Horticultural Society, and the Director of the Experiment Station of the Alabama Polytechnic Institute shall, ex-officio, constitute a board to be known as the State Board of Horticulture, of which the Commissioner of Agriculture and Industries shall be chairman, which board shall have full power to enact such rules and regulations governing the examination, certification, sale, transportation and introduction of trees, shrubs, cuttings, buds, vines, bulbs, and roots, that they may deem necessary to prevent the further introduction, increase and dissemination of insect pests and plant diseases.

SEC. 2.—That the Professor of Horticulture of the Alabama Polytechnic Institute shall act as State Horticulturist and as secretary of said Board of Horticulture under the provisions of this act, and it shall be the duty of the said board to promulgate rules and regulations in accordance with this act for the government of the said State Horticulturist in the duties devolving upon him in execution of the provisions of this act.

SEC. 3.—There is hereby annually appropriated the sum of ($1,500) fifteen hundred dollars, to be disbursed under the direction of the Board of Trustees of the Alabama Polytechnic Institute for the purpose of defraying the expense in the execution of this act.

SEC. 4.—The State Horticulturist or a deputy duly authorized by the Board of Horticulture, shall have power under the regulations of the Board of Horticulture to visit any section of the State where such pests are supposed to exist, and to determine whether any infested trees or plants are worthy of remedial treatment or shall be destroyed, and he shall immediately report his findings in writing, giving reasons therefor, to the owner of the infested plantation, his agents or tenant, and a copy of each report shall also be submitted to the said board. In case of objections to the findings of the State Horticulturist or his deputy, an appeal shall be made to the said Board, who shall have power to summon witnesses and hear testimony on oath, and whose decision shall be final. An appeal shall be taken within ten days and shall act as a stay of proceedings until it is heard and decided.

SEC. 5.—Upon the findings of the State Horticulturist or his deputy in any case of infested trees or plants, the treatment prescribed by him shall be executed at once (unless an appeal is taken), under his supervision, the cost of material and labor shall be borne by the owner; provided, however, that in case the trees or plants shall be condemned they shall be destroyed by the State Horticulturist, and the expense of such action shall be borne by the owner. No compensation shall be allowed for any plants that shall be destroyed.

SEC. 6.—In case any person or persons refuse to execute the direction of the State Horticulturist or of the said Board upon an appeal, a Justice of the Peace or Probate Judge of the county shall, upon complaint filed by the State Horticulturist or any freeholder, cite the person or persons to appear before him within ten days after notice being served, and that the said judge upon satisfactory evidence shall cause the prescribed treatment to be executed, and the expense thereof and cost of court shall be collected from the owner or owners of infested plants.

SEC. 7.—It shall be unlawful to offer for sale, sell, give away or transport perenial plants, scions, buds, trees, shrubs, vines, or other plants, tubers, roots, cuttings, bulbs, known to be infested with dangerously injurious insects or plant diseases. Any person or persons violating this section shall, upon conviction, be fined not less than ten nor more than one hundred dollars for each separate offense.

SEC. 8.—The said Board of Horticulture, its agents, or employes, are hereby empowered with authority to enter upon any premises in discharge of the duties herein described. Any person or persons who shall obstruct or hinder them or their agents in the discharge of these duties shall be deemed guilty of a misdemeanor, and, upon conviction therefor, shall be fined not less than ten nor more than one hundred dollars.

SEC. 9.—The Board shall have the power also to adopt rules and regulations, not inconsistent with the laws and constitution of this State and the United States, for preventing the introduction of dangerously injurious crop pests of all kinds from without the State or regarding the dissemination of crop pests within the State, and for the governing of common carriers in transporting plants liable to harbor such pests, to and from and within the State, and such regulations shall have the force of laws.

SEC. 10.—Be it further enacted, that the members of said Board, any two of whom shall constitute a quorum, in the absence of the third, shall, within thirty days of the passage of this act, and from time to time, draw up and promulgate through the press of the State the rules and regulations necessary to carry into full and complete effect the provisions of this act, carefully defining what diseases or maladies, both insect and fungus, shall constitute infectation in trees or plants, within the meaning and purview thereof.

SEC. 11.—It shall be unlawful for any person, firm or corporation to sell, give away, or ship within the State of Alabama any trees or shrubs or any other plants commonly known as nursery stock, without having a certificate of guarantee of the State Horticulturist of Alabama. A copy of such certificate of guarantee must accompany each box or package sold, given away or shipped. Such certificate must be dated within twelve months. If upon examination such stock is found to conform to the requirements of the said Board of Horticulture, the State Horticulturist must furnish a certificate to that effect. Any person or persons selling, giving away or shipping nursery stock without the certificate of the State Horticulturist shall be fined not less than fifty nor more than one hundred dollars.

SEC. 12.—Each and every person, firm or corporation residing and doing business outside of the State of Alabama, dealing in or handling trees, shrubs or other plants commonly known as nursery stock, shall file a copy of his or its certificate of his or its inspection furnished by the State Horticulturist, nursery inspector or other duly authorized official of his or its State or county with the Secretary of the Board of Horticulture. Upon the filing of this certificate as above prescribed, and upon request of the person, firm or corporation, a certificate will be issued to the same, and official tags bearing copy of such certificate and seal of the Board will be furnished the same at cost, provided, however, that the aforesaid certificate of inspection shall be adjudged satisfactory by the Board. Each box, bundle or package of nursery stock shipped into Alabama by any person, firm or corporation shall bear one of these tags, and shipments of stock not thus tagged shall be liable to confiscation by the Board of Horticulture through its agents or employes.

SEC. 13.—No transportation company or common carrier shall deliver any box, bundle or package of trees, shrubs or plants commonly known as nursery stock to any consignee residing within the State of Alabama when said box, bundle or package does not bear the official tag or certificate of guarantee issued by the State Horticulturist without previously notifying the State Horticulturist of the particulars of the shipment as they may be required by the Board, nor without duly warning the consignee of his risk in accepting said shipment. Failure on the part of any transportation company or common carrier to conform to these requirements shall be deemed a misdemeanor, and shall be punishable in each instance by a fine of not less than ten nor more than fifty dollars. Provided, that no common carrier shall be liable for damages to the consignee or consignor for refusing to receive, transport, or deliver such trees, packages, or boxes, when not accompanied by the tag or certificate herein provided.

SEC. 14.—Any person, firm or corporation receiving from any other firm, or corporation, any box, bundle or package of trees, shrubs, or plants commonly known as nursery stock, which is not accompanied by a certificate of guarantee, or official tag issued by the State Horticulturist to cover said stock, shall be deemed guilty of a misdemeanor, and, upon conviction, shall be fined not less than ten nor more than one hundred dollars.

SEC. 15.—It shall be the duty of the State Horticulturist to make a quarterly report of his work, and of the expenditures under this act to the Board of Horticulture, and said Board shall report annually to the Governor of the State.

Approved March 5, 1903.

Official:

J. THOS. HEFLIN,
Secretary of State.

THE BOARD OF HORTICULTURE.

As provided by the above law the following persons are ex-officio members of the Board of Horticulture:

The Commissioner of Agriculture and Industries, Chairman.

The Hon. R. R. Poole, Montgomery.

The President of the Alabama State Horticultural Society,

Mr. W. F. Heikes, Huntsville.

The Director of the Experiment Station, Alabama Polytechnic Institute,

Prof. Chas. C. Thach, Auburn.

The Professor of Horticulture of the Alabama Polytechnic Institute, to be State Horticulturist and Secretary to the Board.

Prof. R. S. Mackintosh, Auburn.

The Board of Horticulture met at Auburn, March 20, 1903, and in accordance with Section 10 of the above act, the following insects and fungous diseases were considered dangerous and to constitute infestation in trees and plants:

(1) San Jose Scale, (*Aspidiotus perniciosus.*)

(2) The New Peach Scale, (*Diaspis amygdali.*)

When found in a nursery all infested stock to be burned. If San José Scale is found in the immediate neighborhood, all stock must be fumigated or certificate will be withheld.

(3) Black Knot, (*Plowrightia morbosa.*)

(4) Crown Gall, (*Dendrophagus globosus.*)

When found in a nursery all diseased stock to be destroyed, otherwise stock may be shipped.

(5) Peach Yellows.

(6) Peach and Plum Rosette.

All infested trees and nursery stock to be destroyed.

(7) Woolly Aphis, (*Schizoneura lanigera.*)

All badly diseased stock to be destroyed. Other stock to be fumigated or treated with kerosene emulsion.

RULES.

The following rules and regulations were adopted:

Rule 1.—The State Horticulturist is hereby charged with the enforcement of this act, and is directed to locate by personal visits, by correspondence or in such other manner as he may deem best, to locate the above named pests, so far as they exist in this State, and to take such action, in accordance with the above act, as he may deem necessary to control or eradicate the same.

Rule 2.—The State Horticulturist shall have power to require all nursery stock sold within the State of Alabama to be treated with hydrocyanic acid gas, when in his judgment the presence of any pest requires it, for the better protection of the interests of the citizens of the State. Upon the failure of any individual, firm or corporation to comply with this, the State Horticulturist is hereby authorized to withhold his certificate.

Rule 3.—All certificates of examination shall expire prior to July 15th of the year after date of issue.

Rule 4.—All nurseries are to be examined between July 15th and November 15th of each year.

Rule 5.—Definition of Nursery Stock.—In addition to fruit trees, the following if offered for sale are classed as nursery stock, and are subject to the regulations governing the examination and transportation of the same: Strawberry plants, vines, ornamental trees and shrubs. (Including field grown roses.)

Rule 6.—All appeals from the decisions of the State Horticulturist should be addressed to the Chairman of the Board of Horticulture, at the Capitol, Montgomery, Ala.

Rule 7.—All communications relative to the examination of orchards and nurseries should be addressed to the State Horticulturist, Auburn, Ala.

Rule 8.—A deputy duly authorized by the Board of Horticulture shall have the same power and authority as the State Horticulturist in carrying out the provisions of this act under the direction of the State Horticulturist.

It is not the intention of the Board nor the State Horticulturist to cut down and destroy orchards unless the case absolutely demands it, but rather to use some remedial treatment if possible. It will be the aim to see that the nursery stock sold in this State is free, or supposed to be free, from all seriously injurious pests. To make this law most effective everyone interested should help carry out the provisions of the law and to report promptly all cases of the violation of the law by any one.

The purchasers of nursery stock are requested to read Section 14, of the law, which makes it a misdemeanor for them to receive any nursery stock not provided with a certificate or official tag authorized by the State Horticulturist to cover such stock.

NOTES ON SOME OF THE INSECTS AND FUNGOUS DISEASES AFFECTING HORTICULTURAL CROPS.

Only the insects and fungous diseases enumerated by the Board of Horticulture, as very dangerous pests, are here described, and while they do not represent all those that injure our horticultural crops, yet, they do represent the more dangerous ones.

The good old adage "an ounce of prevention is worth a pound of cure" must be our motto, for, in fact, it is the foundation on which our Horticultural Law is built, *i. e.*, to examine all nursery stock so as to keep out the various insects and fungous pests.

Unfortunately the San Jose scale is found in many parts of Alabama. It was brought here on nursery stock from infested localities, and there is no hope of entirely ridding our state of this scale, but with the earnest efforts of the various growers, we should be able to keep it from spreading farther.

The State Horticulturist is ready to do all he can, to help in preventing the spread of the various pests on nursery stock, and to aid the owners of infested orchards to rid their premises of them.

Recommendations.—The best, as well as the most practical way of treating nursery stock, is to fumigate it with hydrocyanic acid gas. This is usually done by the nurseryman before the stock is packed for shipment. It should not be considered as an entirely safe remedy, but, rather, as one of the safeguards to use in securing clean stock. All growers should be continually on the watch for the first indication of any trouble foreign to the natural growth or habit of plant or tree.

After the trees have been pruned and ready to be planted, they may be dipped in the lime, sulphur and salt solution for a moment. This covers the trunk and branches with this insecticide, and should destroy most of the living scales.

Caution—In doing this only dip the top, do not submerge the roots, and do not treat at all when the buds have started. Fumigation or dipping can only be done when the trees are dormant—never after growth has started.

With one or both of these precautions, and then only getting the stock from regularly inspected nurseries, should practically guarantee trees free of any of the above named pests.

Orchard treatment.—When the scale is discovered in an orchard, all badly infested trees should be dug up and burned. These trees will be killed in a comparatively short time, from the injury caused by the scale, and besides, the owner is free from this source of infection. In the end it is a saving rather than a loss.

Undoubtedly the best remedy that we now have is the lime, sulphur and salt wash. This has been tried in a great many places, and has been found very successful in controlling scale insects. While it cannot be expected to kill all the scales at once, yet it kills the larger part of them, and helps to successfully keep them under control. To be effective the lime, sulphur and salt wash must be carefully made, and in spraying every part of the tree, from the ground up, must be covered. It is advisable to go over the trees a second time in order to cover parts overlooked the first time.

Spraying at best is laborious and disagreeable work, and unless done thoroughly and at the proper time, is little better than if not done at all. This wash can only be applied to the trees in winter time, as then the trees are dormant. It seems that the best time to apply it is just before the buds open in the spring.

So far no successful summer treatment has been found. As mentioned above, all badly infested trees should be destroyed and all others not so badly infested should be treated by covering the trunk and larger branches with the lime, sulphur and salt wash. Use one-half the regular strength, and apply by either a brush or spray pump. Be careful not to get too much on the foliage, although it is better to sacrifice some of the foliage rather than not to touch the larger part of the scales.

Spraying Outfits.—Too much can not be said in favor of having strong and effective spraying outfits. A small leaky pump, with only a few feet of hose, and a wornout nozzle are not the proper things to use in spraying trees. It is much better for several congenial growers to unite in purchasing a good, serviceable outfit, rather than for each to purchase smaller and less efficient apparatus.

THE SAN JOSE SCALE, (*Aspidiotus perniciosus*) Comstock.

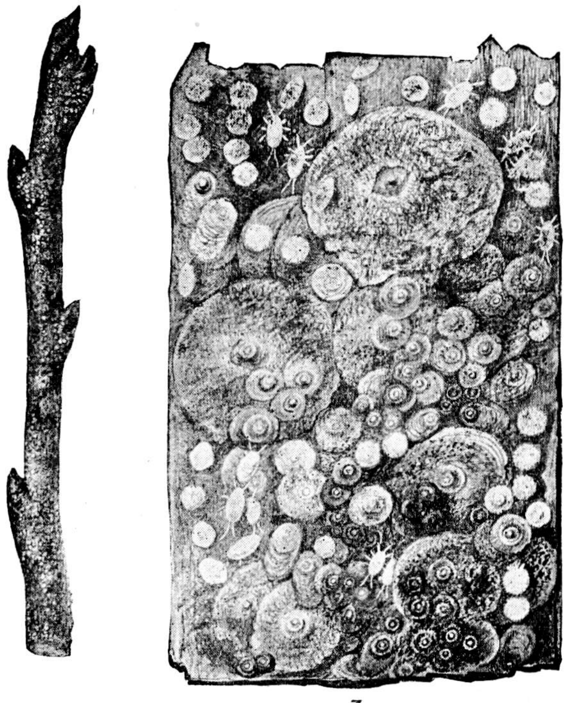

Fig. 1.—Appearance of scale on bark: *a*, infested twig, natural size; *b*, bark as it appears under hand lense, showing scales in various stages of development, and young larvae. (Howard and Marlatt, Bul. No. 3, New Series, Div. of Entomology, U. S. Dept. of Agr.)

How to detect it.—This scale is very small and it is rather difficult for an inexperienced eye to detect it. Roughly speaking, it is about the size of a pinhead. Seen

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The description of the San Jose scale; New Peach scale; Black Knot; Peach Yellows and the Peach and Plum Rosette are by Prof. W. M. Scott, State Entomologist of Georgia; and those of the Woolly Aphis and Crown Gall are by Prof. S. A. Forbes, State Entomologist of Illinois.

under a hand lense the female is dark gray in color, circular and conical in outline, and terminates at the center by a nipple like prominence, surrounded by a distinct ring. The male scales are elongated and smaller, with the nipple near the anterior end. The real insect beneath the scaly covering is plump, circular in outline and yellowish. If crushed with the point of a knife the result is a pale yellowish liquid. The newly-born young are very minute mite-like creatures, long oval in shape, with pale orange color. They are quite active in seeking a suitable spot on which to settle, and in a few hours they have anchored themselves with their beak for life; except in the case of the males, which issue at maturity with wings, and become active again.

When a tree becomes crusted over with these scales the bark has the grayish appearance of having been coated over with dampened ashes.

Food Plants.—The San Jose scale may be looked for upon the following plants: Peach, plum, apple, pear, apricot, cherry, quince, almonds, rose, Hawthorn, raspberry, spiraea, cotoneaster, prunus pissardii, strawberry, flowering quince, mountain ash, gooseberry, currant, flowering currant, grape, English walnut, pecan, black walnut, persimmon, elm, osage orange, linden, euonymus, weeping willow, Kilmornock willow, English willow, golden willow, cotton-wood, Lombardy poplar, Carolina poplar, catalpa, sumach, silver maple, and perhaps some others.

Treatment.—For nursery stock, fumigation with hydrocyanic acid gas in an air-tight room is the only safe remedy; and, in fact, this treatment cannot be considered an absolute surety against the scale, since some unknown opening in the house may allow the gas to escape before it has done its deadly work. Where trees are actually known to be infested they should never be used, but should be burned. There is too great a risk in the use of infested stock, no matter to what treatment it may have been subjected. Fumigation is a good precaution, and every nurseryman should fumigate his stock, not only on account of the probable existence of scale in his nursery, but also on account of other insects that are usually present on nursery trees to a greater or less extent. This work of fumigation is accomplished by packing the trees in a *air-tight* room and subjecting them to the fumes of hydrocyanic acid for thirty-five minutes. The gas is generated by treating chemically pure potassium cyanide with the best grade of commercial sulphuric acid at the rate of $1\frac{1}{4}$ oz. of cyanide, $1\frac{3}{4}$ oz. of acid and 5 oz. of water to every 150 feet of cubic space in the room.

Preliminary Treatment.

Unfortunately there seems to be no satisfactory summer treatment for the San Jose scale, and winter applications must be chiefly depended upon for the control of this pest. However, it is not infrequent that summer spraying can be done to advantage. This insect multplies at a rapidly increasing ratio during the breeding season until checked by cold weather about the middle of November or later. In this climate, therefore, the period of greatest reproduction among the scale insects, and consequently of greatest damage to the infested trees, is from about the middle of September to the middle of November. Trees that are only slightly infested in July may become encrusted with scales by November. Frequently this rapid fall multiplication of the scale, if left unchecked, results in the death of a great many trees before a winter wash can be applied.

The value of late summer or fall spraying in checking the progress of the scale has been determined not only by our experiments, but also by practical work in large orchards. A 10 per cent. strength (or even 15 per cent. when carefully used) of kerosene or crude oil applied in mechanical mixture with water, or in soap emulsion, does not materially damage peach trees in foliage and does destroy large numbers of scale insects, especially the recently issued young and a considerable per cent. of the breeding females. During the breeding season the progress of the scale should be watched, and if it threatens to kill or impair the infested trees before winter sets in, two or three applications of oil should be made. These may be made at intervals of two or three weeks, as occasion seems to demand, but even two applications on successive days or with one day intervening, are considerably more effective than a single one. The trunks and larger limbs should be thoroughly sprayed, but drenching of the foliage should be avoided as much as possible. The oil has a tendency to scorch the foliage, but not to a serious extent if the work is properly done.

HOW TO PREPARE THE SPRAYING MATERIALS.

KEROSENE OIL EMULSION.

Formula and Directions.—An emulsion of either crude petroleum or kerosene may be made from the following formula:

2 pounds potash whale-oil soap.
4 gallons water.
8 gallons oil.

Weigh the soap carefully and place with the water in a vessel over the fire, using a slight excess of water to make up for evaporation. Fit a pump with a short piece of hose, to which is attached a nozzle for throwing a straight stream 3-16 or 1-4 inch in diameter. Pour the oil into the barrel or tub in which the pump is set, and when the whale-oil soap is dissolved, and the solution begins to boil, add it to the oil, and pump the whole vigorously back into itself for a period of at least ten minutes. The stream from the nozzle should be directed straight downward into the mixture so as to stir it to the very bottom. After a few minutes the oil and soap solution will be seen to combine, forming a thick, creamy emulsion, which when perfectly made will remain without change for weeks.

For a 20 per cent. strength add water to make 40 gallons.

For a 15 per cent. strength add water to make 53 1-3 gallons.

For a 10 per cent. strength add water to make 80 gallons.

Materials and Pump Required.—Either crude oil or kerosene will give good results in making emulsion. The soap should preferably be some soft whale-oil soap, such as Good's No. 3. If a hard soap is used the emulsion will be curdy, and only with difficulty mix with water.

The ordinary Bordeaux spray pump answers very well for mixing the emulsion, but almost any pump will do nozzle A "Bordeaux" or "Seneca" nozzle gives a very that can be fitted with the requisite section of hose and satisfactory sized stream for this work, though rather small.

The water used must be soft, for if hard no stable emulsion can be prepared, and it sometimes happens that foreign substances chancing to be present, will prevent the emulsification. In case limestone or hard water is to be employed, it should be broken by the addition of a small quantity of lye. If a lot of soap solution and oil, for any reason, fails to emulsify properly, the best thing to do is to throw the whole away, carefully clean up the pump, wash out all the vessels used and begin over.

Properties of the Emulsion.—The emulsion, if well made of the proper soap, will retain its creamy consistency when cold, and is easily mixed with water in all proportions. No alarm should be felt if a small portion of the soap and water fails to emulsify, and separates at the bottom, nor, if after being exposed to the air for some time, a thin scum forms over the surface. If on long standing globules of free oil rise to the surface, or if a thin ring of oil collects around the sides of the containing vessel, the emulsion should either be thrown away, or warmed up and agitated afresh.

When diluted the emulsion may slowly rise, like cream, to the surface, and in order to prevent this the spray pump in which it is to be used should be provided with an agitator.

Never try to boil the kerosene over the fire; it is not necessary, and besides it is very dangerous.

THE LIME, SULPHUR AND SALT WASH.

FORMULA AND DIRECTIONS.

This wash may be prepared by combining lime, sulphur and salt in several different proportions, but the following appears to be the generally accepted formula:

Quick lime	30 pounds.
Salt	15 pounds.
Flower of sulphur	20 pounds.
Water to make 60 gallons.	

Slake half the lime carefully and place it in a large kettle with 25 gallons of water; grind the sulphur up with a little water, breaking the lumps as fine as possible by passing through a seive and add to the lime; boil.

As it boils the liquid will gradually become thinner and thinner, the lime and sulphur dissolving simultaneously to form a deep orange-red solution. When the sulphur has apparently all entered into solution, which may take two hours or more, slake the remainder of the lime, add to it the salt, and pour the two into the lime and sulphur solution. Boil the whole for from half an hour to an hour longer, strain, and dilute with warm water to 60 gallons. Do not let it become thoroughly cold, but spray while yet warm.

The principal care in making up this wash is to make sure that the sulphur is thoroughly dissolved. Flowers of sulphur is apt to be more or less lumpy, and these lumps are very difficult of solution. The more thoroughly the sulphur is ground up with water before being boiled with the lime, the less time it will take in the boiling.

An iron kettle must be used if the boiling is done directly over a fire. A better and cheaper way, whenever a head of steam is available, is to place the sulphur, lime and salt together in a barrel half full of water, conduct the steam through a pipe to the bottom of the barrel and boil it for two or three hours, with occasional stirring, to make sure that nothing is settling. If a boiler is convenient, a pipe must be so arranged as to conduct steam to a number of barrels at once.

NEW PEACH SCALE. (*Diaspis amygdali* Tryon.)

How to detect it.—This scale is readily distinguished from the San José scale in that the female is a little larger, of a lighter gray color, with the elongated exuvial point ridged and located at one side of the center, and the male is smaller, elongated, with parallel sides and white. The excuvial point is similar to that of the female, but located at the anterior end. A tree badly infested has a white-washed appearance from the color of the male scales. Where only females occur, however, a grayish brown appearance is produced.

It is the habit of these insects to cluster about the trunk and the lower parts of the larger limbs of a tree.

The original home of this insect is probably either the West Indies or Japan. From its probable West Indian origin it gets one of its popular names, "West India" scale.

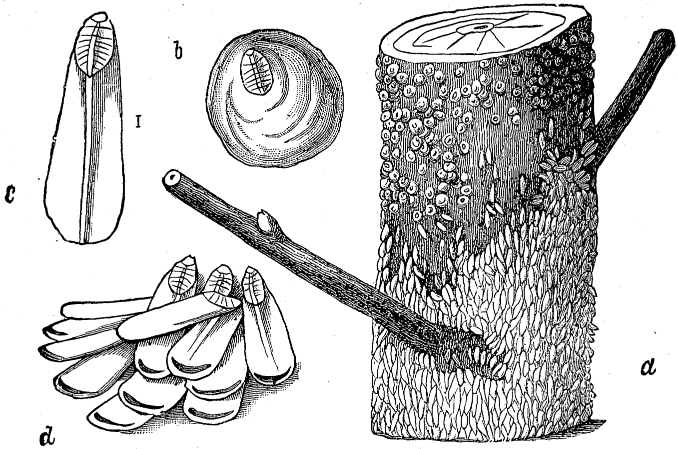

Fig. 2.—The New Peach Scale: *a*, branch covered with male and female scales, natural size; *b*, female scale; *c*, male scale; *d*, group of male scales—enlarged. (Howard, U. S. Dept. of Agr., Yearbook, 1894.)

It attacks the peach, plum, apricot, cherry, pear, grape, persimmon, and a few other plants.

Treatment.—The winter treatment for this insect is about the same as that for the San José scale. The female pass the winter in the mature and partially mature state, and can be killed by the lime, sulphur and salt wash, or by the whale-oil soap treatment at the rate of one pound dissolved in one gallon of water. In Georgia there are three or four broods from eggs, which appear at more or less regular intervals, the first appearing about the middle of March, if the season is favorable. These broods should be watched for and ten per cent. kerosene or whale-oil soap at the rate of one pound to four gallons of water should be applied at the time of their appearance.

It is becoming one of the most dangerous pests with which we have to contend, perhaps equal to the San José scale. Th most vigorous measures should be adopted for its eradication while it is yet in its incipiency.

BLACK KNOT. (*Plowrightia morbosa* Sch.)

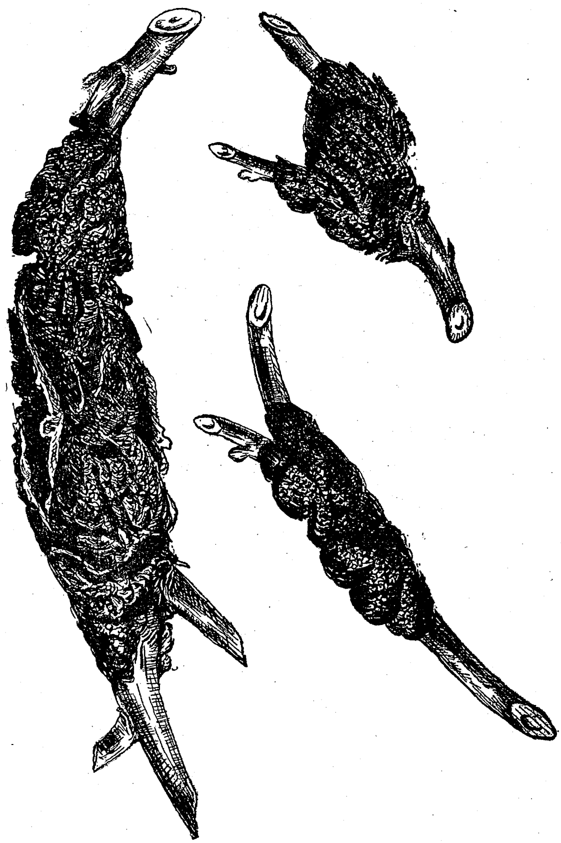

Fig. 3.—Black Knot.—Old knots on cherry twigs, natural size. (Scott, Bul. No. 1, Georgia State Board of Entomology.)

Plums and cherries are subject to the attacks of a disease very expressively termed "Black Knot." This disease is American in its origin and occurs more or less abundantly throughout the United States, but is especially prevalent in the Eastern States, where it seems to have first appeared. In some sections of the East growers of plums and cherries have been forced from time to time to abandon the industry in consequence of the ruinous effects of its work. Cases are on record showing that orchards that paid handsomely one year were completely destroyed the following year or two.

The more intelligent growers are fully aware of the injuries they are liable to suffer from its attacks, and whenever it appears on their premises they lose no time in removing it by cutting off affected parts or rooting up the diseased trees. Through such wise measures the disease has not been allowed to get beyond control.

How to detect it.—Some fully formed knots are illustrated in figure 3. These are large, rough, black excresences, due to the growth of a fungus (*Plowrightia morbosa*) in the cambium layer of the branches or twigs These crusty enlargements may extend entirely around the branch or grow lengthwise on one side. The first swelling usually begins in the spring, when the sap begins to flow; it may, however, occasionally be noticed in the fall. Th first indication is a slight enlargement, usually longitudinal, which rapidly increases in size as the season advances. The bark is soon ruptured and finally scaled off, exposing a yellowish brown crusty surface. In May the fungus bears a crop of infecting spores on the surface of the knot, which gives it a velvety appearance. These spores are soon scattered by the wind or other natural agencies furnishing infection for other trees and thus disseminating the disease. The knot then becomes hard and black as fall is approached.

It has not yet completed its work. During mid-winter another crop of spores is produced and scattered. These gain lodgment in the cracks and crevices of the bark and in the forks of twigs and at the growing points, ready to germinate and penetrate the tissues of the bark as spring opens up.

Treatment.—The most effective method of controlling this disease is to cut out all the knots as soon as they appear and burn them. This work should be supplemented by spraying with Bordeaux (four pounds of copper sulphate and five pounds of fresh lime to fifty gallons of water). Four applications are necessary, two for the winter crop of spores and two for the summer crop. The first should be made about two weeks before the buds begin to open, and the second immediately before they open. The third application should be made about the middle of May at the time the summer crop of spores is produced, followed in about two weeks with the fourth.

All wild cherry and plum trees should be carefully watched, as they are frequently badly attacked, and affected parts must be cut away and burned.

THE CROWN GALL. (*Dendrophagus globosus.*)

This is a dark, rough, abruptly protruding tumor growing most commonly from the crown of the tree, and varying in size from that of a pea to that of the fist, or larger—the latter usually on old and long infested trees. A badly affected tree is likely to show signs of starvation, its growth ceasing and its foliage having a sickly yellow look. Young trees often perish from this disease, which is certainly contagious in some forms and perhaps in all, and even large orchard trees may die and finally break off at the base of the trunk.

Although much the most common above the crown, just below the surface of the ground, this gall frequently grows on the larger roots, and is sometimes seen exposed on the trunk. Appearing at first as a simple lump or tubercle, it may so extend its growth as to girdle the trunk with its large wart-like excresences. Young galls while still fresh have at first the color of the roots from which they grow, but later darken from the accumulation of dead bark on their surfaces. They are at first, while very small, softer than the healthy tissue of the root, but harden with age, and their inner structure be-

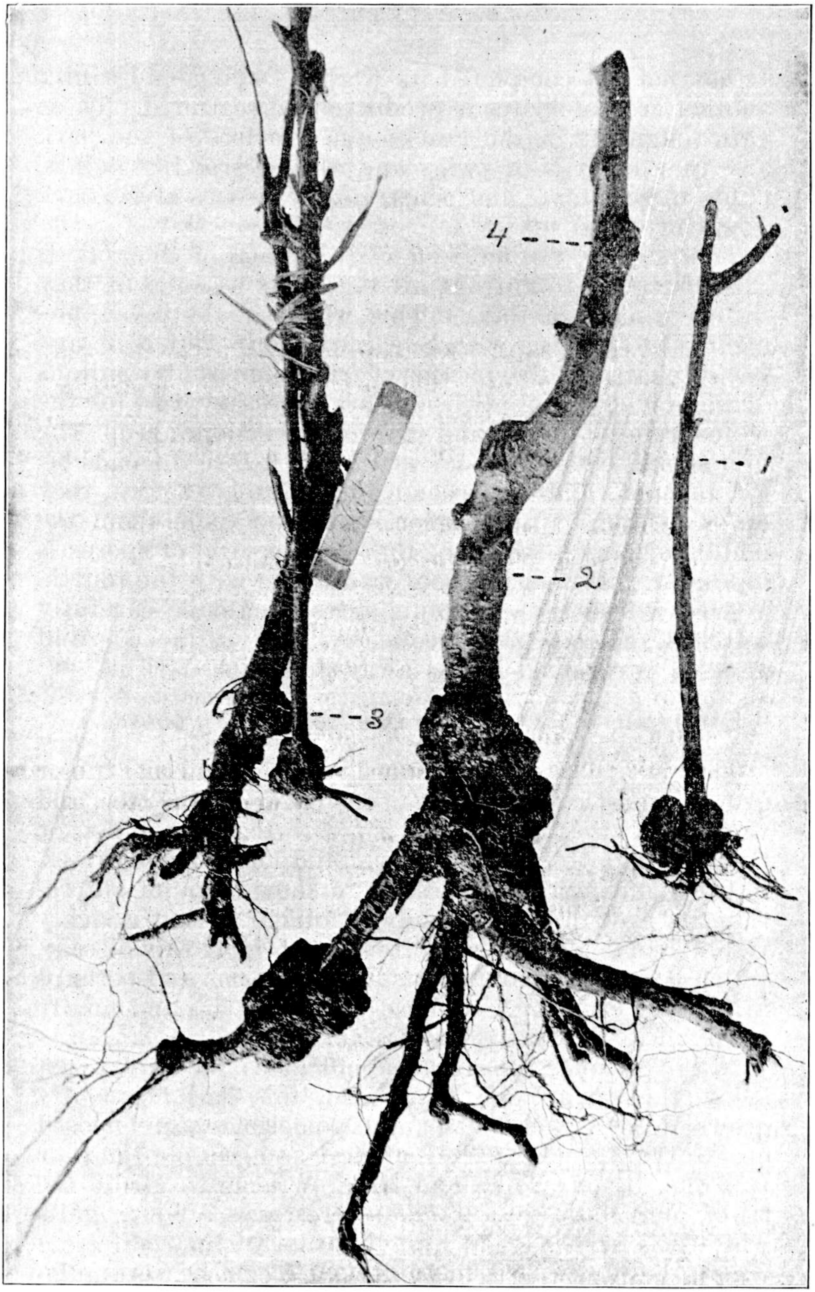

Fig. 4.—Crown Gall. 1, gall on Mariana Plum cutting; 2. gall at crown and on root of Elberta Peach; 3, gall on Peach induced by planting diseased Mariana Plum in juxtaposition; 4, gall induced by innocuiation. (Quintance, Report Georgia State Historical Society, 1900.)

comes irregular and confused. On old galls, soft, white, growing points appear here and there in early spring, which enlarging rapidly, become gradually darker and harder, and by fall take on the appearance of the older growth.

There is much evidence that the crown-gall of the peach, apricot and almond is a contagious disease due to a minute parasitic organism (*Dendrophagus globosus* Toumey) belonging to a peculiar group of fungi known as the "slime moulds," but this conclusion has not yet been fully verified for the apple, the pear, the respberry, or, indeed, for any other of the numerous kinds of fruit and ornamental trees and shrubs on which similar wart-like growths have been observed.

Until experimental work now in progress has been carried so far as to warrant conclusions on this point, the crown-gall of the apple, now extremenly common in manny nurseries of the Mississippi valley, can be regarded as a suspicious object, and not certainly as a dangerous one. But the careful nurseymen, jealous of his business reputation, will not send out even suspected material, and in doubtful cases will give his customers the benefit of the doubt. On this account I strongly advise that no stock of any kind showing galls of this sort on crown, root or trunk should be placed on the market. All trees growing in close contact with those thus affected should have their roots dipped in Bordeaux mixture as a precautionary disinfectant, and the ground on which the stock so diseased has grown should be temporarily used for some other purpose than that of raising nursery stock.

PEACH YELLOWS.

It is American in its origin, and has been known for about one hundred years. It is quite generally distributed over the Eastern States north of Tennessee and North Carolina. Some of the most important peach sections of the East have suffered immensely from its destructive work and in not a few cases entire orchards have been completely destroyed. It seems to prefer peaches, but apricots, almonds, nectarines and Japanese plums are not free from its attacks.

How to detect it.—If the affected trees is in bearing, the first symptom is manifested in the premature ripening of the fruit, which may take place several weeks or only a few days before the normal season of ripening. Premature ripening may be due to other causes, but the yellow peaches bear characteristic bright-red, measly blotches over the skin and streaks of red through the flesh often reaching to the pit. Another reliable symptom is the pushing out of newly formed buds at the ends of apparently healthy twigs or water sprouts, into short shoots with small yellowish leaves. Such buds should not normally put out until the following season. Also, the disease may cause dormant buds on the trunk and larger limbs to push into feeble, often branched shoots, characterized by narrow stiff leaves. This stage is illustated in figure 5, showing the abnormal growth on a tree dying with the yellows. Affected trees may live for three to five years, during which time they are graudally weakened and finally the foliage becomes yellowish or reddish in color.

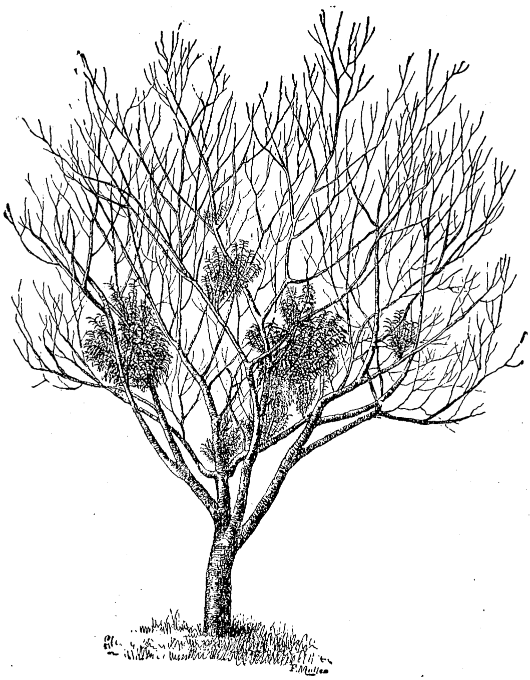

Fig. 5.—Yellows the fourth year. (Smith, Farmers' Bul. No. 17, U. S. Dept. Agr.)

The term "yellows" is somewhat misleading. Quite a number of supposed cases of yellows in this State have been reported to the writer, but, upon investigation, the yellowing of the foliage in every case proved to be due to the peach borers, drouth or some other weakening effect on the trees. Premature ripening of the fruit from similar causes has also lead many to believe their trees to be affected with the yellows. The absence of red spots on the skin and red streaks through the flesh of the fruit should serve to relieve uneasiness in such cases.

The cause of yellows is yet undetermined, but it is definitely known that it is a disease and can be communicated from tree to tree and from orchard to orchard. Experiments have shown that it can be communicated to healthy trees through buds taken from diseased trees, but the manner of its natural spread from tree to tree is yet unknown. It is known, however, that from scattered cases in the orchard it will gradually spread over the entire orchard and completely destroy it if left unmolested.

Prevention.—Since yellows is an incurable disease, we can only look to preventive measures for protection.

(1) Peach trees should not be obtained from nurseries located immediately in infested sections. Such stock is liable to develop yellows after planting out.

(2) Peach pits from affected trees should never be planted. They may reasonably be expected to convey the disease to the young stock.

(3) Whenever the disease appears in an orchard every affected tree should be rooted up and burned. Simply cutting off affected parts is not sufficient. The virus exists in the apparently healthy parts and would soon develope the symptoms of yellows. The whole tree, root and branch, must be destroyed.

PEACH AND PLUM ROSETTE.

Similar to the yellows is a disease known as "Rosette" from the peculiar tufts into which the leaf buds grow on trees under the influence of the disease. It attacks peaches and plums and is quite generally distributed over the northern portion of Middle Georgia, extending from Augusta to the Alabama line, and from Macon to some distance north of Atlanta. The writer has quite thoroughly worked the State over and has never found it south of Macon nor in extreme North Georgia. It also occurs, although to a limited extent, in Eastern Kansas and in Western South Carolina. It seems to be most prevalent in Georgia,, where it has been known for about twenty years. It causes the destruction of many trees annually in infested sections of this State, but the growers do not consider it with any great dread from the fact that they effectively hold it under control by the destruction of all affected trees as soon as the disease appears. In some localities, however, rosetted trees have been left in hedges and waste places to propagate the disease and cause considerable destruction to adjacent orchards.

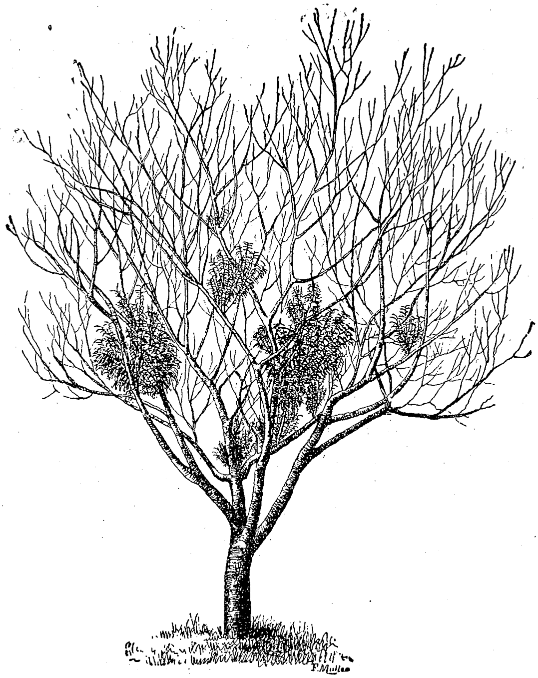

Fig. 6.—Rosette induced in a seeding by innoculation. (Smith, Farmers' Bul. No. 17, U. S. Dept. Agr.)

How to detect it—Figure 6 well illustrates the appearance of a tree affected with rosette. This clustering together of the leaves into rosettes usually takes place in early spring and is one distinguishing character of the disease. The foliage assumes a yellowish green or orange color, or, in case of plums, paricularly a beautiful red color. The leaves have a straight, stiff appearance with inrolled margins. One season is usually sufficient to completely kill the affected tree. In some cases, however, a tree may live two years, especially if it is not attacked in all parts at once; but when a tree is once attacked it never recovers.

Prevention.—The same preventive measures suggested for yellows apply also to rosette, and particularly should all diseased trees be promptly dug up and burned. Fence rows and hedges where peaches and plums are growing should be watched and affected trees destroyed. By a series of experiments, Dr. Erwin F. Smith,* of the U. S. Department of Agriculture, determined that it can be communicated by bud inoculation, it being necessary, however, for the tissues of the bud and stock to unite before inocculation is effected. Further than this its manner of spread is unknown. Dr. Smith suggests that possibly the disease may enter through the roots, but this has not yet been proved. It is certain, however, that it does spread naturally and that a few affected trees left standing in an orchard will in time cause the destruction of the entire orchard. Hence the importance of rooting up diseased trees.

THE WOOLLY APHIS. (*Schizoneura lanigera.*)

This insect is especially injurious to young apple trees, first in the nursery and then in the orchard. It is most abundant and does its principal damage on the roots of the trees, but spreads also to the bark above ground, where it is particularly likely to appear on the young sprouts which start up from the root of an injured or unhealthy tree. Where abundant it forms bluish-white cottony patches, not unlike some kinds of mould, which, on careful examination, are seen to consist of a crowd or layer of minute sluggish insects, their bodies covered with a cottony coating which gives the general effect described. They are usually most abundant on the roots, but sometimes appear above ground also on the bark of

*Farmers' Bulletin, No. 17, U. S. Dept. Agr., page 17.

the trunk or branches. On the exposed parts of the tree they are most likely to be noticed about the collar and at the forks of the principal branches, or wherever an injury to the bark has left a scar. When trees in a nursery or young orchard have a sickly look—the leaves dull and yellowish—and are not growing well, the pres-

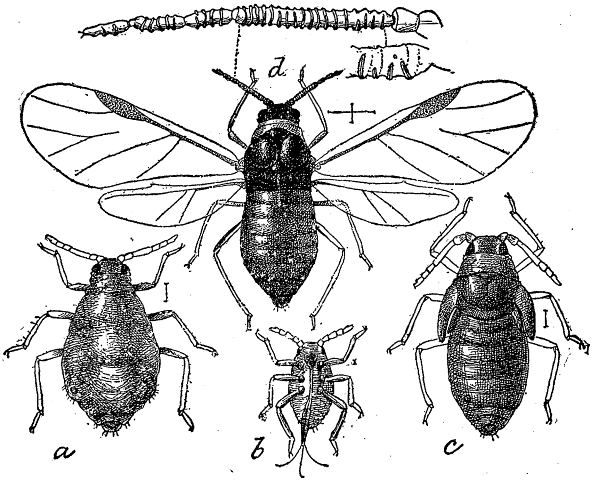

Fig. 7.—Woolly Aphis (*Schizoneura laniger.*)—*a*, Agamic female; *b*, larval house; *c*, pupa; *d*, winged female with antenna enlarged above, all greatly enlarged and with waxy excretin removed. **(Marlatt, U. S. Dept. Agr.)**

ence of this insect on their roots may be suspected even though there may be no appearance of it on the bark above ground. If the roots of such an infested tree be examined they will commonly be found distorted and deformed with hard knot-like enlargements, many of them almost dead, or even in course of decomposition. These gall-like growths occur on roots of all sizes to a depth of a foot or more beneath the surface. Unless the tree is so far gone that the insects have deserted it, they will commonly be found upon these injured roots at all seasons of the year.

The apple is the only tree liable to attack by this insect, the current supposition that it may live on the roots of forest trees being an error due to confusion of injury by the woolly aphis with that by the root-rot. As it lives under ground at all seasons of the year it comes to infest more or less generally the soil itself, although this may be cleared of it by a few months' thorough cultivation sufficient to destroy effectively all living apple-roots. Like many other plant-lice, the woolly aphis multiplies throughout the greater part of the year by the birth of living young from generations of wingless fe-

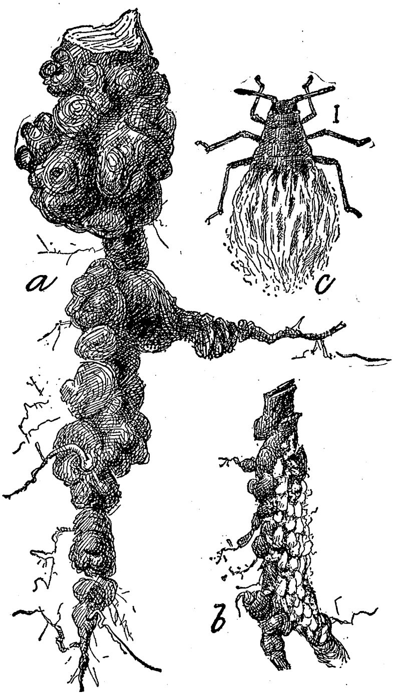

Fig. 8.—Woolly Aphis (*Schizoneura lanigera.*)—*a*, root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root louse, female—*a* and *b*, natural size; *c*, much enlarged. (Marlatt, U. S. Dept. Agr.)

males only, but in October or November winged females appear somewhat abundantly, and, flying freely, especially before the wind, distribute the species widely. From these descend in the same autumn a generation of males and females, the latter of which eventually lay each a single winter egg. This is commonly placed within a crevice of the bark, and, hatching in spring, give rise to a new colony. There may be more or less migration back and forth from the groups above ground to those on the roots at almost any time of the summer and fall.

This insect is universally distributed and extremely common, both in orchards and nurseries, becoming evidently more so to the southward. Being highly injurious to young trees, it is a difficult pest to deal with in the nursery trade. It probably cannot be wholly eradicated from an infested nursery, and, perhaps, can never be completely and permanently kept out of a new plantation. Fortunately, trees a few years old, once well established, commonly suffer but little from its presence, and our preventive and remedial measures must consequently be directed to the preservation of young stock. No tree whose roots are visibly injured by the woolly aphis should be allowed to go from the nursery, and none in the least infested by it should be sent out until the roots have been freed from it by insecticide application.

The simplest method of destruction of the aphis on the roots is dipping for a few seconds in water kept heated to 130-150 deg. Fahr. Where heat cannot be conveniently maintained, kerosene emulsion, diluted to contain about ten per cent. of kerosene, may be substituted. In the nursery, seedlings or graftings may be protected by using tobacco dust freely in the trenches in which they are planted, or by sprinkling together dust in a shallow furrow along each side of the nursery row as closely to the tree, and afterwards covering loosely with earth. Infested trees should not be sent out from the nursery except after fumigation with hydrocyanic acid gas or after dipping the roots in hot water or in kerosene emulsion. Trees with aphis galls or knots should never be sold, but thrown out and burned. Trees which have been growing longest in the nursery are usually the worst infested. Culls kept from year to year, apt to be mere nurseries for the multiplication of these and other destructive pests. In preserving overgrown trees in hope of making a cheap sale, the nurseryman usually "saves the penny and loses the pound."

BULLETIN No. 125. JUNE, 1903.

ALABAMA.

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

Some Diseases of Cattle.

By C. A. CARY
and
F. G. MATTHEWS.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

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PART I.

BY C. A. CARY.

COW POX. VARIOLA.

COW POX is a skin disease naturally occurring in cows and rarely appearing in other cattle. It may be transmitted by inoculation to calves and to man. The true nature of the virus has never been discovered: various kinds of bacteria have been reported as the cause, and some investigators claim that it is produced by an animal micro-parasite.

The period of incubation is said to be from two to four days. The eruption occur usually on the teats, the udder and neighboring parts; some observers report eruptions on the inside of the thighs, on the head, and on the scrotum and perineum of the bull.

The teats at first become slightly swollen, sensitive and somewhat hard; in a short time appear a number of pimple-like modules, having hard or tumified bases, on the teats and udder around the base of the teats. On transparent skin these modules are scarlet red or rose red; on white skin they are bluish white, giving a flourescent reflection; on a dark skin the nodules have a lead-gray color; and, if the skin is thick and tough the pimples may be a dirty yellowish gray in color. The pimples or nodules are enlarged popillæ of the skin and vary in size, yet they average about one-fourth of an inch in diameter. In about two days the outer layer of the skin is raised, around the center of the enlarged pimple, by viscid, yellowish lymph, which is in separate saccules (multilocular vesicles); by thus raising the outer borders of the nodule its center appears depressed. But in some nodules the excess of lymph raises the entire outer layer of skin over the nodule, forming one large unicellular vesicle, filled with thick, yellowish lymph (serum). The vesicles usually become mature in 8 to 10 days, and vary in size from one-fourth to three-fourths of an inch in diameter; they are usually circular on the udder and may be elliptical on the teats. When the vesicles are not broken their contents become purulent (filled with pus), the centre first becomes brown in color which soon extends to the border of the pustule. The pustule dries and a dark brown scab or crust is formed which usually drops off about the fourteenth day, leaving a pale red or white and shining, depressed scar. The vesicles or pustules on the teats are always broken by the milker and the brown scabs come off prematurely and sometimes drop into the milk to be removed from it by the strainer. Complete recovery takes place in the eruptions that appear on the udder in about 21 days; but with those on the teats successive scabs or crusts are removed, ulcers become "cracked" and raw, and healing occurs slowly, requiring in some instances thirty to forty days. During this time re-infection or infection with pus germs may take place and thus successive crops of nodules (possibly vesicles and pustules) and scabs may appear. In one case under my direct observation there were four successive crops of eruptions in four months (winter and spring) on the teats and udder of the same cow. Crusts from the third crop were mixed with dilute glycerine and a calf was inoculated, by vaccination, producing an ulcer with a scab or crust without apparently passing through vesicular and pustular stages. Had I used the crusts from the first crop I am confident true cow pox would have been produced in the calf. Moreover, the calf inoculated had been getting the milk from this cow (not sucking) and may have become immune before being inoculated.

Dr. Van Es, while practicing in Mobile, reported to me a case where a milker became infected on the hand by milking cows with cow pox.

Owing to the fact that man is inoculated (vaccinated) with bovine virus (cow pox virus) to produce a partial immunity to small pox, it is possible that many cows may become inoculated by milkers who scratch their vaccinated arms and fail to disinfect their finger nails before milking the cows. Records (Crookshank and others) seem to indicate that cow pox is usually more prevalent when small pox scares are numerous, and many persons are vaccinated; this relationship appears to be true so far as the imperfect records of cow pox in Alabama can indicate. I have observed that children who drink raw milk sometimes have ulcers not unlike vaccination ulcers, about the mouth or face or on the hands; this might result from scratching pimples, eroded places or sores when the finger nails are covered with infected milk.

The fact that milkers, who become infected with cow pox, were partly or wholly immune to small pox, led the celebrated Jenner to discover and apply the method of vaccinating man with cow pox virus in order to prevent virulent small pox.

The virus of cow pox is fixed and can only be transmitted by direct inoculation. Generally the milker carries it from one cow to another and, if not immune, inoculates himself, or carries it from his vaccinated arm to a susceptible cow. One attack, or series of eruptions, produces immunity in a cow for life. Hence young cows at first period of lactation (with first calf) are the ones most frequently infected; yet older cows may have it if not already immune. It is generally more virulent in winter than in summer.

The chief troubles resulting from cow pox are the annoyance or difficulty in milking and sometimes a decrease flow of milk; the latter may be due to lack of removing all the milk; also "caked bag" or mammitis may be a sequel to lack of removing all the milk. Moreover, there is some danger to non-immune milkers and possibly to non-vaccinated children.

Treatment consists in isolating the affected cows and allowing the same milker to milk the diseased cows and no others. The milker should keep his finger nails cut close and smooth and thoroughly wash and disinfect his hands after and before milking with a 2 per cent. solution of creolin, or corrosive sublimate 1 part and water 1,000 parts.

The udder and teats should be washed just before milking and covered with one of the above antiseptics. After milking apply some of the following to the bag and teats: Copper sulphate 1 dram and water 1 quart. Some have used the following with fairly good results:

Tannic acid	1 ounce;
Salicylic acid	4 drams;
Vaseline	3 ounces.

Apply just after using the copper sulphate solution.

The milk should be boiled before using, especially for children. Apparently it has no bad effects on calves not alowed to suck.

Varicella or false cow pox is characterized by having single celled vesicles and by its rapid course, passing through the papular, vesicular, pustular and healing stages in six to twelve days. The scab or crust is thinner and not depressed in its centre as in cow pox. The vesicles and pustules have the same outline as those of cow pox, but are smaller in varicella than in cow pox.

Notice that these are variations in degree rather than in kind; this makes it difficult to distinguish true cow pox and false cow pox in some instances—especially in the early stages. In varicella there may be successive crops of eruptions on the udder and teats extending over several weeks or three or more months. Possibly the later eruptions are due to infection by pus germs or to mixed infection. The true cause of varicella is also unknown. Yet it is infectious and can be transmitted by the milker from one cow to another and possibly from the cow to the milker. A similar disease in men is commonly called chicken pox; so far no direct relation between the disease in cows and in man has been established. No inoculations have been made as in cow pox.

The treatment for this is the same as for cow pox.

Furunculosis is a disease that is also found on the teats and udder of the milch cow. It is an inflammation of a hair follicle and its subaceous gland, and of a certain amount of connective tissue surrounding them. The cause is an infection through the follicle by one or more of the pus germs, usually the *micrococcus pyogenes*, var. *aureus* or *albus*. Generally the central parts undergo necrosis, or degenerative changes, forming a small pus collection, which usually escapes by a break in the skin and rarely by erupting into the milk sinus or reservoir of the udder or ducts of the teat or udder.

Furuncles (small boils) appear usually about the base of the teats, but may occur anywhere on the udder or teats; some report their occurrence on the vulva and perineum.

At first the furuncle is a hard, swollen nodule, about one-half inch in diameter; in the course of a few days it becomes soft in its centre and with slight pressure may erupt. Another or several more may appear near or around the first one, and thus a series of successive furuncles may appear on the teats and udder during the greater part of the period of lactation. Sometimes the nodules are quite deeply situated and remain without erupting; these are usually about the base of the teat, or in other parts of the udder; they may be, in some cases, tuberculous modules.

No doubt that filthy hands, dirty finger nails, open the way to infection. Pus germs are very often found on dirty finger nails and on the dirty skin of the udder; moreover, long, sharp and rough finger nails are fine instruments for inoculation.

Treatment consists in cleanliness and disinfection. With the finger nails smooth and closely cut, and the udder and hands thoroughly washed, chances for infection are very limited.

After infection, wash the udder with water that has been boiled and cooled; apply a 2 per cent. creolin, lysol or corbolic acid solution; or corrosive sublimate 1 part and water 1,000 parts. Be sure to wash and disinfect the udder well immediately after a furuncle erupts. Remember cleanliness of hands, finger nails and udder will prevent it.

OBSTRUCTIONS TO THE FLOW OF MILK FROM THE TEAT.

Chronic inflammation or irritation of the lining membrane of milk duct or canal in the teat (through which passes the milk from the milk reservoir or sinus in the bag to the bucket or air at time of milking) may lead to a graudual thickening of the lining membrane and consequent narrowing of the duct. The milk will then flow in a very small stream and the calf or milker may be unable to remove all of the milk, and thus "dry up" that quarter or produce clotting of the milk or inflammation of the bag ("garget" or "caked bag.") Chronic inflammation may be a result of the growth of germs in the small amount of milk left in the milk sinus or duct, or the growth of germs in the lining membrane of the duct. The use of a filthy or rough dilator or milk tube may irritate the membrane. The most common cause of infection, according to my observations, is the employment of filthy finger nails or a dirty knife to remove a clot or a temporary obstruction in the duct. The thickening of the lining membrane is usually near the lower end of the duct, but in one instance I found the duct obstructed in the entire length in all four tests; and, according to the owner, the cow was not carefully or properly "dried up."

The duct in the teat may, also, be obstructed by a growth in the substance of the teat, which presses on the duct and obstructs the flow of milk. The growth may be in or on the lining membrane of duct and anywhere along its course, but most frequently at its lower end. In some cases a false membrane develops across the milk sinus or reservoir preventing the flow of milk into the teat; this can be determined by using the milk tube or probe or small dilator.

In extremely rare instances lime-like deposits may take place in the milk ducts and sinuses, and appear in the duct of the teat as sand-like grains or particles obstructing the flow of milk.

The most common causes of obstruction of the flow of milk in the teat are clots of milk (casein) resulting from infection of the milk by germs getting into the udder through the duct in the teat; retention of milk in the udder for a long time; and catarrhal and other forms of inflammation in the udder. Milk is a good food for germs, and various kind of bacteria will grow in it, many of which will precipitate the casein, thus forming clots in the sinus of the udder.

Treatment of obstructions will vary with the conditions presented. Narrowing of the duct may sometimes be relieved by using dilators (figs. 1, 2); it may be necessary to leave the dilator in the canal or duct for an hour or more just before milking. Be careful to cleanse and sterilize the dilator just before using, with boiling water or a good disinfectant. When dilators will not accomplish the desired result, use a small knife blade, lance (fig. 4), or the teat slitter (fig. 5), and enlarge the duct at the place of narrowing; then use the dilator or probe to prevent the narrowing of the duct as the wound heals.

Sometimes growths or small enlargements on the inner surface of the duct may be clipped off with very small sharp pointed scissors or twisted off with small forceps.

Lime or sand-like deposits in the sinus may require considerable dilatation of the duct with the ordinary or spring dilator (fig. 3); or the small forceps may be used to remove the sand-like particles. A false membrane across the milk sinus or reservoir may be pierced and slit open with a small knife (fig. 8). Clots of casein may be removed by using a milk tube (figs. 9, 10), or by using dilators (fig. 3), and complete and frequent milking. If the udder is inflamed use antiseptic injections and applications as directed under head of garget or inflammation of the udder.

PAPILLOMAS OR WARTS on the bag or teats may be clipped off with knife or scissors when the cow is dry; cut about as deep or a little deeper than the thickness of the skin. Care should be taken not to cut around or into the opening of the duct of the teat; it might leave a permanent opening or the contraction of the scar might close the duct. After clipping apply once or twice per day, castor oil, 3 ounces; salicylic acid, 4 drams.

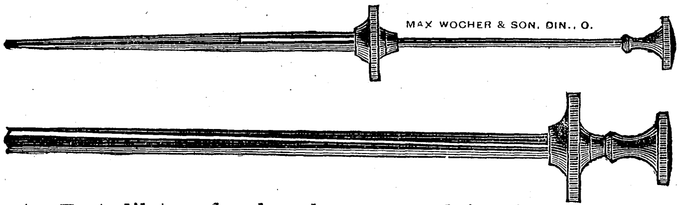


Fig. 1.—Teat dilator closed and open: used in dilating a narrow or contracted milk duct.

Fig. 2.—Grooved dilator for opening obstructed teats.

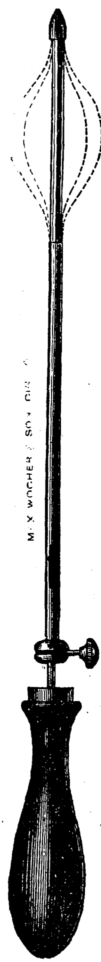


Fig. 3.—Spring dilator for removing membranes, clots, and sand-like particles.

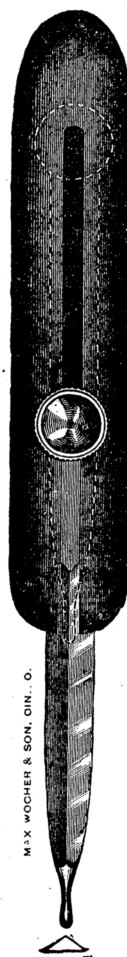
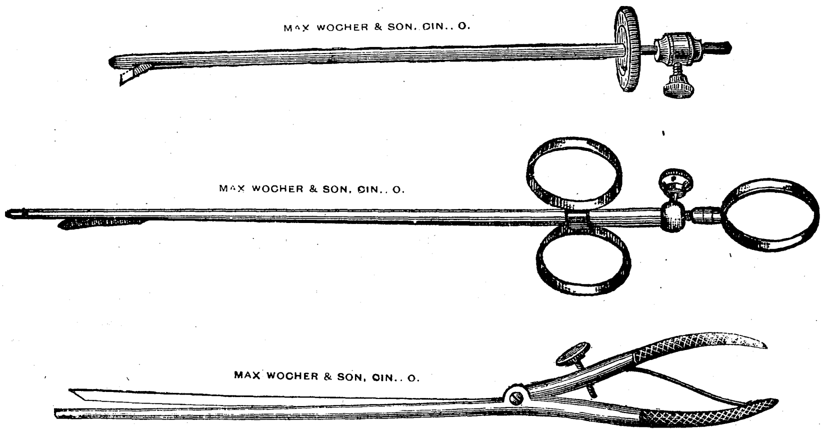
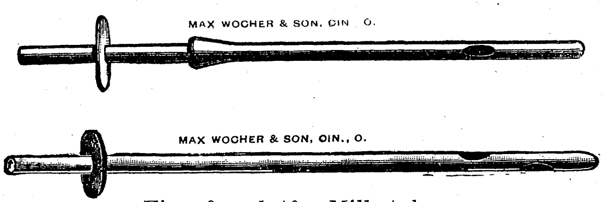


Fig. 4.—Teat lance for enlarging contracted teat ducts.



.Figs. 5, 6 and 7.—Three kinds of teat slitters, any one of which may be used for enlarging narrow or contracted milk ducts.

Fig. 8.—Small tenotome knife (showing only part of handle), which may be used in enlarging a contracted milk duct or cutting an opening in a false membrane across the milk sinus.



Figs. 9 and 10.—Milk tubes.

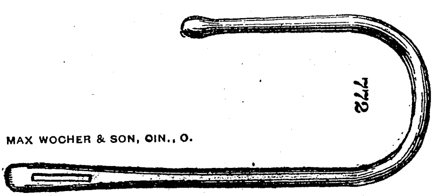


Fig. 11.—Lead probe to be inserted in the milk duct after teat slitting, and retained until healing and danger from excessive contraction of the wound is passed.

TESTS OF EXPERIMENTS WITH KALMIA LATIFOLIA.

We used a 5 per cent. infusion of the leaves, which was prepared under the direction of E. R. Miller, professor of pharmacy.

I. A scrub cow, about 5 years old, weighing 600 pounds, was used.

Her temperature was 103.2 Fah., respirations 10 and pulse 34 just before the drug was given. At 3 p. m. she was given 3 quarts of the 5 per cent. infusion.

At 4 p. m.—

Temparature	103.2 Fah.
Respirations	10.
Pulse	37.

At 5 p. m.—

Temperature	103.4
Respirations	10.
Pulse	36.

Pulse slightly irregular; cow showed distinct muscular weakness; wabbled about as if drunk; pupils slightly dilated; some muscles showed quivering or twitching movements.

At 8 p. m.—

Temperature	102.4
Respirations	11.
Pulse	24.

In attempting to move, cow fell and was unable to rise. Pulse somewhat irregular and weak; muzzle dry and mucous membrane pale and dry; pupils greatly dilated (amaurotic); some muscular twitchings.

At 9:30 p. m.—

Temperature	102.
Respirations	12.
Pulse	36.

Pulse weak, but more regular; cow could rise, but in trying to walk fell; pupils still greatly dilated; muzzle dry, and mucous membranes pale. Air was cool, and cow was shivering.

Next morning cow was up, but weak and wabbling; pulse stronger and pupils normal in size.

Temperature	100.4
Respirations	12.
Pulse	36.

II. A bull calf, about 10 months old, was given at 10:15 a. m. one-half pint of a 5 per cent. infusion of leaves of Kalmia latifolia.

At 9:30 a. m.—

Temperature	99.2 Fah.
Respiration	8.
Pulse	32.

At 11:15 a. m.—

Temperature	100.8
Respirations	12.
Pulse	54.

At this time calf was given one-half pint of linseed oil and 2 drams of tannic acid.

At 1 p. m.—

Temperature	101.2
Respirations	10.
Pulse	48.

Calf was down, unable to rise; pupils dilated; spasmodic twitching of muscles; pulse weak and irregular.

The next morning calf was up ready for its breakfast. The tannic acid may have temporarily prevented the absorption of the poisonous principle, but prevented the oil from producing purgation.

III. A sorrel mare, about 9 years old, weighing about 800 pounds.

Just before giving the drug her

Temperature was	99.
Respirations	12.
Pulse	30.

At 10 a. m. she was given 1 quart of a 5 per cent. infusion of the leaves of the laurel ivy (Kalmia latifolia). She coughed considerable during the drenching, which indicated that some of the infusion went into the larnyx and wind pipe; possibly this made the drug act quicker than usual. At once the mare began to retch, froth at the mouth and breathe rapidly; pupils became dilated; co-ordination of muscular action lost; animal excited and struggling.

At 11 a. m.—

Temperature	96.
Respirations	56.
Pulse	46.

Breathing rapid and irregular; pulse weak; mucous membrane of nose pale and of the eye slightly congested; frequent convulsive movements of the limbs.

At noon—

Temperature	95.
Respirations	60.
Pulse	46.

Breathing still very rapid; pulse weak; animal becomes more quiet; pupils still greatly dilated. Muscular twitchings appear first in the face and extended to all the surface muscles of the body; occasionally there were convulsive movements of the limbs; surface of body cool.

At 1 p. m.—

Temperature	94.4
Respirations	52.
Pulse	46.

Animal very quiet; pupils dilated; eye dull; mucous membrane of mouth and nose of leaden color and mucous membrane of eyes congested; muscles continue to twitch; surface of body cool.

At this time (1 p. m.) the animal was given 1 ounce of 95 per cent. alcohol in 4 ounces of water.

At 2 p. m.—

Temperature	95.
Respirations	30.
Pulse	48.

Animal relatively more quiet; pupils continue to decrease in size; the mucous membranes of nose and mouth become slightly scarlet in color; muscles still twitch. Gave animal another ounce of alcohol.

At 3 p. m.—

Temperature	98.2
Respirations	28.
Pulse	50.

Pupils normal in size; muscles twitching less and more relaxed; mucous membranes of mouth and nose about normal in color, and surface of body warm.

Given another dose of alcohol with small quantity of lysol in it.

At 4 p. m.—

Temperature	99.6
Respirations	28.
Pulse	60.

Animal much better; given another dose of alcohol.

At 5 p. m.—

Temperature	100.4
Respirations	26.
Pulse	63.

At 5:30 p. m. animal was able to rise with a little help; muscles still twitching some; animal some weak, and wabbling, but able to walk about 200 yeards to a box stall.

Next morning her appetite was good, and she showed some signs of having had a hard drive, but 24 hours later she had entirely recovered.

From the three tests and from numerous cases where animals have eaten the leaves of Kalmia latifolia it is very evident that the leaves contain an active poison. Several chemists and pharmacists have found indications of an alkaloid, but a sufficient quantity has never been isolated to test its poisonous effects on cattle or horses or sheep. Sheep and cattle eat the leaves of the shrub in winter or spring when pasturage is short, and the animals are hungry for green feed. No doubt they will eat it at any season where pasturage and feed are short, and the opportunity is given to them. This flowering shrub is very common in nearly all parts of Alabama; possibly more common in hilly regions and along mountain creeks. The shrub flowers in the spring, and is an evergreen, having green leaves all the year around. It is commonly called the laurel or laurel ivy.

TREATMENT.—Alcohol acts as physiological or chemical antidote. Whiskey, brandy or alcohol (dilute) may be given every two hours in 1 to 3 fluid ounce doses. Also, a purgative of 1 to 2 pounds of Epsom salts dissolved in 1 quart of water or 1 to 2 pints of raw linseed oil. Do not repeat the purgative under 24 hours. One to three fluid drams of creolin or lysol may be added to the purgative in order to check fermentation while the bowels are inactive.

The shrub should be cut down, or, better still, grub it up and burn it, and thus prevent cattle and sheep from getting it; this is possible and practicable in pastures.

The Red Buckeye (Aesculus Pavia, L.) is another shrub or small tree whose leaves are poisonous. The clinical symptoms are very like those of poisoning from Kalmia latifolia. The treatment is about the same; at first a good purgative is given and follow it with a stimulant, especially during the period of depression. In pastures grub it up and burn all the Red Buckeye bushes and small trees.

Batchelor (American Journal Pharmacy, 1873, p. 145), found in the seed of the red buckeye, a poisonous glucoside ($2\frac{1}{2}$ per cent. in seed). It acted on the cat somewhat like strychnine. The leaves are said to be most poisonous just before, or about, the time of flowering. Cattle and sheep usually become poisoned by eating the leaves, and occasionally by eating the seed.

POISONOUS PLANTS CONTAINING HYDROCYANIC ACID.

Prof. E. R. Miller, Pharmacist at the Alabama Polytechnic Institute, found that the leaves, bark and root of the *Prunus Carolineanus* (mock orange) contained hydrocyanic acid.

Prunus serotina (wild cherry),

Prunus Virginiana (choke cherry, and

Prunus Persica (peach), all contain hydrocyanic acid at times in their leaves. They contain amygdalin, a glucoside and emulsin, a ferment or enzyme. In the presence of water the emulsin acts on the amygdalin and hydrocyanic acid, glucose and a volatile oil are formed. The action of the ferment is destroyed by boiling.

The leaves of these plants are said to be more poisonous or contain more hydrocyanic acid when kept in a wilted condition, without completely drying out, for several hours. In the rumen or first stomach of the ox or the sheep where there is little or no acid and where the food macerates in a watery secretion, neutral or slightly alkaline, would be an admirable place for emulsin to act on amygdalin and produce hydrocyanic acid.

Sorghum (*sorghum vulgare*), according to Peters, Slade and Avery, of the Nebraska Station, contains hydrocyanic acid when it is stunted or checked in growth by dry seasons and also *young, frosted* or second growth sorghum may contain it. No doubt, many of the reported cases of sorghum poisoning are due to acute indigestion (bloat) and not to hydrocyanic acid. As the conditions now stand no one can tell when sorghum is poisonous without a feeding test or a chemical analysis. Cases have been reported of poisoning from feeding kaffir corn and pasturing Johnson grass, but the presence of hydrocyanic acid has not been discovered in Johnson grass.

In August, 1902, Mr. J. P. Logan, of Selma, Ala., reported the following facts to me:

Nine head of cattle were turned into a Johnson grass pasture for the first time; it was about four o'clock in the evening; the cattle became sick in ten minutes after eating the grass; gave 8 of them linseed oil and alum; 2 died that night and 6 recovered; one not treated died in three hours.

The Johnson grass from this field was tested for hydrocyanic acid, and none was found in it. The recoveries, by the treatment given, seems to indicate that the cattle had acute indigestion.

In July, 1899, during a very dry time, Mr. Hazzard, a dairyman of Birmingham, Ala., turned 20 cows into a sorghum field that had been injured by army worms and by drouth; in twenty minutes, he says, 18 were dead; 2 were saved by treatment. The 18 cattle died within 50 feet of the gate through which they passed into the sorghum field.

Hydrocyanic acid is a very unstable compound, and this accounts for the fact that many plants that sometimes contain it do so only under certain conditions and for a short time. Any condition that checks or stunts the growth of sorghum should lead one to regard it as a dangerous feed until proven otherwise.

Symptoms of hydrocyanic acid poisoning are the same regardless of the source of the drug. Of course the larger the dost the more rapid and fatal its action. It can be absorbed from the unbroken skin when in a pure watery solution: it is readily absorbed from the alimentary canal acting as a sedative and anaesthetic on the mucous membranes. Small doses depress the heart by stimulating the vagus centre in the medulla; large doses stimulate the vagus centre and depress the heart by acting directly on it, paralyzing it almost instantly. The vaso-motor centre is paralyzed and blood pressure falls very low.

The respiratory centre is paralyzed usually before the cardiac or vaso-motor centres. Toxic doses produce insensibility and coma; in animals convulsions may occur. Large dose paralyze the peripheral nerves and the voluntary muscles. Shortly before death the spinal cord is paralyzed. The pupils are dilated. In brief, hydrocyanic acid quickly depresses respirations, the pulse or heart action and blood pressure, and paralyzes the muscles and nerves of the limbs; depresses the action of the alimentary canal and dilates the pupil. In many cases these actions are so quick that there is no time to give antidotes or treatment. Drowsiness, running at eyes, twitching of the muscles, staggering gait, inability to stand, involuntary passing of urine and feces, dilated pupils, frothing at the mouth—are given by Peters as the prominent symptoms.

In cases where time is given for TREATMENT give a stimulant of 1 to 4 ounces of brandy, whiskey, or diluted alcohol or ether. When the animal can not swallow, give the drug per rectum or hypodermically. Stimulate respiration by holding dilute ammonia to the nose and by giving one-half grain doses of strychnine hypodermically once every three or four hours.

As soon as the animal can swallow give cow or ox 1 quart of melted lard (not too hot), or 1 quart or raw linseed oil and 1 pint of syrup diluted with 1 pint of water. If cow begins to swell from the formation of gas by fermentation in the stomach and intestines, give ½ ounce of creolin in 1 quart of water. Do not repeat purgatives under twenty-four hours. Sheep and calves take doses of medicine about one-fourth as large as full grown cattle.

In all cases where possible prevent the animal from eating the leaves of the mock orange, the cherry and the peach—especially wilted leaves on recently cut or pruned branches. In case of sorghum, always test the stunted sorghum by cutting and feeding a little before turning cattle into the field to graze on it. In fact, it is best and safest to begin to feed it gradually, by the soiling method, and after the cattle have been brought up to full feed in that way, they may be turned into the field for a short time each day until they become accustomed to it. Very few cases of accidental poisoning have been produced by cutting sorghum and feeding it to cattle; yet such instances have occurred both with sorghum and kaffir corn.

Phytolacca decandra has been reported as poisonous for cattle. G. R. White, in the Journal Comp. Med. and Vet. Arch., 1902, p. 439, reports that 5 cattle out of a herd of 13 were affected with haemorrhagic enteritis accompanied with dysentery. These cattle had eaten large quantities of phytolacca, and White attributed the enteritis to the eating of that plant.

From an unpublished article of Prof. E. R. Miller, of the Alabama Polytechnic Institute, at Auburn, I obtained the following facts:

Three different times Prof. Miller became sick following the grinding of the roots of phytolacca. The sickness was very like the preliminary symptoms of influenza; alternate periods of chilling and high fever; intense headache; insomnia and restlessness; some irritation of nose and throat; lasting for about 24 hours. Two students were very similary affected; also a negro ground the roots of phytolacca and was similarly troubled. One student was not affected; another had irritation of the nose and throat and eyes, lasting about 24 hours.

The professor became affected three different times; 3 students and a negro once and one student was apparently unsusceptible. The following was reported to Prof. Miller:

A boy applied a decoction all over his body for the itch, it produced vesication, and the skin peeled off as from a blister. It is reported that many people eat young poke root as "greens;" possibly the cooking produces some change that renders the poison inert.

It is also suggested that the young plant may not have or contain the toxic principle; as a rule, most plants contain the greatest amount of their active principles just before or at the time of blossoming.

The seed or fruit of phytolacca are said to contain *phytolaccin*, phytolaccic acid, sugar and gum; the root of phytolacca a resin, probably a glucoside and a volatile acid. Prof. Miller and his students have obtained strong indications of several alkoloids.

Having never treated a case of phytolacca poisoning, I can only suggest that small oleaginous purgatives be given and the animal be fed soft feed in small quantities. Raw linseed oil one-half pint and creolin 1 to 2 drams might be given once or twice per day. If the animal is in pain give 1 to 3 drams of fluid extract of belladonna or 4 drams of tincture of opium two or three times per day.

DYSENTERY IN YOUNG ANIMALS.

Young calves, lambs or colts may have an infectious form of dysentery that begins usually during the first few days, or not later than two weeks, after birth; in some instances infection may occur in calves several weeks old. The cause of the disease, according to Nocard, is a short, stumpy, bacillus with rounded ends; frequently found arranged in parrallel lines, like a comb, with short, close teeth; sometimes they are in linear series, having very short joints, becoming thicker until last segment, which is longer and club-shaped. Some are swollen in the centre and drawn into threads at extremities; others are ovoid like cocco-bacilli. From Nocard's description the bacillus seems to take on a variety of forms; it is found in pus and in free or intercellular masses. It is an obligative aerobe; stains always by Gram's method; grows in or on all media at a temperature above 86° F. (best at 95° F. to 100.4). It grows best on coagulated blood serum where in 36 to 39 hours appear a number of colonies with a shining surface, slightly raised in the centre, and appearing to send a number of roots into the medium; these colonies are white on serum from the horse, bright yellow on serum from the ox, and gray on coagulated blood.

Nocard, Lasage and Delmer believe that the principal, if not the only, method of infection is by way of the umbilical (navel) cord. Infection occurs during birth or immediately following birth while the cord is soft. Possibly it occurs in the vagina or vulva, or most likely after the cord is torn or broken, and the young is on the ground. Nocard attempted to infect calves by the alimentary canal and by the respiratory passages, and failed. But he succeeded by subcutaneous inoculation.

The experiments of Nocard, Lasage and Delmer were confined to calves in Ireland and on the continent of Europe; and their tests may not be conclusive, yet the evidence points very strongly toward navel infection.

Law, Friedberger and Frohner, de Bruin, Moussu, Deikerhoff, and others believe the disease is infectious. Many attending or predisposing causes are given, some of which are aids to transmission or infection. The following are given by various authorities as causes, both of infectious dysentery and of ordinary diarrhoea, or dysentery:

The young or new-born offspring failing to get the first milk (colostrum) which is laxative in its action and is consequently required to remove the meconium (fœtal feces) from the alimentary canal of the young. Without it the young animal is liable to have indigestion, constipation or diarrhœa: any one of these conditions might favor infection with the germ of dysentery.

Filthy, dirty milk; sudden changes from whole milk to skim milk, or from skim milk to whole milk, or sweet milk to sour; putting a young calf on a cow far advanced in the period of lactation (milk contains too much solids); adding too much meal to milk or giving too much dry meal or corn to young calves when the salivary glands are insufficiently developed to digest the starchy food; giving cow's milk to the foal without proper dilution or modification; filthy buckets or udders; damp, filthy, unclean stalls, barns and pens; bad water from infected wells, tanks, troughs or vessels; ergotized grasses; mouldy, decaying, irritating vegetables or grains or hays; too much cotton seed or cotton seed meal; allowing colt or calf to suck when dam has been over-heated by violent exercise; feeding young calf or colt only once every twelve hours; feeding too much (over feeding); great irregularity in feeding, allowing calf or colt to get very hungry and then rapidly devouring a full feed.

Symptoms.—Some cases begin with constipation; others with soft, soon becoming watery, bowel discharges, which may be white like undigested milk, or grayish or yellow in color. At times the calf or colt is restless, with more or less straining to pass feces; appetite (stops sucking) is lost; abdomen may become distended or swollen and tender or tucked up (contracted) and tender; feces becomes frothy, bad smelling and sometimes streaked with blood; calf may bellow and slobber; the calf, colt or lamb may become dull,, stupid, weak, emaciated and die in one to three days, or may live one or two weeks and die or make a slow recovery.

Some cases have pneumonia, inflammation of the articulations, peritonitis, laminitis, hepatitis (inflammation of the liver), or opthalmia (inflammation of the eyes). This disease is very frequently found in herds where infectious abortion or tuberculosis exists.

About 80 per cent. of the cases in foals are fatal; 54 to 90 per cent. in calves and 66 per cent. in lambs.

Post mortem conditions—Here and there may appear erosions or desquamations and red or congested areas in the mucous membrane of the intestines, and sometimes in the stomach. Catarrhal exudate or pseudo-membranous patches may occur on the mucous membrane of the intestines. Peyer's patches may be infiltrated and prominent; sub-mucous infiltrated, softened, and marked by small red spots (hæmorrhagic spots.) Sometimes hæmorrhages may be found in the small or large intestine or in the stomach. In calves and lambs the desquamation of epithelium is most marked near the pyloric end of the fourth stomach. The contents of the intestines may be yellowish, white, gray, red, mucou-purulent and very fœtid. The intestinal lymph glands are usually enlarged.

Some cases show inflammatory changes in the lungs, liver, peritoneum, kidneys, spleen, heart, articulations, and eyes.

Treatment.—Prevention is the only means of successfully combatting this very fatal disaese. Cleanliness and disinfections will usually keep it from a place or herd. The stalls, pens, barns, buckets, water, feed, milk, cows and calves must be kept clean. Regular feed, with proper quantity and quality, avoiding any or all sudden or radical changes and the extremities of too little and too much feed, will tend to maintain healthy calves, colts and lambs.

It is always safer and better to milk a cow that is far along in the period of lactation and dilute the milk with water that has been boiled and cooled and feed it to the calf than to turn a young calf to such a cow. Do not force meal, corn or other grain upon the young calf before its digestive apparatus is sufficiently developed to digest them. At least wait one or two weeks and then begin the use of such feeds very gradually. Never permit the calf to eat mouldy, decayed or rotten feed or hay or vegetables; keep it in well ventilated, clean, dry stall or pen and give it freedom in a clean, grassy pasture all the time that weather will permit.

Nocard recommends the following:

"White scours is generally the consequence of an umbilical (navel) infection which takes place at the time of parturition. Farmers may prevent the disease by conforming strictly to the folowing instructions:

1. Cows that are at the point of calving should be provided with dry and clean litter until after the act of parturition.

2. As soon as the premonitary signs of parturition are observed the vulva, anus, and perineum ought to be washed with a warm solution of lysol, of a strength of 20 grammes to a liter of water (2 per cent. solution). At the same time a large quantity of this solution may be used to syringe out the vagina.

3. As far as possible the calf ought to be received into a clean cloth, or at least on a thick layer of fresh litter, which has not been soiled by urine or excrement.

4. Immediately after birth the cord should be tied with a ligature (strong string) that has been soaked in lysol. (The tie is made 2 to 3 inches below the abdomen and the cord cut off one-half inch below the ligature.)

5. Mop or cover the umbilicus and remainder of the cord with the following solution:

Rain water	1 quart.
Iodine	30 grains.
Potassium iodine	1 dram.

6. The disinfection of the umbilicus and cord should be completed by applying the following:

Methyl alcohol	1 quart.
Iodine	30 grains.

7. When the alcohol has evaporated the operation will be completed by dressing the cord and umbilicus with a thick layer of iodised collodion (1 per cent.). As soon as the collodion has dried the calf may be left with its mother."

In one outbreak of infectious dysentery in valves I have had good results by employing the following dust powder:

Tannic acid	3 ounces.
Boric acid	3 ounces.
Iodoform	4 drams.
Salicylic acid	4 drams.

Mix and apply to the ligated cord and umbilicus (navel) immediately after birth and two or three times per day during the first three days. This thoroughly disinfects and also dries up the cord very quickly. It can be applied with a dust blower or sifter.

If calves are allowed to suckle a cow, it is always best to wash the udder once or twice daily with a 1 or 2 per cent. solution of creolin or lysol. Just before birth it is wise to wash the vulva, anus, perineum and tail of the cow with one the above disinfectants.

Barns, lots and pens must be thoroughly cleaned and disinfected. Change calves and cows from one cleaned and disinfected place to another and keep well calves entirely isolated from sick ones. Use plenty of lime, whitewash, carbolic acid, creolin, lysol and other disinfectants on walls, floors, etc. Above all wash and scrub often the walls and stalls.

Curative Treatment is not very promising; hence the great number of remedies herein suggested.

It is usually best to begin the treatment with a purgative in order to remove the fermenting and irritating materials in the alimentary canal.

For the calf or colt give 1 to 2 ounces (2 to 4 tablespoonsful) of castor oil; the lamb can be given one-fourth as much. Or, rubarb may be given in 30 to 60 grain doses to the calf or colt and 7 to 15 grains to the lamb. Or, calomel 6 grains for colt or calf and 1 grain for lamb.

Tincture of opium is sometimes given with, or following, the purgative.

Law recommends the following:

Tincture of cinnamon.......	2 fluid ounces.
Chalk	1 ounce.
Gum arabic	4 drams.

Mix and give to calf or colt 1 tablespoonful 2 or 3 times per day.

Cadæc uses:

Subnitrate of bismuth	5 grains.
Salicylic acid	5 grains.
Naphtol	20 grains.
Syrup	5 ounces.
Distilled water	4 ounces.

Mix and give to calf or colt 1 to 2 tablespoonsful after each time it is fed.

Another authority advises the following:

Coal tar	5 ounces.
Boiling water	6 quarts.

Let cool and give one-half pint evry half hour. This is very useful in cases where liver is involved, (indicated by yellow mucous membrances).

Lime water is sometimes useful: Give on to four tablespoonsful after calf has taken its milk. It is well to boil the milk and allow it to cool without putting cold water into it.

Some give a one or two per cent. solution of creolin; 1 to 2 ounces for calf or colt once or twice a day.

If the calf, colt or lamb is very weak, it may require a stimulant; such as coffee or a teaspoonful (calf or colt) of turpentine with egg or milk, or tincture of capsicum, a teaspoonful.

Wine of ipicac is said to be very valuable in some forms of dysentery in man. It may be given to calves or colts in 1 tablespoonful doses; 10 drops to the lamb.

ACUTE INDIGESTION IN CATTLE.

This is sometimes called "hoven" or "bloat." In the first stomach or paunch, there may be undigested, fermenting food, resulting in the formation of gases(carbon dioxide, hydrogen sulphide, etc.) and possibly some acids or toxic alkaloids or glucosides.

The causes are not always apparent, but generally it is due to over feeding or sudden change from dry feed to green succulent peavines, potato vines, corn, sorghum, clover, oats, potatoes or turnips which undergo fermentation in the paunch. When a cow or an ox lies down for some time, as in milk fever, lung fever or tick fever, the digestive organs may be checked in action or partially paralyzed; then fermentation may occur.

SYMPTOMS.—If gas is formed the abdomen becomes distended and resonant; (left flank larger than the right,) respirations are rapid and shallow; temperature about normal; animal may grunt or moan.

In some cases (Dieckerhoff) the greatest swelling or distention of the abdomen may appear in 15 to 20 minutes after eating clover (especially when the clover is in a partially withered or wilted condition on a hot day).

In some cases of indigestion there is no appreciable quantity of gas formed and consequently little or no distention of the abdomen and flanks; the appetite may be partially or completely suspended; little or no rumination (chewing and regurgitating of the cuds), the paunch or first stomach is inactive or paralyzed; bowels normal in acting during the first day, constipated or inactive thereafter, except in few instances where the bowels may be very loose and active; pulse may be accelerated; temperature normal; and in the cow the flow of milk is greatly decreased. The animal may die in 1 to 4 hours or may recover in from 2 to 8 days. When toxic gases, alkaloids or glucosides are rapidly forming death may occur in a comparatively short time.

Treatment may be preventative or curative. Avoid over-feeding of concentrates; such as corn, cotton-seed meal, oats, wheat etc., and decayed, moldy, rotton feed. But it is most difficult to prevent cattle from getting too much green feed when they accidentally get into the corn, sorghum, pea patch or clover. Prevention means continual care and watchfulness. Change from dry to green feed gradually. Curative remedies are directed toward removing the undigested food and preventing fermentation and death while removing these materials from the ailmentary canal. If the animal can swallow, give 1 to 2 lbs. Epsom salts and 10 to 20 drops of croton oil in one quart of water; do not repeat this under 12 to 24 hours. Follow or precede this with 1 tablespoonful of strong creolin in 1 quart of water. If you have nothing else and the animal continues to bloat or swell, repeat the creolin solution every two hours until the bloating ceases. If you have no creolin, dissolve as much table salt as you can in two quarts of warm water and give 2 quarts of salt water every 3 or 4 hours. If you have no Epsom salts give 1 to 2 pints of raw linseed oil, or castor oil, or cotton seed oil, or melted (not hot) lard. Remember, do not repeat the dose of Epsom salts or oil under 12 to 24 hours.

In case the animal is greatly swollen and about to die before purgatives and antiseptics can act, then you can puncture the rumen with a trocar and canula or a knife. This should be done on the left side some where between the hip point (haunch) and the last rib. Cleanse the left flank with soap and water and weak creolin solution; cut an opening through skin, about one-half inch long; now push the trocar and canula into the paunch (3 to 4 inches deep), pull out the trocar and let the gas escape through the canula for one or more hours; when you desire to remove the canula always insert the trocar into it and remove both together, this prevents infection of the wound. In case you have no trocar get a long quill or better a joint of swamp cane about the size of a lead pencil or pipe stem, boil it in water, (at least scald it), make a sharp bevelled edge on one end, and push the sharp end into the paunch through the opening made in the skin as directed above. After removing the trocar and canula or cane stem, apply weak creolin solution to disinfect the place; also give purgatives and antiseptics internally if not already given.

Feed carefully for the next few days, always give salt every day; granulated salt is better than rock salt.

PART II.

BY G. F. MATTHEWS.

ABORTION.

Commonly known as miscarriage or losing, slipping or slinking the calf, colt, lamb, whichever the case may be.

Abortion may be defined as delivering (parturition) before the end of the regular period of pregnancy (gestation) or before the young has fully completed fœtal life whether the little creature be dead or alive. Foetal live refers to life before birth, the young up to this time being a foetus. The average period of pregnancy in farm animals is for mare and jennie, 11 months and 15 days; cow 9 months and 15 days; sheep and goat 5 months; sow 4 months. If an animal delivers a few days before time the deviation is unimportant since the period of pregnancy may vary a few days with different individuals and under different circumstances.

Abortion, from an economic standpoint, takes rank among former animals as follows: Cow, Mare, Sheep, Sow. The cow is the most liable while the sow is seldom subject to the mishap.

The viability or whether the fœtus is capable of living is another question. Usually it is dead. A dead foetus may be delivered at any time during pregnancy, but when abortion occurs in the first two-thirds of pregnancy the foetus is always dead. In the last third a live fœtus is frequently born.

The later the stage the more likely is the little creature to live. Many die immediately, and others are weakly and prove to be absolutely worthless, and in rare instances one becomes sufficiently vigorous to develop into a valuable animal.

Some idea of the number of living calves delivered by aborting cows in the last months of pregnancy and their value may be had from the record reported by Nelson of the New Jersey Experiment Station. Twelve cows aborted. Four births occurred between the 6th and 7th months; four between the 7th and 8th months; and four between the 8th and 9th months. Three of the twelve were dead: 1 died; 6 were killed and 2 were raised. Thus only a small percentage were of sufficient promise to be kept, and it is a question if it ever pays in the long run to raise any of them.

Abortion may be either non-infectious or infectious. When occurring in the latter form it assumes an enzootic or an epizootic type and it is of greatest importance to recognize this form in order to prevent the spread of the contagion.

Non-infectious abortion.

Non-infectious abortion results from some known cause or accident, irregular feeding, improper feed, etc., or happens only as a casual affair not preceded or followed by miscarriage in the same individual or other members of the herd. Not only should the home herd be excluded as a sourse of the disease, but the mishap should be free from any relationship whatever with a similar accident among cows which the attending bull may have served.

Causes: The causes of non-infectious abortion are too numerous to discuss in detail. Frequently it is to be ascribed to the poor condition of the pregnant animal. This may result from insufficient or improper food and irregular feeding. The fœtus dies for the want of nourishment, and is expelled as a consequence. Chronic wasting diseases may have a like effect by deranging digestion impairing assimilation and impoverishing the blood.

According to some authors an extremely fat condition predisposes an animal to abortion. This is said to occur most frequently in old cows of improved beef breeds suffering with fatty degeneration of the heart, the circulation being weak and irregular and insufficient to supply the fœtus.

Drinking ice-cold water and feeding upon pastures covered by frost, or eating herbage which has been injured by frost, have caused abortion. One writer reports an instance where one-fifth of the pregnant ewes in a flock of sheep aborted immediately after drinking from a hole made through ice.

Overloading the paunch (rumen) with succulent foods, like green sorghum, clover and cow-peas, especially when covered by dew; apples, sweet potatoe vines or tubers, etc., and gorging the animal with stimulating foods like corn, wheat, peas, beans, cotton-seed and cotton-seed meal are exciting causes.

Foods improperly harvested and improperly cured, musty, molded and partially decayed foods may set up fermentation in the paunch, which compress the womb and kill or displace the fœtus.

Acute diseases, manifested by colicy pains or circulatory disturbances, may be followed by abortion. Diseases of the rectum and urinary organs, as diarrhoea and inflammation of the kidneys, bladder, etc., are predisposing causes. Parasites, like worms in the intestines, liver or lungs, and lice, are accessory causes.

Medicines injudiciously administered to ailing animals are as liable to cause abortion as the affliction. Large doses of purgatives are to be avoided, also another class of drugs known as ecbolics, rye-smut, corn-smut; cotton-root bark; cotton-seed, and cotton-seed meal, probably possess to a slight extent the active principles of cotton-root bark. Evil effects from this source have been overestimated. Grain smuts, seeds, leaves, etc., containing medicinal principles, must be consumed in enormous quantities usually to cause deliterious effects upon healthy organs. Taking for example, the smut of rye (ergot), which is the most potent of the class; it is said to require 10 pounds of the select drug to produce acute poisoning in a 750-pound cow. Such enormous quantities are not likely to be consumed at one time. The chief danger is in pasturing cattle continually on pastures where smut is abundant. A moderate quantity is consumed each day, without bad effects at first, but after a few days the active medicinal principles in the smut will have accumulated to such an extent as to cause chronic poisoning (ergotism), and abortion. Chronic poisoning from rye smut is rare, and it is questionable if corn smut ever has that effect. Drugs, like spanish fly, which irritate the urinary organs, and purgatives which stimulate the involuntary muscles of the rectum to excessive action should be given to pregnant animals with caution, if at all.

Sudden fright, thunder storms, chasing by dogs, and the smell of blood, or the discharge from an aborting animal, may cause abortion in sensitive, highly-bred Jerseys.

Miscarriage may follow sudden changes in the weather especially if the victims are poorly nourished.

Violence in any form is a fruitful cause of abortion. Mares which "balk" or refuse to pull and cows which "sulk" or refuse to travel about from the unmerciful beatings received.

Jars and jolts in railway cars, and shipping long distances may cause the trouble.

Mounting other cows or being mounted by other cows or the bull; falling into ditches or having the hind foot slip unexpectedly into gutters behind the cow; jumping fences; crowding through door ways; and so on indefinitely may result in abortion.

While it stands to reason that slight injury is less liable than severe violence to result in abortion, the results cannot be judged by the extent of the violence, for at one time an animal will carry her fœtus successfully through a violent accident, and at another time abort after sustaining the most insignificant injury.

In one case a calf which was born alive, but required the assistance of a surgeon for delivery, and died as a consequence of the manipulation, was found to have one hind leg bent at right angle just above the hock. When the flesh was boiled off, the bone showed evidence of having been broken, union being complete with the exception of a small spicule of bone projecting from that part where the tissue had separated most. The owner had not seen any accident, but remembered a break in a rail fence, made, probably, by this cow, about one month prior to delivery. At any rate, it shows that a pregnant animal may suffer violence little short of death of the fœtus and not abort.

On the other hand, the most insignificant accident may be responsible for abortion. A mare had one hind foot to slip unexpectedly through the board crossing over an open ditch. The foot sank but a few inches, not more than 12 or 15, as the drain was not deep. However, the mare aborted and the owner could ascribe the mishap to no other cause.

A dead fœtus is seldom retained, though in exceptional cases it may remain in the womb until quite putrid. The fœtus may be killed as a result of external violence; die from displacement or twist of the womb; excessive collection of fluids in the fœtal membranes; deformation; diminished circulation or impaired nutrition, whether affecting it directly or indirectly through condition of the mother.

The symptoms, cause and after treatment does not differ materially from that of infectious abortion. The principal requisite in treatment is to remove the cause. Directions for treating retention of the after-birth (placenta) always a serious consequence in these cases and prolapsus of the uterus, will be given in the treatment of infectious abortion.

INFECTIOUS ABORTION.

By infectious abortion is meant that form of abortion which has a tendency to recur in the same subject or is associated with—proceeds or follows—abortion in other animals. Single cases caused by infection cannot be distinguished from the non-infectious sort.

Prevalence in Alabama.—

Infectious abortion is said to be widely distributed over the civilized world. In Alabama it is confined largely to the herds in the vicinity of the larger towns and cities.

The hardy range or "scrub" cattle of the State, like wild cattle, are remarkably free from the disease.

At present marked interest is being manifested in breeding beef cattle. This interest is increasing.

Several herds have been started in various parts of the State, and there is a growing desire to breed up the native cattle. Improved stock have been shipped from the North, Northwest and West for this purpose.

One purpose of this article is to acquaint present and prospective breeders with the nature of the disease and warn them of the dangers of introducing a disease which would prove detrimental to the business. The first requisite in breeding beef cattle is to secure the greatest number of vigorous calves. Infectious abortion strikes with certain fatality at this part of the industry. The only way to avoid incurring the dangers of an infectious disease is to prevent its introduction.

Dairymen, especially those who keep cows for milk and milk products, often fail to realize the economic importance of the disease. Such dairymen do not value the calves. Indeed, the loss of the calf in this case amounts to nothing, and the matter might be dismissed if there were not other sources of loss. There is another reason why some persons are led to believe abortion is no disadvantage. Occasionally a cow having missed one calving period, aborts before the next and begins to give a full flow of milk.

This is well illustrated by the report of four cases which came under the observation of W. W. Cook of Vermont Experiment Station. So also is the pecuniary loss illustrated.

One cow aborting two months before the time to drop a calf, yielded 200 gallons of milk, or the equivalent of 70 pounds of butter less than she had yielded the previous year after normal birth.

Loss from the second cow was 240 gallons of milk with a butter equivalent of 60 pounds and from the third 200 gallons of milk or 75 pounds of butter. The fourth cow, which had been milking 16 months and had carried her fœtus 7 months, miscarried without aparent disadvantage. In fact, this cow the previous year, 5 months after delivery, gave 15 pounds of milk per day and 21 pounds per day 5 months after aborting.

Causes.—Infectious abortion, as the name implies, is caused by an infectious agency, or contagion. Authors do not agree as to the nature of the germ or as to how the germ brings about the act of abortion. American and European investigators do not agree and European investigators do not agree among themselves as to the identity of the microbe. Some claiming a micrococcus and others a bacterium as the effective agent. American investigators have found true bacilli belonging to the coli group in the membranes and womb of aborting animals. Aside from this there are other reasons for separating the disease in America and that in Europe into two different types. The disease in Europe is more virulent; a longer time is required to establish immunity; and there seems to be a difference in the manner in which abortion is brought about, viz.: in some cases the germ invades the fœtus, inhabiting the alimentary canal, in one instance, and the meninges of the brain and spinal cord in another; again the infection is insinuated between the cotyledons on the maternal and fœtal membranes, and modifies the fœtal food supply, causing in either case the death of the fœtus, which, for that reason, is subsequently expelled. In America no writer has ever reported the presence of the germ in the fœtus, and the number of living fœtuses born indicate that death from modified food supply is not a prerequisite.

In view of these facts the writer will confine the discussions to what he may term the *American* form of *Infectious Abortion.*

It is singularly significant that all American investigators have found closely related, if not identical bacilli associated with the disease.

Chester, of the Delaware Experiment Station, isolated from the placenta of an aborted calf, a bacillus closely resembling the bacillus coli; which produced slight catarrh of mucous membranes when injected into the vagina of a cow. Law and Moore, of New York, found in a number of aborting cows, widely distributed over the State, a bacillus almost, if not identical, with bacillus coli in form and culture characteristics. This, also, caused more or less catarrh when injecting into the vagina of healthy cows. Law further states that this particular microbe could not be found in the vaginal discharge of cows in herds free from infectious abortion.

Kilborne and Th. Smith studied a bacillus of the coli group, infesting the vagina of aborting mares. Supurating catarrh resulted from vaginal injections in mares and cows.

At this Station we have isolated from vaginal discharge and from ulcers on the vaginal mucous membrane of two heifers which have never been bred, but which are supposed to be infected with the abortion microbe, a bacillus which is indistinguishable from the bacillus coli morphologically and closely resembles Chester's bacillus in culture characteristics. Inoculation into the mucous membrane of the vulva of an old cow, not pregnant, was followed by the formation of a small ulcer and a discharge.

The cow came in heat in a few days, but the symptoms were more pronounced than in ordinary oestrum.

Planted into the prepuce of a rabbit a small ulcer formed with undulating borders surrounding a slightly depressed granular surface.

The heifers in question, one an Angus and the other a Shorthorn, came to the hospital last February with a discharge from the vagina.

The Angus had been to the State fair in November previous, being shipped to and from the fair by rail. No disease of the kind had ever been observed in the herd prior to this outbreak, and it is supposed that the disease was contracted while at the fair or from the stock cars in which the animals were shipped.

There is a bare possibility that the germs might have been brought unintenionally to the Station on the clothing of an attendant who came from another State about one month before the disease was first noticed.

No ulcers were found on the vaginal membranes of the Angus, but there was evidence of extensive previous ulcerations. The Angus was supposed to have contracted the disease first, gradually acquiring a resistance for the microbe, and was on the way to recovery. In this case the disease yielded readily to antiseptic treatment.

The Shorthorn probably contracted the disease from the Angus, though a steer occupied a stall between the two in the barn. This heifer was at the climax of an acute attack. There was ecchymosis of the mucous membrane of the vagina as for farward as could be seen, with extensive exfoliation of the epithelium and ulceration. The discharge was odorless, but dirty, grayish and heavily turbid.

The vagina was irrigated with 2 per cent. creolin solution and packed with iodoform gauze once per day for the course of two weeks.

This discharge soon ceased, but a kind of stimulation of the genitals, probably irritation, continued as the animal was frequently in heat.

Oestrum, or heat, recurred every seven to ten days, manifested by a swollen and loose condition of the vulva. The discharge was somewhat profuse and yellowish, translucent instead of transparent.

The ulcers gradually disappeared from the visible mucous membranes and the application of medicine was discontinued. About two weeks later the animal was brough up for final examination and dismissal. But it was found that another crop of ulcers had appeared. This time the catarrh was much less severe, and the visible ulcers were very few, limited in size and closely resembled the one on the prepuce of the inoculated rabbit.

The animal was subjected to another course of treatment. Iodoform incorporated in vaseline was applied at intervals of three days by means of a swab of gauze introduced into the vagina and so manipulated as to smear the salve over all parts of the vagina. Rapid improvement followed.

About three weeks later another examination was made and a few small transparent vesicles but little larger than a pin-head were found. These vesicles were kept under observation one week. No change occurred in size, but they became somewhat more raised and translucent. There was no zone of congested capillaries surrounding the vesicles, but the vaginal mucous membrane remained more congested than normal.

This is believed to be the third crop of colonies.

Where could this renewed infection have come from? The tail and external parts were carefully disinfected and cleaned from all locia. Evidently the source of reinfection was from the uterus (8) Fig. 12—through the os uteri.

There is no doubt that the microbe inhabits the womb. Law and Moore found it on the "uterine mucosa and fœtal membranes."

Then, the successive reinfections of the vagina is accounted for by the fact that the microbe growing in the uterus (8) is protected from therapeutic measures and passing out through the os uteri (7) re-establishes a footing in the vagina as soon as the field is free from disinfectants. This, doubtless, also accounts for the almost invariable failures, however thorough the measures may have been to rid aborting animals of the infection.

Modes of Distribution.

1. The infection may be introduced into a herd by the admission of cows or bulls from infected herds. When a newly purchased cow is the carrier, whether she may abort or not, transmits the disease to cows

usually in adjoining stalls, which miscarry, sometimes one after another in consecutive order down the line of stalls. The disease may be confined to one side of the barn for years. If the bull distributes the infection, infection occurs promiscuously through the herd.

2. Allowing the bull to serve infected cows or patronizing a bull which has served infected cows.

3. Shipping in cars and keeping in pens or stalls which have been occupied by aborting animals.

4. An attendant who removes the afterbirth of an infected cow has been known to transmit the disease to other cows operated on afterwards.

5. It is possible to have the infection transmitted from one herd to another by the interchange of help or by securing milkers, herdsmen, etc., from dairies where the disease prevails. Overalls and like clothing which are worn at one farm go with the owner to new localities, oftimes without even a washing.

6. The manner of handling manure in cow barns where one trench receives the excrement from a whole row of cows in open stalls may be responsible for the spreading of the disease in the herd. It is the rule to begin at one end of the trench and push the manure along until enough accumulates to shovel in quantities, thus the discharge from an aborting cow may be scattered behind a dozen or more animals.

How the germ gains access to the genetal organs may be explained as follows:

When the bull is infected, it is easily understood how germs would be introduced into the vagina at copulation. There are a number of instances on record where the purchase, borrowing or patronizing of bulls have been responsible for serious outbreaks. More often the disease spreads from one cow to the next nearest, and so on as already indicated.

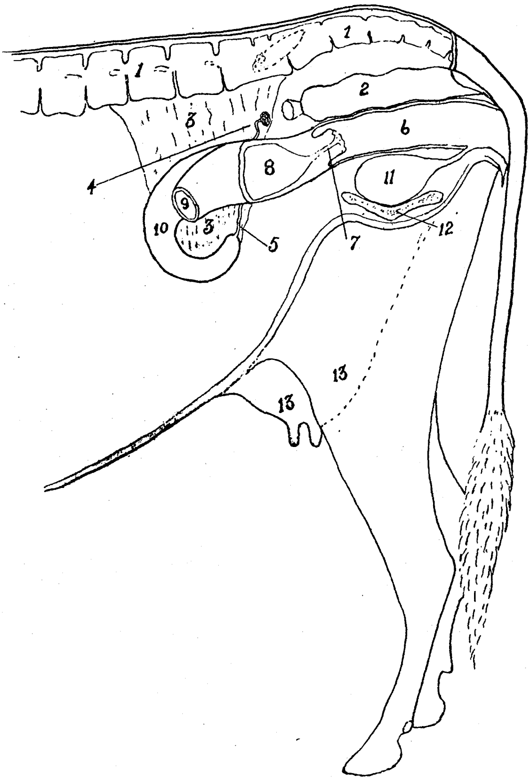


Fig. 12.—1, backbone; 2, rectum or last gut; 3, broad ligament of womb; 4, ovary or pride; 5, Fallopian tube; 6, vagina or first division of womb; 7, os uteri or opening between the two parts of the womb; 8, uterus or deep portion of womb; 9 and 10, horns of the womb; 11, bladder; 12, pelvic bone. [Nos. in () refer to Fig. 12.]

In order to understand how this may occur the reader who has no knowledge of the female generative organs, is referred to the diagram Fig. 12.

To exemplify one possible course the infecting agents might take, we will say: A cow lying in the stall has the switch on the tail soiled in a manure trench, which has been smeared with infection from an aborting subject. The cow goes out to pasture; the filth dries and is scattered over the rump by the switching tail. Some germs lodge upon the vulva and find their way into the vagina (6) where they multiply with prodigious rapidity. The germs are actively motile, and make their way through the os uteri (7) into the uterus or inner division of the womb (8), thence through the horns of the womb (9 and 10), and possibly up the Fallopian tubes (5) to the prides or ovaries (4).

Remembering the catarrh caused by the microbe, it would be strange indeed if its presence in the small Fallopian tubes did not sometimes result in obliteration of the passage and sterility. In fact, many animals do become sterile.

The existence of the Microbe in the Womb.

The indications are that the germ causing abortion remains in the infected womb for years, though no more than one, two or three abortions may occur. This is not incompatible with our knowledge of germ life. A little blood from one of our Southern cattle, apparently in perfect health, injected into the circulation of cattle brought from the North is followed by violent fever, typical of Southern cattle, or Texas fever. In this way it is proved that an animal which has had no fever for one, two or more years harbors the living parasite in its blood, and is capable of transmitting the disease to susceptible animals. Authorities are now agreed that the infection causing swine plague, often mistaken for hog cholera, live in the lungs of the pig after recovery from the acute attack, and continues to be a source of infection for other pigs many months and possibly years. This explains the reason the disease breaks out year after year when once introduced.

Nelson, after the second year's experience with the disease in the herd at the New Jersey Experiment Station, observed that either the microbe had modified its life habits to better suit the cow or the cow acquires a tolerance for the germ. At any rate, the cow carried her calf longer the second time and often carried the full period the third time. But newly purchased cows were attacked with renwed violence and young cows were more susceptible than old cows. One young cow, $1\frac{1}{2}$ years old, aborted $2\frac{1}{2}$ months after conception, and two cows, each 2 years old, aborted at 2 months, while older cows aborted after the fifth month, and the second year no cow aborted under 6 months.

Immunity.

This tendency on the part of the microbe and its host to adjust themselves to each other results after two or three abortions in a form of immunity. However immunity in this case is not meant to convey the idea that the cow is rid of the germs, but that she simply will not abort again, while for a long period the germs remain in the womb and may be transmitted to susceptible animals.

SYMPTOMS.—The first one or two months of pregnancy abortion occurs without labor pains or straining, and sometimes the fœtus lodges for a few hours in the vagina with portions of the fœtal membranes hanging from the vulva or the fœtus may be found in the stable or pasture. If these evidences pass unobserved, the discharge from the vulva may be mistaken for heat; but if the cow refuses the bull then, and allows service in due course of time, the evidence, in connection with supposed previous pregnancy, though circumstantial, is quite conclusive that abortion had occurred. Known non-infectious cases are traced to some misfortune or accident. But cases caused by infection, not being expected, more frequently pass without due consideration. However, it may be a serious mistake to neglect such cases because of the danger of disseminating the disease. Though many have claimed that abortion seldom occurs before the fifth month, the contrary is quite probable, but, being of apparently little consequence, is not taken into account.

Referring again to Nelson's experience, four cows supposed to be pregnant required service again, and abortion was suspected, though no expelled fœtus was found. This supposition was strengthened by the fact that these cows had already aborted or did abort later.

The last half of pregnancy the symptoms are more marked and the consequences more grave.

One, two or three days before delivery the ligaments relax, the flanks sink, the vulva enlarges, and the milk has a colostrum-like appearance. The discharge from the vagina is less thansparent than normal—yellowish red in cows and white in mares. Labor pains precede delivery. The animal walks around in a circle, looks at the side, lies down and gets up again; strains; and the fœtus is expelled.

The fœtal membranes pass out with the fœtus in the early stages of pregnancy, but are liable to be retained during the last half. This not infrequently happens after regular birth, but more is liable to occur after premature deliveries. The afterbirth may come away in the course of three or four days, and no further trouble be experienced. Occasionally the placenta is retained until it decays in the womb. The animal ceases to ruminate, and eats sparingly and irregularly. She stands alone with the head down, or occasionally turns to look at the side. She is dull, weak and listless. The discharge from the vulva may be profuse or slight; it is watery and carries more or less decayed tissue, making it heavily turbid and giving a dirty, nasty appearance, and an offensive odor. The tail is soiled by the putrid discharge. Frequent efforts are made to urinate. The animal becomes lean and bony (emaciated), and may linger weeks in this condition. The system may cast off the putrid matter, and the cow recover, or if the condition grows worse, she grows weaker and weaker until death. Less frequently the animal dies from blood poison.

Prolapsus of the uterus or inversion of the womb is sometimes a sequel to abortion. Inversion of the womb is recognized by a tumor-like mass projecting from the vulva, moist and red at first, but becoming dark—almost black—and dry after long exposure.

TREATMENT.—Retention of the afterbirth (placenta) and inversion of the womb occur so frequently in connection with abortion that it is deemed advisable to include these accidents in the treatment.

Where the womb is inverted, secure the cow in a narrow stall; wash with 2 per cent. creolin solution; oil with vaseline or lard and when the cow is not straining replace by pressing against the mass with the palms of the open hands. If the effort is not successful, or if the womb is inverted again as often as replaced, obtain the assistance of a surgeon or some one who has had experience with such cases.

An afterbirth retained longer than three or four days should be removed by manual effort. Secure the animal in a narrow, open stall.

The arm bare to the shoulder, is washed in 2 per cent. creolin solution and introduced. The os uteri (7) will be found dilated as long as the afterbirth remains connected with the womb, and should the afterbirth decay in the womb, the os uteri will remain sufficiently open to admit a man's hand long after delivery. (If all the fœtal membrane is expelled when the calf is born the os will close in one to three days.) Whatever parts of the afterbirth protrudes from the vulva is grasped by the free hand and gently pulled while the hand in the womb traces the membrane to its attachments and each attachment is separated by teasing with the ends of the fingers.

In neglected cases where the afterbirth has decayed, the membrane will be found in a semi-fluid state collected in the deepest cavities of an apparently paralyzed womb. The putrid content is scraped or scooped out with the hand, fingers kept close together and bent half way to palm.

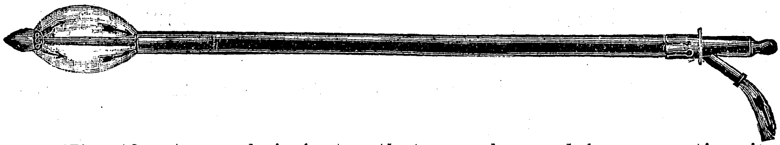


Fig. 13.—A womb irrigator that may be used by connecting it to a fountain syringe.

The womb is flushed, with 2 per cent creolin solution, and again scooped out and the process repeated until the womb is clean. Creolin solution may be introduced by means of an ordinary fountain or rubber bulb syringe with a long rubber discharge tube, the free end being carried arm's length into the womb by the hand.

Prevention.—Referring now to the disease proper prevention is urged as the only economical course to pursue. Enough has already been said to imply that the infection once introduced will baffle the most careful effort to effect its destruction. Some of the principle means by which the disease is distributed have been detailed and it is not necessary to refer to the subject again, except to urge that no animal be purchased from any herd where the disease prevails, or has been known to exist in enzootic or epizootic form. Equal care should be exercised over the bull's patronage where the disease is suspected in the vicinity.

After the disease has appeared in the herd the affected animals should be isolated, at any rate given a special corner in the barn to themselves. And immediately after the bull serves an infected cow the penis and prepuce should be thoroughly disinfected.

The different methods of treatment have given uncertain results:

1. Efforts have been made to control the disease by injecting small quantities of some antiseptic, like carbolic acid, under the skin at long or short intervals, or by requiring the animal to consume such remedies with the food. But it is quite probable the only good accomplished was to satisfy the owner until the affected cow acquired immunity.

2. Flushing the womb with solutions of disinfectants have not been attended with the results expected. Persons who have applied these remedies with the greatest care and thoroughness have been surprised to see the disease appear again in the subjects treated. We have already considered the structure of the female generative organs, and it is readily understood how the germ inhabiting the deeper portions of the womb, cut off from the outer portion with the exception of a small opening, the os uteri (7), could escape the most thorough effort to apply remedies in such manner as to be efficient.

3. Attempts to stamp out the disease by means of antiseptics has met with so little success that some writers have recommended the slaughter of all animals affected. Disposing of the animals with a view to pur-

chasing new subjects is, however, an unsatisfactory practice. All experience goes to prove this. For example, Mörck refers to a herd where the animals were sold off as they aborted and new ones purchased to take the place for a period of eight years without improvement. The owner then resolved to keep the animals at all hazards, and within two years abortion disappeared from the herd. This method would be practicable where the owner is prepared to sacrifice all exposed animals for slaughter and begin business with new stock and in different quarters. A cow, it matters not how valuable her milking qualities, should never be sold for breeding purposes if she is suspected of having infectious abortion.

4. There is another recourse for the breeder; he can establish immunity in his herd. This will, perhaps, entail the loss of two or three calves, for each cow, and a reduction of milk during as many periods of lactation, but, after all, it is doubtles the most economical course to pursue.

In making up a forecast for a line of treatment we are reminded that cows which miss one calving period and abort before the next or those which carry almost full time, often give a full flow of milk, seeming to suffer no inconvenience from the mishap. Also the number of living calves delivered by aborting cows implies that it may be possible to bring the infected cow to the full period of pregnancy, thereby securing a viable calf. Then, presupposing irritation, as previously intimated, to be the active cause of abortion, the first object of treatment should be to tide animals which show signs of aborting over the crisis by giving anodynes. Such a course of treatment gave highly satisfactory results at the Vermont Experiment Station. After four abortions had occurred three out of nine other cows pregnant, showed signs of aborting, but the act was prevented by the administration of laudanum and all the animals delivered without accident at the proper time. These animals were kept under the influence of the drug two weeks. Pulverized opium or laudanum may be used. For the cow the powder may be given in 2 or 3 drachm doses, or the laudanum in wine glass doses six hours apart. To counteract the tendency of the opium to constipate the animal one-fourth pound of Epsom salts may be given in the feed or as a drench dissolved in water twice a day. Fluid extract of Indian hemp is a better remedy, if a reliable quality of the drug can be had. Its effect endures longer and it also has the advantage of not interfering with the action of the bowels. The dose is one fluid ounce two or three times a day. In either case the remedy should be given several days, and weeks, if necessary.

If by this means cows can be rendered immune without ill effects upon the animal or loss of calf or milk product to the owner, all will be accomplished that could be expected.

Much can be done to prevent the spread of infection by disinfecting infected cows and bulls and premises occupied by such animals. As a matter of fact treatment is not complete without the general use of disinfectants. There is a bare posibility of freeing the animal of infection if the case be taken in hand immediately after delivery before the os uteri (7) has closed. Then the deeper parts of the womb (8) may be irrigated with the solution to be used.

Creolin or lysol in the proportion of 1 part to 50 of water is preferable for flushing out the womb. Either solution may be left in the womb with little danger, since neither drug is poisonous. However, if the animal does not eject the surplus fluid, which usually happens within half an hour, it may be well to wash out the womb with water which has been boiled and cooled These applications should be made two or three times a day while the os uteri (7) remains open, but after the os closes the application once a day should be continued for ten days.

Other antiseptic solutions, as carbolic acid 1 to 40 parts water, or corrosive sublimate 1 to 3,000 or 1 to 5,000 parts water, may be used, but requires to be washed out in a very short time because of the poisonous nature of the drugs.

The tail and other parts near the vulva should be frequently cleaned with the antiseptic solution employed.

An ordinary fountain or a rubber bulb syringe may be used for injecting solutions. The nozzle should be carried arm's length into the womb.

To disinfect bulls the nozzle of the syringe is introduced into the prepuce, and the fore-skin is held tightly about the nozzle until the cavity flows full. The practice of irrigating the genital organs with antiseptic solutions just prior to service is not to be encouraged, since conception is very uncertain after such applications. Every precaution should be taken to disinfect premises occupied by aborting animals. All dead fœtuses and membranes should be burned or enveloped in quicklime and burned.

Litter in the stall where abortion occurs should be piled up in a corner, or, better, shoveled into a box and mixed with milk of lime (1 measure of freshly slaked lime with 2 measures of water). Mop the stalls with bluestone solution (4 pounds bluestone, 4 pounds fresh lime, dissolved in 40 gallons of water), and whitewash as soon as dry.

Abortion occurring in cows which have been purchased from herds the reputation of which are not known should arouse suspicion and be isolated from other animals, and not allowed service by a bull kept for general use. Some young or old bull ready for castration may be used to test such cows.

MILK FEVER.

Dropping After Calving.—Parturiant Fever.

Cause.—The cause is unknown.

Opinions on this part of the subject are very numerous and varied. Some claim the disease is caused by the growth of bacteria in the udder or the elaboration of bacterial products which are absorbed into the circulation. Others hold that it is due to a bloodless condition of the brain or, on the the contrary, to the congestion of the brain.

The view once held that the shock at the time of calving could be responsible for the disorder is hardly tenable, since it seldom, if ever, occurs in connection with difficult parturition. More recent investigators have turned their attention to the modification of the blood, finding it extremely rich and dense, so dense in fact, that the red blood corpuscles are reduced fully one-half normal size. Whether this is due to the blood being surcharged with albuminous and fatty matters stored up for the formation of colostrum or first milk, failing to be excreted by the udder, or whether the current of nutrition intended for the fœtus failing to find its way out through the usual channel, reacts on the system through the blood, has not been determined.

Another line of argument purports to establish the theory that toxic products are produced in the womb and absorbed, leading to a form of intoxication. The arguments adduced are interesting. The fact is pointed out that the os uteri or neck of the womb (7) is open quite a long period of time before the expulsion of the fœtus, thus admitting infection and allowing time for the development of poisonous products. The absorption of these products is facilitated by the absence of a material placenta in the cow to which the disease seems peculiar. The parts are retracted and the blood irregularly distributed in the womb and intestines. This in connection with the presence in the womb of a profuse adherent and semi-solid gelatinuous mucoid substance, translucent in appearance and far less ropy than the clear and liquid discharge after normal delivery particularly favors this idea.

As a matter of fact calving is an essential condition; the disease never appears except in connection with calving, usually one or two or three days after that act, and, in rare instances, may occur a few hours beforehand. Two other conditions, less essential, but quite as constant, should be mentioned. First, the cow is nearly always a deep milker and in full flesh. Second, the disease occurs in mature cows seldom earlier than the third calving, and when delivery is easy. More or less disorder of the digestive organs always accompany the disease, but this is probably secondary, though some have thought this a source of a part, at least, of primary cause.

All breeds are subject to the malady, but the leading milk breeds, Jerseys, Holsteins, Geurnseys and Ayershires are the most frequent victims.

An animal which has once suffered with the disease is liable to have it recur at the next calving.

Symptoms.—The cow calves with ease, in most instances the afterbirth (placenta) is passed with the calf. For a period of time varying from a few hours to three and rarely four days, the cow is in apparently good health. Then, if the first signs are noticed, the cow looks anxiously after the calf; the gate is unsteady; the knees appear weak and the hind quarters rock from side to side, and the hind feet are awkardly lifted and replaced one after another in order to regain equilibrum. This is the treading act sometimes noticed. The tail also swings back and forth, following the motion of the body. The temperature is now 102-103°, the normal being 101°. Pulse only slightly accelerated, full strong and regular.

In the course of half an hour the cow staggers, bellows, walks blindly against objects, and, at times, tries to mount the manger. The hind feet are lifted high and awkardly, apearing to strike at the abdomen. She stumbles over objects and falls completely or only to the knees, but rises again. The eyes wander, appear wild and glassy or peculiarly lusterless, the rays appear to be reflected rather than transmitted. The head hangs pendant from the withers and is disposed to swing far to one or the other side. The animal seems to lose her balance and falls; falls with the limbs sprawled as if under the influence of an intoxicant. She is now unable to rise again to her feet, but at times, seeming to recover, momentarily from a torpor, an effort is made to rise. The result is characteristic. The cow comes to her knees, but the effort of the hind limbs to bear up the posterior part of the body overbalances the equilibrum at the front and the cow tumbles a half length forward. The pulse is now rapid, weak and irregular; temperature uncertain, but may be 103-105°; head and horns are said to be hot; membranes of the eye red and tears flow freely. The sphincter muscles at the anus relaxes; heat radiates from the part and rectal temperatures become less and less reliable.

After a varying period the torpor passes into complete coma. The cow lies on her breast with her head turned around to one side, the muzzle resting on the ground. This position illustrated in figure 14 is a characteristic

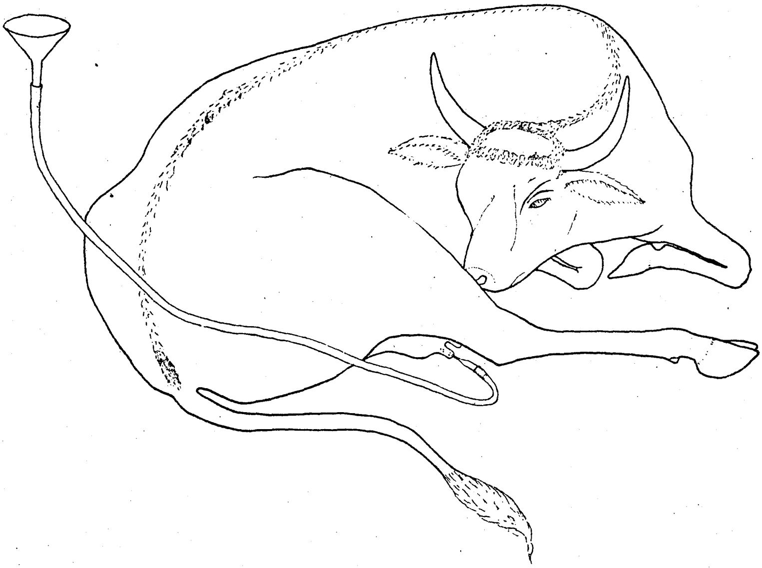


Fig. 14.—Characteristic position of cow in comatose condition. Funnel, rubber tube and milk-tube arranged for injecting Schmidt's solution.

symptom. Or the animal may stretch broadside upon the ground. While in this position the paunch (rumen) is more elevated than the head and fluids from the paunch flow to the head. About one gill of green fluid carrying particles of masticated food in suspension collect in the uppermost nostril. The presence of this fluid accounts for the rattling, gurgling sound which now accompany breathing. The muscular tissue of the gullet (œsophagus) is paralyzed. So, also, are the muscles of the voice box (larynx). Thus, when the head rests on a plane lower than the paunch liquids may gravitate unhindered to the head, collect in the nose and when the head is raised, which occurs periodically, the fluid flows back to the pharynx, thence between the paralyzed vocal cords and down the wind pipe to the lungs. Ordinarily this would cause violent coughing, but the cow is not now capable of the act. However, in fatal cases, when the wind pipe is opened after death, particles of food are found adhering to the surface of the inflamed mucous membrane. The rattling, gurgling sounds just referred to should be distinguished from sonouous vocal sounds emitted by animals when no fluids have been allowed to come in contact with the vocal cords. These sounds are low and moaning, and are due to the vibrations of the relaxed vocal cords during expiration.

Sensibility has disappeared, the animal no longer responds to pin pricks. A better test for the comatose state, however, is to place the finger on the eyeball: If the eyelids do not close the animal is insensible. Respirations are slow and indicate deep sleep. Temperature normal or below normal.

Course—The disease appears one, two and rarely three or four days after delivery. The sooner the more serious will be the consequences.

Taking a case of average severity, the couse will be about as follows: One-half hour after the first symptoms, which are seldom observed, appear, the cow is staggering, bellowing and falling; a half to one hour later she is down, but able to make efforts to rise; one to three hours she lies in a semi-conscious condition, then passes into a state of coma. In order to test whether the cow is conscious offer to put the finger in the eye, if the eye is not sensitive to the touch, the comatose stage is reached. Coma persists six to fifteen hours in favorable cases, or in fatal cases, until death, which transpires from one to four days after the first symptoms are noted.

TREATMENT—All cows which are heavy milkers and in good flesh, especially cows which have suffered an attack of milk fever, should have the feed reduced, or, what is better, be turned out to find a living on scant pastures. Lean cows are seldom (if ever) attacked, therefore an effort shauld be made to reduce the cow's flesh as a preventative measure. Some regime of exercise on a reduced food supply should begin not less than two weeks, and longer, if possible, before the cow is due to deliver. The practice of giving a purgative when the cow begins to spring is of questionable utility, if not objectionable. It is not a good practice to give purgatives to heavily pregnant animals. Three courses of medicinal treatment are admissible and attended with varying degrees of success.

1. Give a purgative while the cow is conscious, but by all means never administer drenches after the animal is unable to hold up the head. Medicines are then liable to go down the wind pipe, causing pneumonia and death.

During the comatose stage the animal must be kept braced in a normal position. This is one of the most important features of treatment, and should be executed even if it is necessary to watch over the animal day and night. Bags filled with straw or cotton-seed hulls are very convenient for bracing the animal on the breast. If she lies stretched upon the side, bags should be used to elevate the head as high as the highest part of the body.

For a good purgative use Epsom salts 1 pound, common table salt ½ pound, ground ginger 1 ounce, and aloes ½ ounce. Mix in two quarts of water; shake and drench.

Drench always through the mouth and never through the nostrils.

2. The second course of treatment aims at the same result, *i. e.*, to empty the bowels, but has the advantage of avoiding the dangers of giving drenches. Divide two grains of eserine sulphate in three parts, dissolve each part in a little water and inject into the wind pipe at half hour intervals by means of a hypodermic syringe. Repeat in twenty-four (24) hours if the animal shows no signs of recovery. This course is attended with moderate success.

3. The third course is that of Schmidt. This is by far the safest and most successful treatment known, 90 per cent. of cases are said to recover.

Dissolve 2 drachms of iodide of potash in one quart of water which has been boiled and cooled to blood heat. Inject one-fourth of the solution into each teat after milking out thoroughly. Leave this in the udder 12 hours; milk out and repeat if the animal shows no signs of improvement.

A funnel, rubber tube 3 to 5 feet long, and milk tube, connected as illustrated in Fig. 14, may be used for injecting the solution. The milk tube is inserted into the teat and some of the solution is poured into the funnel by an assistant. If the liquid refuses to flow at first compress the rubber tube a few times in the hand. This will force out some of the air and start the flow. If a milk tube cannot be secured, almost any druggist can make a tube that will serve by heating a glass rod of suitable size in an alcohol flame and drawing it out to the proper proportions. Then the broken ends of the glass are rounded in the flame.

A rubber bulb or fountain syringe may be used instead of a funnel. All vessels and apparatus to be used for injecting medicine should be thoroughly disinfected in boiling water before use.

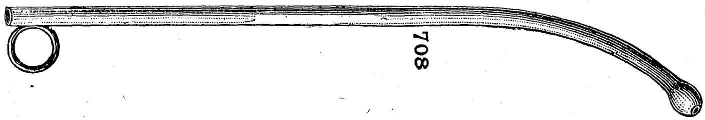


Fig. 15.—Female catheter.

Some think it advisable to introduce the hand into the womb, remove the mucous and portions of placenta that may have been retained, and irrigate the womb with 2 per cent. creolin, or some other suitable antiseptic solution. The foregoing courses of treatment should be supplemented by one-half grain doses of strychnine given hypodermically, or one grain doses given in capsules on the root of the tongue every three or four hours. Keep the animal braced in a normal position or the head elevated and expect recovery in 15 to 24 hours.

In some instances the animal suffers with debility after recovery from the acute attack. The writer's experience with such cases is limited, but usually the animal eats sparingly, digestion is impaired, and the excrement softer than normal, and lacking color. If there is no improvement, death occurs in the course of one, two or three weeks.

Some animals never fully overcome the effects of an attack of milk fever. This is manifested by the reduction in milk flow. In order to ascertain approximately the amount of permanent injury sustained from milk fever, questions were addressed to four parties taken at random, whose cows had been successfully treated with Schmdt's remedy.

Mr. L. H.: Has your cow given as much milk since she had milk fever, and how much has been the reduction?

Ans. "My cow does not give as much as before the attack. She gave a little more than three gallons, but since she has given but little more than two gallons, and I have never been able to get her above two and one-half gallons per day."

Mr. J. T.: "My cow has had two attacks, the first severe, and the second very mild. There was a reduction of one-half gallon in the milk flow after the first attack, but have not noticed any reduction after the second."

Mr. S. T.: "My cow has her third calf. Nearly two months ago she suffered a severe attack of milk fever. The milk yield is now nearly three gallons per day, which is better than at any time in her previous history."

Mr. W.: "My cow suffered a severe attack of milk fever about one month ago. She is 10 or 12 years old. She improved rapidly and as evidence that her health is unimpaired she has a ravenous appetite. She gives as much milk as ever, about 3 1-2 gallons, without extra feed."

These animals were treated by the writer or Dr. C. A. Cary, and we testify that the cases were genuine milk fever or parturient apoplexy of a severe type. Each animal passed through a stage of complete coma lasting for several hours.

INFLAMMATION OF THE UDDER—GARGET—MAMMITIS—MASTITIS.

The udder of the cow is divided into four distinct glands or portions, with complete partitions, i. e., one-quarter is not connected with another.

Prominent among the causes are imperfect milking, allowing some of the milk to remain in the udder which becomes infected, curdles, begins to decompose, and inflammation follows.

Heavy milkers are most frequently attacked. Extremely easy and extremely difficulty milkers are equally liable. Hard milkers because these are more liable to be imperfectly milked; easy milkers because a drop of milk is often carried suspended to the point of the teat, which, becoming infected, infects the milk within the udder. Milk is an ideal medium for the growth of bacteria. Injuries to the udder, like kicks, blows, etc., and even the calf punching the bag while sucking, are claimed to cause the disease.

Symptoms.

The bag is swollen, feverish, painful, and red with congested blood. Milk flow is reduced, and the milk is changed in appearance and character. The milk is lumpy or watery and may be tinged with blood. As the disease progresses it assumes the appearance of whey, containing shreds or floccules of solid matter. In some cases there is little flow or none from the teat, the bag becomes hard and unyielding, if a hind quarter the inflammation extends far up toward the vulva.

Pus or matter may form and decay progress till the affected quarter literally rots out or if inflammation is limited the pus may be discharged, the bag softens and recovery follows, though the power of the gland to secrete milk may be permanently diminished. Often the diseased products are not cast off through the teat, but an abscess forms between the teats or to one side of the bag, and opens. Pus in varying quantities discharge and stringy, ragged particles of decayed tissue may be drawn out. Such cases are prone to recover after apparently successful treatment.

Treatment.

Prevention: Milk cows with new-born calves, especially heavy milkers, not less than four times a day for a few days after delivery. Forbid the filthy practice of moistening the teat with milk before milking. Allow no filth from the bedding or portions of the after-birth to adhere to the udder or to the legs near the udder. Provide clean stables and clean bedding. Cleanliness, in all probability, is the best preventative.

Remedial: Treatment is systemic and local. Drench the animal at once with the following: Epsom salts, 1 lb., common table salt, 1-2 lb., powdered ginger 1 oz., powdered belladonna (roots or leaves) 1-2 oz., mixed with two quarts of water. Supply abundance of fresh cool water.

Begin local treatment by injecting into each teat 1-2 pint of Schmidt's iodide of potash solution (potassium iodide 2 drachms, water which has been boiled and cooled, one quart.) After the first application inject onece per day, 1-2 pint into the affected quarter only.

Rub the affected part once each day with campho-phenol (a saturated solution of camphor gum in carbolic acid; carbolic acid 1, camphor 3-5.) This medicine may be applied with the bare hands with perfect safety, and is the remedy par excellence for external use in garget. It relieves pain, and penetrating destroys infection, and acting as a counter-irritant (a mild blister) it softens the parts and hastens absorption of diseased products.

A simple treatment for which much is claimed is the application of water as hot as can be borne, at frequent intervals, followed by glycerine, vaseline or lard smeared over the parts. Glycerine is to be preferred. Empty the teats frequently by hand or by means of a milk tube, if necessary. (Fig. 10.)

ments of
Mead Wilcox.

BULLETIN No. 126. OCTOBER, 1903.

ALABAMA.

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute.

AUBURN.

A LEAF-CURL DISEASE OF OAKS.

With 1 plate and 3 text-figures.

E. MEAD WILCOX, Ph D. (Harvard).

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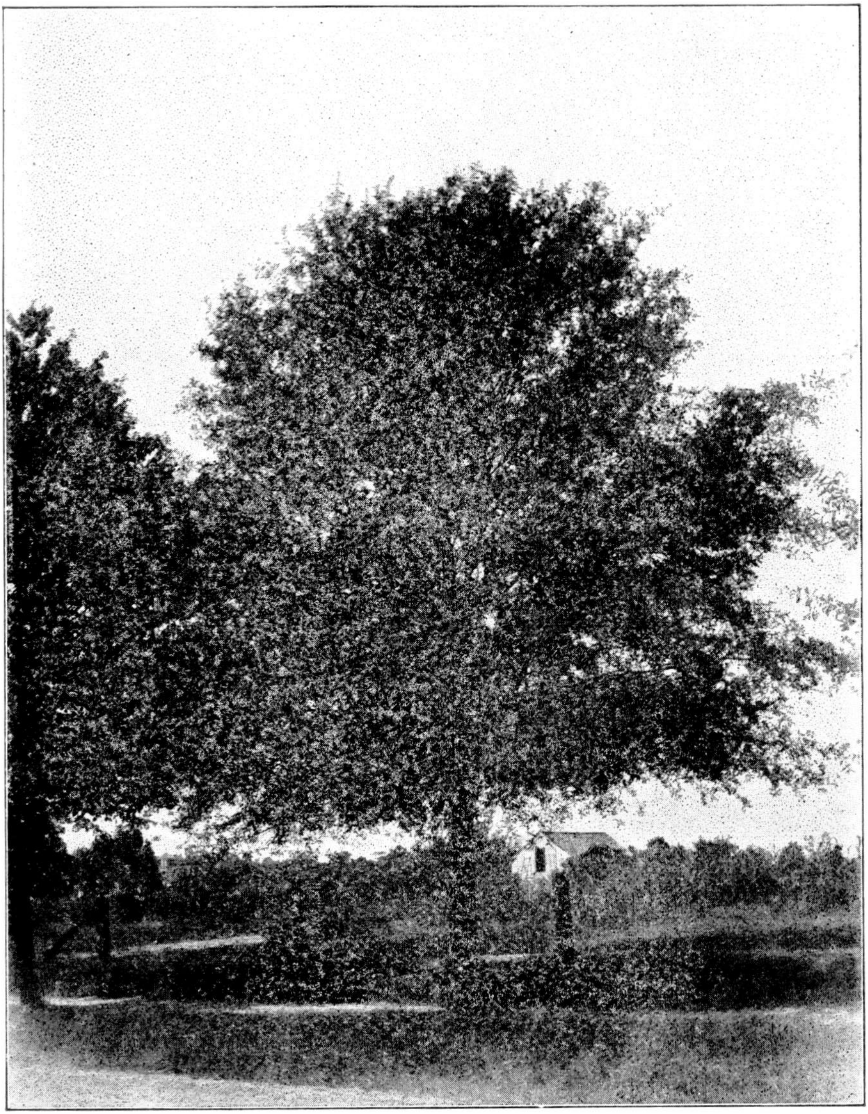

Plate 1.—Quercus nigra, one of the common shade trees in Alabama.

A LEAF-CURL DISEASE OF OAKS.

BY E. MEAD WILCOX.

Several of the native oaks are widely planted and highly prized in this State as shade trees both along city and town streets and about private dwellings. No small part of the beauty of a city or town is to be found in the number and character of the shade trees along its streets. While shade trees about private dwellings add much to the general appearance and attractiveness of the home and contribute largely to the comfort and pleasure of the occupants of the house. In fact, the general condition of the shade trees along the streets of any town may well be taken as a fairly accurate index of the prosperity and intelligence of the people of the community. Many of our people now appreciate the value of good shade trees and are desirous of protecting them against all their enemies. The purpose of the present bulletin is to call attention to one of the fungus diseases of some of our native oaks that threatens now to destroy many of these trees, particularly in our cities and towns. If, incidentally, more interest is aroused in home and city adornment through the agency of good shade trees, a useful purpose will have been accomplished in that direction.

It is a pleasure to acknowledge here the kindness of numerous correspondents in this and other States who have sent the writer specimens and notes of great value. I wish also to give expression here to my indebtedness to Dr. N. L. Britton, Director-in-chief of the N. Y. Botanic Gardens, and members of his staff, and Miss Josephine A. Clark, Librarian of the U. S. Department of Agriculture, for many exceptional favors and helpful assistance rendered in the consultation of the extensive litearture in their charge.

NATIVE OAKS USEFUL AS SHADE TREES IN THIS STATE.

The distribution over the state of the oaks that are most important for shade purposes in this state follows. Quotation marks enclose the statements made in Mohr's Plant Life of Alabama regarding the special habitat of each of the species. The species are arranged alphabetically by the scientific names.

SCARLET OAK. *Quercus coccinea* Muench).—This well known oak is frequent in the mountain region in "dry uplands, sandy and rocky soil."

LAUREL OAK. (*Quercus laurifolia* Michx—.This species occurs over the southern half of the state but is most characteristic of the central pine belt and the coast plain. It occurs in "low rich woods." This is one of our most highly prized shade trees on account of its evergreen foliage.

WATER OAK. (*Quercus nigra* L.)—This oak is rather common from the Tennessee river valley south to the coast occurring naturally in "low rich woods and sandy pine-barren swamps." This tree is very widely planted as a shade tree in every part of the state.

WILLOW OAK. (*Quercus phellos* L.)—This species is found from the Tennessee river valley southward to the central pine belt of the state but is not common in the southern half of the state. It occurs "in the bottom lands, borders of swamps. Most frequent in the coves of the Tennessee basin in low woods of a cold damp soil." This is also widely planted as a shade tree and in some towns practically to the exclusion of all other oaks.

BLACK OAK OR QUERCITRON OAK. (*Quercus velutina* Lam.)—This species occurs from the Tennessee river valley south to the upper portion of the coast pine belt. The bark is the so-called "quercitron bark" employed for tanning and as a dyestuff while the timber is of some value.

LIVE OAK. (*Quercus virginiana* Mill.)—This oak occurs only in the coast plain district and rarely extends north of about 31°. This, one of the valuable timber and tanning trees of the state, is at times in the coast plain counties a very important shade tree.

SYMPTOMS OF THE DISEASE.

The disease now under consideration makes its appearance early in the spring before the new leaves are mature. A number of grey or bluish spots appear on the leaf and the more rapid growth of the parenchyma of the leaf at these points renders the surface convex on one side and concave on the other. The concave side of this spot or area is frequently on the upper side of the leaf but the spots on the same leaf may show variation in this regard. Some trees have been seen in which the great majority of the concavities were upon the lower surface but this is by no means the rule. These characteristic depressions, or "pockets," in the leaf result from the more rapid growth set up in that part of the leaf by the presence and action of the fungus causing the disease. These areas vary in diameter from 0.25 to 1 cm and are either isolated or confluent. In some of the narrow leaved oaks, such as *Quercus phellos* and *laurifolia,* it is not rare to find the spots confluent over so large a part of the whole leaf that the leaf is as badly curled as occurs in the peach leaf-curl, a closely related disease.

The rapid spread of the disease from one leaf to another may lead to a partial or even complete defoliation of the tree in early summer. However serious the outbreak of the disease and the resulting defoliation may be, the tree generally attempts by the formation of new leaves to compensate itself for the foliage lost. In extreme cases of defoliation it is not uncommon to see a tree with an entirely new foliage covering in midsummer. In most cases the second growth of leaves is not so badly injured by the disease as was the first and it may entirely escape the attacks of the disease.

It is plain therefore from what has been said that the general effect of the disease upon the tree is much the same as defoliation due to any other cause. The effect of such a disease upon the life of the tree may best be appreciated when one recalls the fact that one of the most important functions of the leaves is to elaborate within their tissues the food material for use by the various parts of the plant in the building up of new tissues and other purposes. Even the roots are dependent upon the leaves for the food required for their growth and the defoliation of the tree may result in the most serious damage to the root system of the plant. Defoliation may result also in the great reduction of the growth in diameter of the stem, and particularly in the reduction in the amount of reserve food material stored up in stems, roots and buds for the following year's growth.

The second growth of leaves results from the proleptic development of buds intended for the following year's growth. And since, as just stated, these buds have had stored in them less food than usual owing to the diseased condition of the foliage of the tree, it is natural that the second growth of leaves developing from them should not be so luxuriant as was the first leaf covering of the tree. Under such conditions, therefore, the tree enters upon the second year's growth with a very small supply of reserve food material. The cumulative effect of the disease may therefore result in many cases in the death of the tree from actual starvation. It is very rare however that the most severe attack of the disease will result in the death of the tree during the first year.

FUNGUS CAUSING THE DISEASE.

The fungus causing this disease is one of the lower *Ascomycetes*, a group characterized by the formation of its spores in small sacs of "asci," singular "ascus." This fungus is very closely related to the *Exoascus deformans* causing the well known leaf-curl disease of peaches. Unlike the latter our fungus does not possess a perennial mycelium and is carried over from one year to another entirely through the agency of the ascospores. These germinate in the spring and form a mycelium that spreads out beneath the cuticle of the leaves of the host to form there a more or less extensive network of hyphæ. From this vegetative mycelium the asci arise in large numbers. These are more or less cylindrical in form and are packed closely together side by side. See Fig. 1.

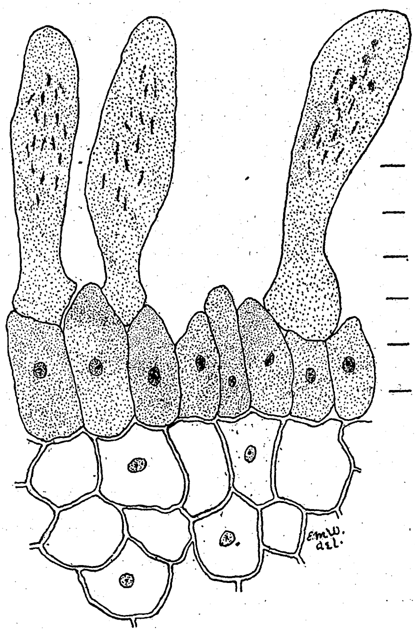

Fig. 1.—Cross section of a portion of a diseased leaf, showing the young asci of the fungus. Each division of the scale is equivalent to 10 mu.

The asci arise between the epidermal cells and the true cuticle and break through the cuticle toward maturity.

Each ascus contains at maturity a large number of small spores though it is probable that in younger stages the typical condition is the 8-spored ascus. These original 8 spores however multiply to a large extent within the ascus resulting in the much larger number that is to be found in the mature asci. The asci in the material we have examined are from 50 to 75 mu long and from 15 to 25 mu wide. The spores measured vary from 1.5 to 2.5 mu in diameter.

As has been mentioned in the discussion of the symptomoloy of the disease, the asci arise in small roundish areas upon the surface of the leaf. In the original description of this fungus Desmazieres states that the spots arise on the lower surface of the leaf but this is certainy not uniformly the case. We have noticed that in *Quercus velutina,* the black oak, the spots are generally upon the lower surface only. The same fact is recorded for this species by Robinson 1887. In *Quercus nigra,* the water oak, and some other species the spots occur on both the lower and upper surfaces of the leaves. In all the species examined these spots are at first rather definite but sooner or later several of the spots fuse together so that the spore bearing areas became very indefinite and large.

Like many of the fungi the species under consideration has been referred to under a rather large number of names in the past. Desmazieres in 1848 published the new genus *Ascomyces* Mont. & Desm. to include the single new species *Ascomyces coerulescens* Mont. & Desm. But the genus *Taphria* had been established by Fries in 1815 who assigned to it but one species, *Taphria populina,* now known as *Taphria aurea.* Fries in 1825, however, complicated matters by altering his first published name *Taphria* to *Taphrina,* to avoid, as he stated at the time, confusion with Taphria a genus of insects. Tulasne in 1866 revised the genus *Taphrina* of Fries and made it include also the species of *Exoascus.* Robinson followed Tulasne and Johanson also in including all the species of the genera *Ascomyces* and *Taphrina* and *Exoascus* in the genus *Taphrina,* as extended by Tulasne.

In my judgment the plan followed by Schroeter 1894, in taking up the original genus *Taphria* Fries is by far the best and is in accord with present practices. Schroeter assigns to this genus all those species whose asci at maturity are multisporic and to the genus *Exoascus Fuckel* he assigns all those species whose asci at maturity are 8, or rarely 4, spored. In accordance with the above statements our species shold be written *Taphria coerulescens* (Mont. & Desm.) Schroeter, and the following would be its synonomy:

Ascomyces coerulescens Mont. & Desm. 1848.
Taphrina coerulescens (Mont. & Desm.) Tulasne. 1866.
Ascomyces quercus Cooke. 1878.
Ascomyces alutaceus Von Thuemen. 1879.
Exoascus coerulscens (Mont. & Desm.) Sadebeck. 1887.
Taphria coerulescens (Mont. & Desm.) Schroeter, 1894.

PREVENTION OF THE DISEASE.

The fungus causing the disease now under consideration is an annual and its mycelium does not perennate within the tissues of the host as is true of many of the closely related forms, such as the peach leaf-curl fungus. The treatment of such fungi is very much more readily carried out than is the case with perennial fungi, a portion of whose mycelium lives over winter within the host plant itself. In fact in the case of the particular fungus causing this disease no part of the mycelium enters the host plant farther than directly beneath the cuticle of the leaf.

During the spring of 1902 an attempt was made to prevent the appearance of the disease upon a specimen of the water oak, *Quercus nigra*. The ordinary Bordeaux mixture was employed, made according to the following formula:

Copper sulfat or "blue vitrol"....	4 lbs.
Unslaked lime	4 lbs.
Water	50 gallons.

Place the copper in a coarse cloth sack and dissolve it by suspending the sack in a wooden vessel holding about 15 gallons of water. The lime is then to be slaked with just enough water to ensure thorough slaking. The slaked lime is then to be made into a paste having the consistency of thick cream by adding water and stirring. When the solutions thus prepared are cold the lime water is to be poured into the copper sulfat solution through a fine sieve. Water is then to be added to make the solution up to the required 50 gallons and the whole thoroughly stirred before and while using. If too little lime has been employed the solution may injure tender foliage and the potassium ferryconaid test should be applied to determine this point. The test consists in adding to a small sample of the prepared mixture a few drops of a solution of potassium ferrocyanid made by adding one part by weight of the salt to five parts of water. If, upon the addition of a few drops of this solution, the bordeaux mixture becomes a reddish-brown one may know that not enough lime has been employed in the preparation of the spraying solution. After the addition of more lime test again in the same manner and consider the solution ready to use only when no discoloration appears after the addition of a few drops of the test solution to a small sample of the spraying mixture.

The tree employed in our experiment was thoroughly sprayed about ten days before the buds opened and then at intervals of ten days three more sprayings were given. The dates were as follows: February 26, March 9, March 18, and March 26. Of course the first and all subsequent dates must be determined by the advancement of the season. Although the sprayed tree was in close proximity to unsprayed trees of the same species that were badly injured by the disease, the sprayed tree was only very slightly affected by the disease. More extensive experiments must be undertaken before one could say with any certainty that this line of treatment will in all cases be effectual in preventing the outbreak of this disease. But the one positive demonstration of the value of this treatment renders it very probable that the disease may be held in check by such treatment as that outlined above. It is expected that further experiments along this line will be undertaken during the coming spring with several species of oaks that are known to have had this disease during the present season.

HOST INDEX OF THE FUNGUS.

The fungus now under consideration has been reported as occurring on the following species of oaks in the states named.

Quercus alba L. White Oak. Conn. N. J.

Quercus brevifolia (Lam.) Sargent. Blue Jack. Ala. S. Car.

Quercus coccinea Muench. N. J. Wisc.

Quercus digitata (Marsh.) Sudworth. Spanish Oak. Ala.

Quercus laurifolia Michx. Laurel Oak. Fla.
Quercus marylandica Muench. Black Jack. Ala.
Quercus minor (Marsh.) Sargent. Ala.
Quercus nigra L. Water Oak. Ala. Fla.
Quercus phellos L. Willow Oak. Ala. Fla.
Quercus rubra L. Red Oak. N. H. N. Y.

GEOGRAPHICAL DISTRIBUTION OF THE DISEASE.

The distribution of this disease by states is shown in **Figure 2.**

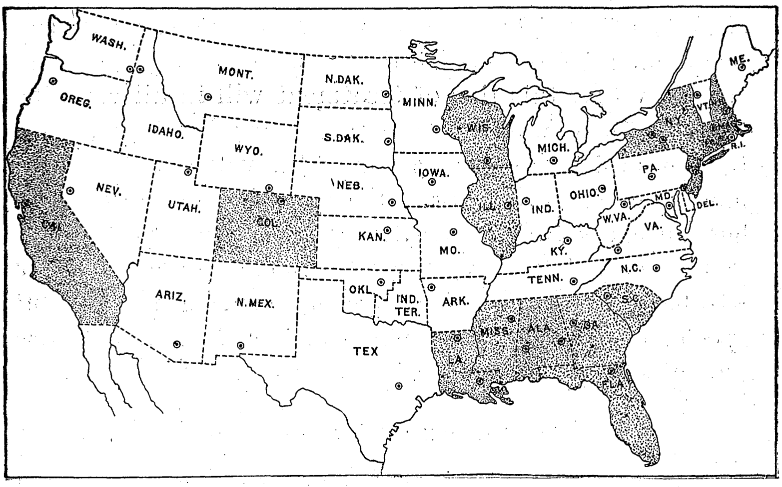

Fig. 2.—The disease described in this Bulletin is known to be present in the states shaded.

It is very likely that the particular fungus causing the disease herein considered is found outside of the areas there indicated but serious outbreaks of the disease are to be expected only in the gulf states. It would appear that the climatic and other conditions are in that region more favorable to the development of the fungus than those prevailing to the north and west. Specimens of leaves showing the disease and the fungus herein described have been examined by the writer from the following States: Alabama, California, Colorado, Connecticut, Florida, Georgia, Illinois, Louisiana, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, Rhode Island, South Carolina and Wisconsin.

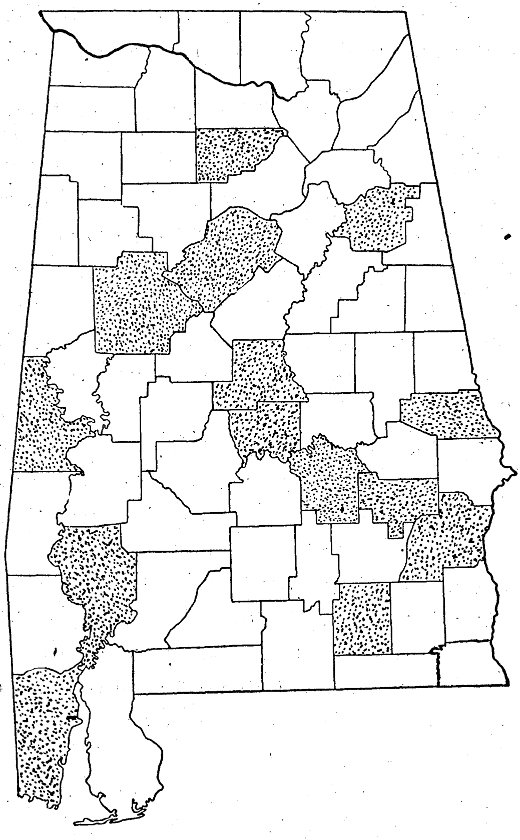

Fig. 3.—The disease described in this Bulletin is known to be present in the counties shaded.

In figure 3 is shown the local distribution of the disease in this State by counties so far as the writer has been able to examine material. The disease no doubt does much damage in every county of the State but particularly in the counties south of the Tennessee river valley. Material of the disease has been examined from the following counties: Autauga, Barbour, Bullock, Calhoun, Chilton, Clarke, Coffee, Cullman, Jefferson, Lee, Mobile, Montgomery, Sumter and Tuscaloosa.

OTHER SPECIES CLOSELY RELATED TO TAPHRIA COERULESCUS.

The following notes upon related species described as growing upon species of *Quercus* may be of interest.

Ascomyces extensus Peck .1886. Reported on leaves of *Quercus macrocarpa* from New York state.

Exoascus kruchii Vuillemin. 1891. This species was found by Kruch in Italy upon leaves of *Quercus ilicis*, and is by Schroeter referred to *Taphria*.

Ascomyces quercus Cooke. 1878. This was reported by Cook in Rovenel's American Fungi upon leaves of *Quercus cinera*. It is identical apparently with our *Taphria cocrulescens*.

Ascomyces rubro-brunneus Peck. 1887. This was reported by Peck upon leaves of *Quercus rubra*.

It is quite probable that all the above species belong in the genus *Taphria* but their specific standing we have not determined with sufficient certainty to refer to the matter in this connection.

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1878 Ravenel's American Fungi. Grevillea 6:129-146. On page 142 is the original description of *Ascomyces quercus* sp. n. This is reported from South Carolina upon leaves of *Quercus cinerea.*

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Fries, E.

1815 Observationes Mycologicæ. 1:217. On the page cited Fries gives the new genus *Taphria* Fr. and lists but a single species under it, ie *"Taphria populina"* on leaves of *Populus nigra, tremula* and *dilatata.* Fig 3 on plate 8 shows *Taphria populina.*

Fries, E.

1825 System orbis vegetabilis. On page 317 he gives the generic name *Taphrina* which he substitutes for the previously published name *Taphria*. His reason for so doing is stated to be to avoid confusion with the genus of insects named Taphria.

Fries, E.

1829 Systema mycologicum. On pages 520-521 are notes on *Taphrina* Fr.

Fries, E.

1849 Summa vegetabilium scandinaviæ seu enumeratio systematica et critica....2:518. On the page cited is a description of *Taphrina* Fries with *Taphrina populina* as the first mentioned species.

Fuckel, L.

1860 Enumeratio Fungorum Nassoviæ. On page 29 he gives a description of the new genus and species *Exoascus pruni,* and gives a figure of the same species in figure 26 on plate 1. This establishes the genus *Exoascus.*

Fuckel, L.

1869 Symbolæ Mycologicæ. Beitraege zur Kenntniss der rheinischen Pilze. On page 252 he gives under the genus *Exoascus* Fuckel the following species: *pruni, deformans* and *alni.* Fuckel here states his preference for separating the multispored species from the 8-spored, assigning the former to the genus *Ascomyces* and the latter to the genus *Exoascus;* and his objection to the inclusion of both genera in the one genus *Taphrina* as done by Tulasne in 1866.

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OF

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AUBURN.

Alfalfa in Alabama.

By

J. F. DUGGAR, Director and Agriculturist.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

ALFALFA IN ALABAMA.

BY J. F. DUGGAR.

The present bulletin combines the results of experiments made by this station and the experience of a number of farmers who have begun to grow alfalfa in different parts of the State, as kindly furnished in correspondence with the writer. This is intended as a preliminary report. Extensive experiments on alfalfa in co-operation with the United States Department of Agriculture were undertaken by this station during the fall of 1903. It is the expectation to present those results, and others, in a future publication.

Alfalfa, or lucern, (*Medicago sativa*), belongs to the family of plants that normally bear enlargements or tubercles on their roots, through which these plants are able to take the introgen of the air. Alfalfa is a perennial, living for many years without reseeding. Great numbers of buds put out from the old root each year as soon as the coldest portion of the winter is past.

During the first few months of its life alfalfa may be regarded as a tender plant, both as regards cold and drought. After it has passed through its first summer, alfalfa is extremely resistant both to cold and to drought.

The name lucern, which also is properly applied to alfalfa, has led some men, unfamiliar with alfalfa and acquainted with sweet clover or melilotus, sometimes incorrectly called lucern, to confuse the two plants. These are much alike when young. Alfalfa is a much smaller, fine stemmed plant, having purple blossoms and a coiled seed pod.

Alfalfa has, for many centuries, been an important plant, especially in the warmer portions of Europe. Above all other crops alfalfa may be credited with the foremost place in the development of the arid regions of the United States. At no distant day it will doubtless assume important proportions in the agriculture of Alabama. On all soils suitable to it in this State, it will doubtless become one of the principal foundations on which the live stock industry will be based.

USES.

Alfalfa is useful for hay making, for feeding green (or soiling), for pasturage, and for the fertilization of the soil. Its most important use is as a hay plant. Alfalfa yields more hay per acre than any other leguminous forage plant. Indeed, in yield it has few superiors, sorghum perhaps being the only one of importance in Alabama, and this falling far behind alfalfa in nutritive value. Alfalfa hay is much more nearly a complete food than is the hay of Johnson grass, sorghum, crab grass, etc.

The following table gives the composition of green and cured alfalfa, and for comparison the composition of certain other forage plants, the chemical data being taken from Henry's "Feeds and Feeding" and from McBryde's tables.

Pounds of food material in 100 pounds of forage.

	Protein or muscle-formers.	Starch, sugar, etc.	Fat, wax, etc.	Woody fiber.	Ash.	Water.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Alfalfa hay	14	43	2	25	7	9
Cow pea hay...........	17	42	2	20	8	11
Johnson grass hay	7	46	2	29	6	10
Crab grass hay	7.8	45	2	28	8	9.2
Cured corn blades	6	36	1	22	5	30
Sorghum hay (verydry.)	4	37	3	24	4	28
Green alfalfa	5	12	1	7	3	72
Green rye	2.6	7	.6	12	2	75.8

The nutrients of most value are those in the first three columns. An *average* quality of cowpea and of sorghum hay is believed to be a little poorer, and corn blades (fodder) a little richer, than shown by the figures in the table.

From the above table it will be seen that alfalfa is about as rich as other hays and corn blades in starchy materials and sugar, and about twice as rich in muscle-forming material. Alfalfa hay is about equal in composition to the best grades of cow pea hay, but is not so coarse. Alfalfa hay is suitable for horses, cattle of all ages, and sheep. It is sometimes used in the Southwest as the exclusive food for farm teams, but it is generally advisable for working animals to have some corn in addition to alfalfa. However, the use of alfalfa hay greatly reduces the amount of corn necessary to keep working teams in condition. For six weeks last summer Capt. J. C. Webb, of Demopolis, Ala., fed all the mules on one of his plantations on alfalfa alone. Although they were at work they kept in satisfactory condition. Alfalfa hay has also been successfully used as part of the winter ration for hogs. Alfalfa hay is similar to melilotus hay in composition, but much more palatable. It is less coarse, makes a better appearance, and, unlike melilotus hay, it is salable.

As a soiling plant, alfalfa may be utilized throughout every portion of Alabama, since the small area needed for this purpose will enable the soil to be suitably manured or limed or otherwise brought into condition for its successful growth. The especial advantage of alfalfa for soiling is the early date at which it is available, rye being the only other practicable crop which may be cut as early in the season. Alfalfa remains green throughout the year except in December, January, and February. In Central Alabama, alfalfa has been cut for food for horses as early as March 11. In nutritive qualities, green alfalfa is decidedly superior to green rye, and is eaten with relish by all farm stock and poultry.

Alfalfa is sometimes used as a pasture plant on soils to which it is well adapted, but is too valuable for hay or soiling to justify its general use for pasturage, until the acreage in alfalfa is greater than is needed for hay making and soiling. Pasturage shortens the life of the alfalfa plant by enabling weeds to outgrow it, and by packing the soil too closely around the crown and roots, and also by the injury resulting from very close continuous grazing. Stock should never run on an alfalfa field when the ground is wet or frozen, nor during the first year after the seed are sown. Cattle and sheep are subject to bloat when grazing on alfalfa. It is safer in this respect for horses, and perfectly safe for hogs. No one can afford to graze cattle or sheep on alfalfa unless thoroughly informed in regard to all possible precautions for decreasing the amount of bloat and unless he has a surplus of alfalfa over and above that which he can use for hay and soiling. The principal precautions against bloat are (1) feeding dry food before cattle or sheep are first turned on alfalfa; (2) gradually lengthening the daily grazing period; (3) allowing stock grazing on alfalfa to have access at the same time to a pasture containing palatable grass.

Alfalfa makes an unrivaled pasture for hogs. One may conservatively estimate an acre of good alfalfa pasture as capable of supporting a sufficient number of hogs to weigh at least 1,000 pounds. This record has been greatly exceeded. F. D. Coburn says: "Ten young hogs per acre will not damage alfalfa, and should make 1,000 pounds of gain in a season, under ordinary conditions, without grain." While hogs make satisfactory and economical growth on green alfalfa alone, they more completely utilize this crop when a little corn is fed. Alfalfa used as a hog pasture, should be mowed whenever it becomes tall or coarse, to promote fresh tender growth. Rings in the hogs' noses are advisable to prevent destruction of alfalfa pastures by rooting. The young shoots on alfalfa remain green practically all winter in central Alabama.

Alfalfa has been made into silage with varying success. In our climate where we have frequent rains, the silo might prove a profitable means of utilizing cuttings of alfalfa too much injured by rains to make good hay, but still succulent.

In Alabama alfalfa should be uesd for soil-improvement only after it has outlived its usefulness as a food plant. Alfalfa greatly enriches the soil in nitrogen gathered from the air.

YIELDS OF ALFALFA HAY.

The following estimates of their yields of alfalfa hay obtained are reported in correspondence by the parties named below:

Total no. tons. per acre.	No. cuttings.	Reported by	County.	Date 1st cutting.
3 unmanured 5 to 6 manured	4 to 7	J. C. Webb	Marengo	
4 to 5	4 to 5	J. I. Thornton	Greene	May 1.
1½ medium land 5 on bottoms	4	Dr. W. J. McCain	Sumter	May
½ to 2½	3	P. G. Lightfoot	Greene	May 10
	3 or 4	E. F. Bouchelle	Greene	April 20, '03
1 to 5	3 or 4	J. O. Hays	Greene	May 10
2 to 4	4 to 6	S. Selden	Greene	April
1½ prairie 1 post oak 0 sandy land		J. McKee Gould, Jr.	Greene	May 10
	4	W. M. Hill	Hale	May 1
	4 or 5	B. B. Rudolph	Lowndes	May 10
3	3	M. H. Traylor	Lowndes	Fall sowing May Spring sowing June
1 to 3	4	J. A. Dillard	Montgomery	Mch 24
3	3	Judge W. H. Tayloe	Marengo	
	4	Cobb & Macmillan	Sumter	April
2½	3	E. H. Allison	Morgan	

The yields estimated by the above named alfalfa growers as the average production under their conditions indicate that after the first season alfalfa can be cut three to six times (usually 4 times), and that the yield of hay on good land is three or six tons per acre. Land producing less than two tons per acre may yield a profit, but should not be selected for alfalfa without first being fertilized with some legume, with manure, or with fertilizers.

The most usual date for the first cutting as found by the above named growers is about the first of May or earlier. When sown in the spring one would expect no cutting of consequence for a month later, and much less than a normal yield the first season of growth. On poor lands with unfavorable seasons no cuttings worth raking are obtained during the first season from spring sowing.

The following extract from Bulletin No. 20 of the Alabama Canebrake Experiment Station, at Uniontown, prepared by the writer, illustrates the possibility of obtaining from prairie soils large yields of alfalfa the first season, even from spring sowing.

"A tract of dark pebbly hillside of medium fertility was plowed and harrowed, and alfalfa seed was sown broadcast on March 20, 1903. The stand was so thick that weeds were not troublesome until the growth of alfalfa was checked by drought, which prevailed almost continuously from about the middle of August until November.

"Up to that time alfalfa made rapid growth and afforded three cuttings by September 3. Because of continuous dry weather, growth after that date was too slow for another cutting to be obtained, though with the ordinary rainfall of September and October a fourth cutting would doubtless have been secured.

"This alfalfa occupied all of 'Cut 23' except 1-20th of an acre, used for another forage plant. The area of this plot, according to a survey made by Mr. T. M. Cocoran, was 55-100 of an acre. Mr. Corcoran's survey is made the basis of the calculated yield per acre in the following table.

"Each cutting of hay required only one day in curing. It was then regarded by Mr. Richeson as dry enough to store in the barn, where it kept without molding.

"The yields of hay thus cured were as follows:

	Lbs. per plot.	Lbs. per acre.
June 16	1,030	1,871
July 15	1,682	3,058
Sept. 3	1,922	3,495
Total	4,634	8,424

"This shows a yield of more than four tons of hay per acre when stored. It would probably not be safe to regard this as thoroughly cured hay, suitable for storing in large masses. If, to be thoroughly conservative, we assume that a further drying out to the extent of 25 per cent. after being placed in the barn would be necessary before we could regard this as thoroughly cured hay, we should still have a yield of more than three tons per acre. This is an unusually large yield for spring sown alfalfa in its first season of growth, and is probably as much as can *ordinarily* be expected from very young alfalfa, even when sown in the fall. The conditions producing this large yield were a thick stand, abundant rains from March to August, thorough surface drainage, and a supply of root tubercles.

"To emphasize the statement that this was upland prairie land of a fair degree of fertility, the following facts are mentioned: Corn without fertilizer and without any special treatment, averaged in the two cuts which bordered the alfalf area 21 bushels per acre. The land sown to alfalfa in March, 1903, was in 1902 in cotton, without fertilizer; and in 1901 it had borne a crop of corn without cowpeas. No stable manure had been applied in very recent years, and it is not known that any manure had ever been applied."

The following is another instance showing the possibility of getting good yields from alfalfa the first season, even when sown in spring.

Mr. W. L. Ennis, Livingston, Ala., reports as follows: "Sowed 23 pounds of alfalfa seed, inoculated with earth from a bur clover field, on March 20, 1903, on the best land we had, about one acre. Yields of baled hay were as follows:

"First cutting, 21 bales; second cutting, 40 bales; third cutting, 17 bales. Total, 97 bales. Average weight of bales 104 1-2 pounds." This is about 5 tons per acre.

PRICES AND PROFITS.

Those Alabama alfalfa growers who have sold alfalfa report that the price in recent years has been not less than $13 to $15 per ton. Even if we assume a minimum yield of 4 tons of hay per acre on land to which alfalfa is adapted, and a minimum price of $10 per ton, there would still be larger profits in growing alfalfa than most other field crops. Captain John C. Webb, of Demopolis, Ala., writes: "It has paid me better than any other crop I ever planted."

Mr. W. L. Foster is reported in Louisiana Bulletin No. 72 as follows in regard to alfalfa in the bottoms of the Red River, near Shreveport: "It costs an average of $1.25 to $2.00 per ton to put [alfalfa hay] in shape for the market."

The books of another alfalfa grower in the same region showed a cost of $1.90 per ton to cut, cure, market, and bale a crop of this hay.

The same publication contains this significant paragraph as to the profits of alfalfa in that region:

"When the land is seeded to alfalfa by the owner and rented out, he gets fifteen dollars an acre, and the renter furnishes his own harvesting tools, or he gets eighteen dollars rent and furnishes the harvesting tools. This is on land that rents for five dollars an acre for cotton."

SOILS FOR ALFALFA.

At present the most important question in connection with alfalfa in Alabama is the determination of soils on which it can be made a profitable crop. In determining the best soils for alfalfa we shall be helped by bearing in mind that this plant needs a soil (1) well supplied with moisture, (2) well drained, (3) having an abundance of lime, (4) rich in other plant food.

Alfalfa is at its best when grown under irrigation, which fact indicates its response to large amounts of water judiciously applied. In humid regions alfalfa is pre-eminently a crop for valleys, because on these low levels there is a relative abundance of moisture even during dry seasons. On the other hand, the roots of alfalfa in congenial, well drained, permeable soils, penetrate to great depths in search of moisture. But with the poor drainage in a large part of the south this habit of alfalfa is not fully utilized. The need for ample supplies of moisture can be better understood by the statement that ordinarily hay plants must pass through their leaves about 400 tons of water for every ton of hay produced, or 1,600 tons of water per acre for every crop of four tons.

Drainage, important for most ordinary farm crops because of the need of the roots for air, and because of the deeper growth of roots in drained soil, is doubly important for any leguminous or soil-improving plant like alfalfa. For not only do the roots of such plants need water, but the nitrogen-fixing bacteria in the root tubercles must have thorough soil ventilation in order to perform their work of transforming the valueless nitrogen of the air into the valuable nitrogen of plant food. Whatever may be thought by some of the sufficiency of shallow ditches and levees for draining prairie land sufficiently for cotton and corn, it is certain that such mere surface drainage is insufficient for alfalfa, as, indeed, we believe it to be for the maximum results with other crops. Deeper ditches are needed for alfalfa.

No argument is needed to show the greater convenience and saving of land and work if some of these ditches could be converted into underground drains, whether box drains of plank, pole drains, or whether tile be the material employed. If tile drainage in Alabama can be shown to be cheap enough and continuously effective for any field crop, that crop will be alfalfa. While few farmers owning land valued only at $15 or $25 per acre will be found at present willing to make the large expenditure necessary for tile drainage, this investment will doubtless be found feasible on certain stiff bottom lands, otherwise peculiarly adapted to alfalfa, especially as these lands advance in price because of their suitability to alfalfa. The establishment of tile factories in the south, or the co-operative purchase of tile machines would so greatly cheapen the cost of tile drainage as to make it practicable for alfalfa fields and other land farmed intensively.

Alfalfa should endure for many years. One of our correspondents has alfalfa plants seventeen years old growing on prairie land. If a field of alfalfa, free from disease and from excessive growth of weeds, begins to fail when only a few years old, deficient drainage may be suspected. Alfalfa is usually spoken of as needing an open soil. While permeability is desirable, yet in Alabama the soils to which it has thus far proved best adapted are lime soils of close texture.

PRAIRIE SOILS.

Taking up the different soils somewhat in the order of their proved or probable fitness for alfalfa we must deal first with the Central Prairie Region of Alabama, extending from Union Springs in a northwest direction past Montgomery, Selma, Uniontown, Demopolis, and Livingston, and into Mississippi. In this region a few very small patches of alfalfa were grown many years ago. So far as I can learn, Capt. J. C. Webb, of Demopolis, was the first one in that part of the State to grow alfalfa on any considerable scale. One of his earliest plantings was made on a shallow gray soil underlaid near the surface with white rotten limestone. This field lay next to the

Tombigbee bluffs, on the western edge of Demopolis, and hence was well drained. Steers had been fed here on cottonseed meal and hulls, and the growth of alfalfa was most satisfactory. Capt. Webb has since largely increased the area which he devotes to alfalfa. The prinicpal part of the alfalfa area of Alabama is now in Greene and Sumter counties.

Prairie soils may be subdivided into quite a number of classes merging into each other by imperceptible gradations. Those prairie soils are best suited to this crop which are best drained and best supplied with vegetable matter.

Extensive inquiries were made of a number of growers of alfalfa in Alabama, and below follows a summary of their answers to the question as to the character of soil in the prairie region best suited to alfalfa.

All expressing an opinion preferred lime to sandy or clay soils. Black prairie is the choice of most of these correspondents, some of these expressly naming black bottoms or slough land, others fertile black upland soil. Those who prefer bottom land specify bottoms that are well drained. Two prefer "hammock" land, one of these describing his favorite alfalfa soil as "alluvial land overlaying stiff prairie." One choses shelly prairie, two cedar "hammock," and one gray upland prairie and "hammock," and another yellow prairie. One correspondent has succeeded best in growing alfalfa on the mixed soil at the base of white marl hills.

On the farm of the Canebrake Experiment Station at Uniontown, alfalfa has done remarkably well during its first year's growth on upland of medium quality, and containing a small number of rough pebbles. We are far from recommending alfalfa for that grade of prairie soil that consists *largely* of these roughened pebbles and that is too poor to make fair crops of cotton. Alfalfa needs fertile soil.

Answering the question what soils are unfit for alfalfa, these correspondents are almost unanimous in naming sandy soils. Three (including one farmer who has a very large acreage in alfalfa) specify post oak, and one especially designates black post oak.

With the confessedly incomplete data now available the soils of the prairie region of Alabama may be tentatively ranked in about the following order as regards their suitability for alfalfa:

First class: Black bottoms, well drained, and drained alluvial lime bottoms containing a little sand.

Second class: Black uplands; shelly gray uplands, and rich chocolate uplands.

Third class: Poor gray to white prairie, and poor, stiff red or post oak land.

OTHER LIME SOILS.

As to the suitability to alfalfa of the soils of the remainder of the State, there is much less evidence available. From theoretical considerations there is every reason for expecting alfalfa to succeed in all the lime soils of the Tennessee Valley region, and in the narrow lime valleys in the northeastern part of the State.

Messrs. E. H. Allison and R. P. McEntire, of Decatur, write of their success with alfalfa in that part of the Tennessee Valley, and other instances of success in that part of the State have been heard of, but not confirmed by answers to our inquiries.

There is reason to expect the best red calcareous soils of Talladega, Calhoun, and counties north of these, to give satisfactory results with alfalfa. In a word, there is a prospect for the successful growth of alfalfa on rich, well drained lime soils in any part of the State where they occur.

Rich bottoms in every part of the State, if not subject to long or otherwise injurious overflows, and not too wet or too sandy, are probably suitable for alfalfa. If they are deficient in lime it can be added with the probability of profit.

SANDY SOILS.

While it is possible that alfalfa can be grown under garden conditions, on almost any soils in Alabama, yet it is probable that it will not be a profitable sale crop on upland sandy or clay soils deficient in lime unless they are exceptionally rich. In order for it to be grown at all successfully, on these soils, great care will be required and in many cases heavy applications of stable manure or lime (the latter being supplemented by large amounts of commercial fertilizers) will be necessary. It then becomes a question whether it is more profitable on these sandy uplands thus to coddle alfalfa or to rely on hardier forage plants, as hairy vetch, cowpeas, soy beans, sorghum, etc. We are certainly not yet in a position to recommend alfalfa for non-calcareous upland soils except on a very small scale. However, the great value of the plant on congenial soil makes it worthy of trial in a small way on every class of soils.

LOCAL EXPERIMENTS IN PROGRESS.

To determine the suitability to alfalfa of each of the principal soils of the State, this station in co-operation with the United States Department of Agriculture, last fall arranged for an experiment with alfalfa in nearly every county in Alabama. The unusually dry fall, necessitating late planting, and the early occurrence of frost and freezes, destroyed the stand of alfalfa in many of the experiments referred to. It is planned to continue the work along this line.

FERTILIZERS FOR ALFALFA.

One ton of alfalfa hay contains approximately 44 lbs. of nitrogen, 10.2 lbs. of phosphoric acid, and 33.6 lbs. of potash. Hence a crop of four tons contains as much nitrogen as is found in 2,450 lbs. of cotton seed meal, as much phosphoric acid as is contained in 336 lbs. of high grade acid phosphate, and as much potash as is contained in 1,075 lbs. of kainit. It would cost, to buy all these amounts of plant food in the form of commercial fertilizers, approximately $35.00. Fortunately not all of this is removed from the soil, the greater part being the value of the nitrogen, the largest proportion of which the alfalfa doubtless gets from the air. It would, however, require about $8.75 worth of phosphate and kainit to replace the amount of phosphoric acid and potash which would be removed from the soil of an acre by a crop of four tons. Hence it is evident that even the richest prairie soils, if cropped for many years in alfalfa, will need to have their supplies of phosphoric acid and potash replenished by the application of manure or fertilizers. This will be especially true if Johnson grass hay has previously been removed from these soils for a number of years, thus making heavy drafts on the soil's supply of these two minerals.

According to Wolff, one ton of alfalfa hay contains 70 pounds of lime, or 280 pounds in a crop of four tons. In three experiments on the station farm at Auburn lime has proved highly beneficial to the growth, permanency and hardiness of alfalfa.

In the case of soils not rich in lime it will be necessary from the beginning to apply this material, as is clearly shown in the experiments on the station farm at Auburn. Not only do lime and phosphoric acid directly stimulate the growth of alfalfa on soils deficient in these minerals, but their presence is believed to favor the development of tubercles, on the abundance of which largely depends the thrift of the alfalfa plant. From 6 to 12 barrels, equal to $\frac{1}{2}$ to 1 ton of unslaked lime, or to at least $\frac{3}{4}$ to $1\frac{1}{2}$ tons after slaking, may be applied per acre. Liming (or the use of manure or wood ashes) will be indispensable for alfalfa on acid soils, of which there are large areas in Alabama. To test a soil for acidity, a strip of blue litmus paper should be kept in contact with the moist soil until damp. If the soil is acid the color of the paper will change to pink. On application to the writer litmus paper for this test will be furnished free.

Where there is no local experience to guide one in selecting fertilizer, the following formula (or stable manure), is suggested as a fertilizer for alfalfa, in regions where the use of commercial fertilizers is general:

400 pounds acd phosphate per acre and 50 pounds muriate of potash per acre.

The above is not intended to take the place of lime, where the soil is deficient in lime, but tos upplement it. When lime and acid phosphate are both used for any crop they should be applied separately, and one should be worked into the soil before the other is applied. Tubercles on the roots of alfalfa should supply it with nitrogen. But if the roots are devoid of tubercles, nitrate of soda or cotton seed may be needed.

FERTILIZER EXPERIMENTS AT AUBURN.

On reddish sandy upland soil at Auburn, capable of producing only about 10 to 12 bushels of corn per acre, without fertilizer, ten plots of alfalfa were sown, October 29, 1900. The soil was not acid. All plots were at that time fertilized at the same rate per acre, namely, 320 pounds of acid phosphate and 80 pounds of sulphate of potash. An effort was made to inoculate the seed, but this was not entirely successful.

A good stand of plants was found on all plots the latter part of the following March and the early part of April, when different nitrogenous fertilizers were applied to these plots as shown in the next table.

Alfalfa made extremely poor growth in 1901 on the plots receiving no manure. On all plots, weeds, leaf rust, a sclerotial disease of the roots, and perhaps nitrogen starvation, killed the larger part of the plants. The lime and the stable manure plots suffered least and kept the best stands. No plot made a yield worth harvesting separately. October 7, 1901, without plowing, an additional amount of seed was disced in on all plots.

Again in the phenomenally dry summer of 1902, the alfalfa on *most* plots did not yield enough hay to justify raking it up. However, the plots were clipped four times in 1902—May 6, June 17, Sept. 13, and October 10. On the best plots, those to which stable manure had been applied about 15 months before, and which were now reduced by disease and dry weather to a mere fraction of a stand, the yield was only about one ton of hay for the entire season. The extreme drought of 1902, extending practically from the middle of April to August, will be recalled by most readers.

In the summer of 1902, the poorest plots of alfalfa were plowed up and planted in New Era cow peas in drills. These made slight growth, but were kept clean by late cultivation. The plots then plowed up as being the poorest were those which 18 months before had received per acre either 200 pounds of nitrate of soda or 500 pounds of cotton seed meal or no fertilizer.

September 13, 1902, inoculated alfalfa seed, 20 lbs. to the acre, were sown on these plots, first running a disc harrow several times over the small growth of cow pea vines, a procedure that in ordinary seasons would not suffice to dispose of a crop of cow peas of the usual luxuriance, but which is sometimes a satisfactory treatment of cow pea stubble. On all these plots and nearly all other plots, 2,000 lbs. of slaked lime (equal to about 1,200 lbs. of unslaked lime) were harrowed in. Next March certain other plots where the stand had become very thin were plowed and sown in alfalfa.

The stand of alfalfa on other plots, (those which eighteen months before had been fertilized with either manure or lime), was thickened by drilling in with a grain drill a small amount of alfalfa seed, mixed with sand to make the distribution more uniform.

The yields of hay obtained in 1903 on each plot are shown in the following table:

Yields of alfalfa hay per acre in 1903, and fertilizers per acre previously used.

Plot.	When sown.	Fertilizer for 1901.	Fertilizer winter 1902-1903.	Lbs. hay per acre. May 20.	July 26.	Sept. 25.	Total.
1	Sept. 13, 1902........	320 lbs. acid phosphate 80 lbs. sulphate potash.	240 lbs. acid phos. 1 ton slaked lime.	....	700	900	1600
2	Sept. 13, 1902........ Drilled.	200 lbs. nitrate of soda. 80 lbs. sulphate potash. 320 lbs. acid phosphate.	240 lbs. acid phos. 1 ton slaked lime.	....	500	1000	1500
3	Sept. 13, 1902........	500 lbs. cotton seed meal. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	1 ton slaked lime.	....	1100	1200	2300
4	March 18, 1903......	320 lbs. acid phosphate 80 lbs. sulphate potash.	6 tons horse manure. 1 ton slaked lime.	....	1600	2000	3600
5	Oct. 29, 1900........	20 bbls. lime. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	240 lbs. acid phos. 1 ton slaked lime.	2300	2050	2300	6700
6	Oct. 29, 1900........	18.4 tons horse manure. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	240 lbs. acid phos. 1 ton slaked lime.	2400	2200	2200	6800
7	March 18, 1903......	80 lbs. sulphate potash. 320 lbs. acid phosphate. 22.2 tons cow manure.	240 lbs. acid phos. 1 ton slaked lime.	....	900	1600	2500
8	Oct. 29, 1900........	22.5 tons horse manure. 320 lbs. acid phosphate. 80 lbs. sulphate potash. 20 bbls. lime.	240 lbs. acid phos. 1 ton slaked lime.	1400	1100	2000	4500
9	March 18, 1903......	320 lbs. acid phosphate 80 lbs. sulphate potash.	80 lbs. nitrate of soda. 240 lbs. acid phos. 1 ton slaked lime.	....	800	1000	1800
10	March 18, 1903......	6 tons rotton cowpea vines 320 lbs. acid phosphate. 80 lbs. sulphate potash.	340 lbs. acid phos. 1 ton slaked lime.	....	900	1300	2200

The results for 1903 shown in the above table may be summarized as follows:

(1)—Spring and fall sowing afforded practically the same yields, about one ton of hay per acre the first summer.

(2)—Nitrate of soda applied at the rate of 80 pounds per acre with the seed in spring failed to increase the yield.

(3)—Six tons of stable manure more than doubled the yield the first season when applied in February to fall sown young alfalfa plants.

(4)—Eighteen tons of stable manure enabled alfalfa to yield 3.4 tons of hay per acre the third season after the application.

(5)—Lime, at the rate of 20 barrels per acre, resulted the third year after application in a crop practically equal to that obtained by the use of 18 tons of stable manure at the same time.

(6)—The application of both lime and large amounts of stable manure together did not increase the yield the third year after application as compared with either applied alone.

The first cutting of hay was nearly pure alfalfa, the second contained considerable crabgrass, and the third cutting contained more crabgrass than alfalfa.

EFFECTS OF LIME AND INOCULATION COMBINED.

On October 3, 1902, three plots of sandy soil of fair quality on the Experiment Station farm at Auburn were sown with alfalfa. Phosphate and muriate of potash were used on all plots. Polt 3 had neither lime nor inoculation; plot 4 was not limed, but inoculated as follows: Soil from an old alfalfa field 100 yards distant, was stirred into water, the seed dipped into this water, and then thirty bushels per acre of the same soil was sown broadcast and harrowed in promptly. Plot 5 was similarly inoculated and 1,000 pounds per acre of slaked lime was applied. Winter killing was severe on all plots, but much more severe on plots 3 and 4 than on the plot which was both limed and inoculated. Figure 1 shows in the lower part that on the plot both limed and inoculated the young plants had covered the ground; few and small were the plants surviving plants on plot 4, as shown in

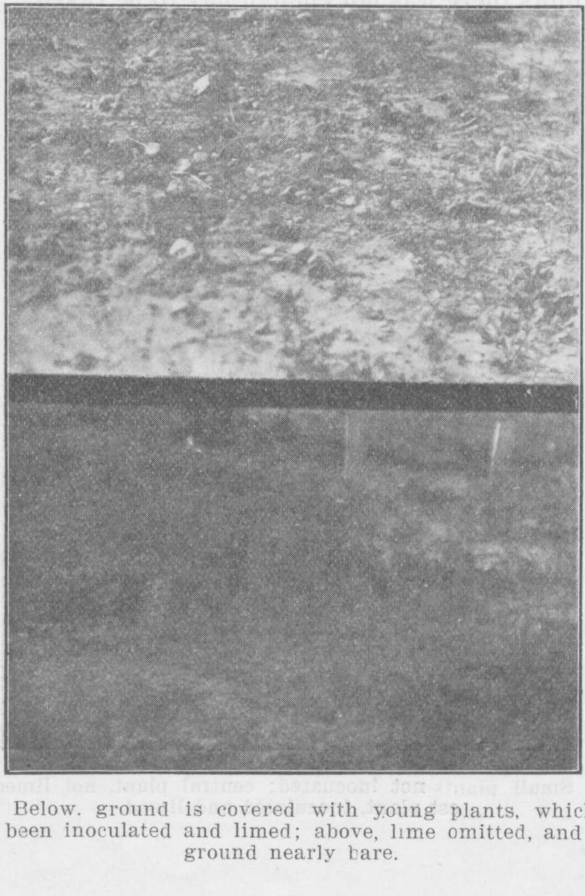

Fig. 1. Below. ground is covered with young plants, which have been inoculated and limed; above, lime omitted, and ground nearly bare.

the upper part of Figure 1. Figure 2 shows typical plants taken in April from each plot. Note the abundance of tubercles on the plants from the plot that was both limed and inoculated. The liming and inoculation seemed to make the young plants hardier and more resistant to cold. No one of these plots was a success, there being left at the end of winter only about half a stand on plot 5, and much less on the other two plots. The total yield for the season was 2,266 pounds per acre where liming and inoculation had been employed, while on the other plots there was not enough hay to be raked.

Fig. 2. Small plants **not** inocuated; central plant, not limed; largest plant, inoculated and limed.

An adjacent plot was sown in crimson clover at the same time that the alfalfa was sown, and after the cutting of the crimson clover, the same plot was sown in June in broadcast sorghum. The yields obtained give an interesting illustration of the fact that under ordinary conditions on sandy land unsuited to alfalfa, other crops often furnish a far larger quantity of forage. The yield of crimson clover on this adjacent plot was 6,100 pounds per acre, and the amount of sorghum hay obtained at one cutting during the same season was 13,000 pounds per acre. These are exceptionally good yields of both crimson clover and sorghum. This is an extreme case where all conditions were highly favorable for crimson clover and sorghum, and exceedingly unfavorable for alfalfa.

FERTILIZER EXPERIMENTS ON PRAIRIE LAND.

A series of fertilizer experiments on 10 plots was begun in 1902 in co-operation with Mr. J. O. Hays, Sumter county, Ala., by whom the fertilizers were applied in accordance with the writer's plan. The seed were not sown until April 3, only a few weeks before the beginning of the memorable drought. In the absence of any considerable amount of rain until August 28, the fertilizers were without effect. No hay was raked, but Mr. Hays reports that this alfalfa, though sown late, "stood the drought better than any other forage plant, and is the only one that kept a good lively green color, while Bermuda grass was parched perfectly yellow, and sorghum was twisted and stopped growing."

It should be added that eight of the plots were inoculated with soil from an old alfalfa field.

In 1903 Mr. Hays again undertook a fertilizer experiment for this station. On June 13 he writes: "Plots 9 and 10, the ones most highly fertilized, are the best."

These both received per acre 200 pounds cotton seed meal, 240 pounds acid phosphate, and respectively 200 and 100 pounds of kainit.

MANURE.

For the prairie region it may be said that no fertilizer except stable manure has yet been sufficiently tested on alfalfa to determine its suitability. In numbers of instances stable manure has greatly increased the yield of alfalfa on prairie lands, and the most experienced growers of alfalfa use it so far as the limited supply permits. The benefit from the use of stable manure is a common experience in west Alabama, and the application of manure has immensely increased the yield of alfalfa on the lime land of Mr. J. A. Dillard near Montgomery, Ala., as the writer can testify from a personal inspection.

However, the question may well be raised whether alfalfa is the best crop on which to apply stable manure which is so scarce and so sure to largely increase the yield of any crop. So far as concerns the nitrogen of stable manure, alfalfa could well dispense with that. For alfalfa thoroughly inoculated and on land sufficiently well drained to insure fair soil ventilation, should be able to obtain through its root tubercles unlimited quantities of nitrogen from the air. On the other hand, sorghum or cotton, not having this means of securing nitrogen, would make good use of the nitrogen as well as of the other constituents of stable manure. In favor of the application of manure to alfalfa is the fact that this application in winter promotes early development of the plants, and forces the alfalfa to a sufficient height for cutting at a time when other forage is scarce. Moreover, if immense quantities of stable manure are used it will serve as a mulch, retaining the moisture in the soil and alleviating the effects of drought. On the other band, surface application of manure without incorporation with the soil results in great loss of the valuable portions of the manure and is ordinarily a wasteful method of application.

INOCULATION.

Alfalfa belongs to that family of plants able to derive a large part of their nitrogen from the gaseous nitrogen of the air. This is done through the agency of enlargements on the roots, called tubercles or nodules. Within these tubercles dwell countless numbers of microscopic vegetable organisms, usually referred to as nitrogen-fixing bacteria or germs.

Root tubercles of alfalfa, clovers, vetches, cowpeas, velvet beans, and other legumes, are essentially fertilizer factories engaged in the manufacture of nitrogen. This is a fertilizer material, which, when bought in the form of cotton seed meal or nitrate of soda or ammoniated guano, costs about 15 cents per pound. The importance of the work of root tubercles may be realized from the fact that a crop of any one of these plants growing on an acre usually contains from 75 to 200 pounds of nitrogen in roots and tops taken together.

When the germs necessary for causing tubercles to develop on the roots of alfalfa are absent from the soil and from the seed, the roots of alfalfa have no tubercles. The proper germs, which we may designate as alfalfa germs, are usually absent from the sandy and non-calcareous soils of Alabama, and often from other soils. More frequently there are a few of the proper germs present either in the seed sown or in the soil, so that tubercles develop on a small proportion of the plants.

A leguminous plant without tubercles is a drone that no farmer can afford to provide for. Such plants depend entirely upon fertilizers for their expensive nitrogen or draw it from the earth, thus impoverishing the soil.

The farmer has it in his power to cause tubercles to develop on the roots of his alfalfa, and thus to force the plants to provide their own nitrogenous food, and to enrich the land in nitrogen. When leguminous plants form their tubercles without aid from man we may speak of the process as natural inoculation. Experiments on a number of soils at Auburn and observations of young alfalfa plants in a number of other localities, lead us to conclude that the alfalfa germ is wanting or not present in sufficient numbers in most of the sandy and clay soils of Alabama that are deficient in lime. On such soils the necessary germs must be supplied by the process of inoculation, or more accurately, by artificial inoculation.

The material used for inoculating alfalfa may be soil from a field where alfalfa or bur clover (a plant of the same genus) has in recent years been well supplied with root tubercles, or it may be a concentrated patented material now being manufactured in the laboratories of the United States Department of Agriculture.

To inoculate with soil we have used the following methods, depending on convenience and on the amount of inoculating soil available.

(1) With small amounts of inoculating soil: To about a peck of soil from an old alfalfa or bur clover field add several gallons of water; stir well; allow a few minutes for settling and then moisten every alfalfa seed thoroughly with the muddy water, which contains the necessary germs. Then dry the seed by mixing with them more of the same inoculating earth in a dry condition and crushed as fine as possible. Cover seed promptly.

(2.) With large amounts of inoculating earth: Moisten the seed as above; dry as above, if convenient; sow broadcast per acre 20 to 30 bushels of the same earth in as fine a condition as possible, and harrow in seed and inoculating earth as promptly as possible. The method of inoculation and the amount of inoculating soil can be varied according to convenience.

Directions for use accompany the pure cultures sent from Washington. Dr. A. F. Woods, under whose direction this inoculating material is distributed, authorizes me to state that the Department will supply free inoculating material for alfalfa to any parties whose names I shall send in, and who will furnish their own seed. Applicants should state the number of acres that they will plant.

On prairie soil the writer has repeatedly observed that alfalfa plants are, when young, well stocked with tubercles. The cause for this is evident from the recent investigation of Dr. C. G. Hopkins, of the Illinois Experiment Station. Under date of February 2, 1904, he writes as follows with reference to his bulletin now in press, and gives permission for this use of his results: "The investigations reported in this bulletin prove conclusively that the bacteria of sweet clover are similar to the bacteria of alfalfa."

RESULTS OF INOCULATION OF ALFALFA ON SANDY LAND.

In an inoculation experiment with alfalfa made by the writer in February, 1897, the yield of alfalfa at the first cutting was increased 336 per cent as the result of inoculation. The soil within the plots was from a sandy field near Auburn, and the inoculating material was the dust sifted out of bur clover seed and derived from the soil on which bur clover had grown. In several later field experiments the use of bur clover earth has produced tubercles and greatly increased the yield of alfalfa.

Figure 2 shows typical alfalfa plants taken in April, 1903, from three plots at Auburn, sown the preceding October. The small plants on the right had been neither limed nor inoculated and were free from tubercles; those in the center had been inoculated, but not limed; the largest plant had been inoculated and limed, and here the supply of tubercles is abundant. Soil from an old alfalfa field was used in this experiment as inoculating material.

INOCULATION OF ALFALFA ON PRAIRIE SOILS.

In the light of Dr. Hopkins' demonstration we can now see why it is unnecessary to inoculate alfalfa on fields where melilotus (sweet clover) has recently grown, and produced tubercles, as it almost invariably does on prairie soil. It would still seem advisable, however, to inoculate alfalfa seed to be sown on such prairie land as has not recently grown melilotus. While these germs have probably been widely distributed by wind and water and otherwise, in the prairie region, we have no proof that they are present in all fields of prairie land in sufficient numbers for *best* immediate results with alfalfa.

Indeed the observation made by Mr. J. O. Hays in our fertilizer experiment on gray prairie land in Greene county, previously referred to, seems to indicate that there is an advantage, at least during the first few months of growth, in inoculating alfalfa on some lime land. In 1902, on land which had been used as a pasture for a number of years, he reports that on the six-months-old inoculated alfalfa plants tubercles were abundant, while up to that time none had been found on the plots not inoculated.

Relative to a similar experiment in 1903, he writes under date of June 13, 1903, as follows: "I inoculated all plots except No. 8, which seems to be the poorest of any of them.'"

In view of Dr. Hopkins' conclusions, we can now recommend that earth from an old melilotus field be used for inoculating alfalfa, where this is decidedly more convenient than to use earth from alfalfa or bur clover fields or than the pure culture of the laboratory.

TIME TO SOW.

The following is a summary of results of sowing alfalfa on the station farm during the eight years that work has been under the writer's charge:

We have records of fall sowings on ten different dates. In every case when alfalfa was sown broadcast after November 1, the stand was ruined by cold. In one case alfalfa sown as early as October 7, (1901), was almost completely winter killed. Plants from seed sown as early as September 13 (1900), and as late as October 29 (1899) survived the winter, although in other years a considerable proportion of the sowings made in late October resulted disastrously.

We have records of eight dates of spring sowing of alfalfa on the station farm. These point to the first half of March as better than a later date.

In our co-operative experiments with alfalfa in 1903-1904, arranged for in nearly every county in the State, fall sowing was made unduly late by drought, and cold weather came on unusually early, and has been unusually continuous. Moreover, in most cases there was insufficient moisture to cause the young plants to grow rapidly. Under these conditions, it is estimated from reports thus far received that in considerably more than half the experiments the stand of alfalfa was ruined. These reports afford an interesting comparison of the relative hardiness towards cold of the young plants of alfalfa, crimson clover and hairy vetch. The first two, when very young, are almost equally sensitive to cold, while hairy vetch is much hardier in this respect than either.

Alfalfa has been successfully sown in Alabama, both in the early fall and in the early spring. The principal advantages of fall sowing are the following:

(1.) A larger yield of hay obtainable the first summer;

(2.) Less danger of having the alfalfa overtaken and crowded out by crab grass and weeds;

(3.) Use of teams in preparation for alfalfa in August and September, when they would not be employed in preparing for the usual crops.

The chief advantages of spring sowing are as follows:

(1.) Freedom from risk of winter killing, to which fall sown alfalfa, especially that sown late, is liable.

(2.) Opportunity to sow alfalfa after cotton, the best of the hoed crops to precede it;

(3.) Usual better condition of the land for plowing in December and January than in August and September.

Each reader must contract these opposing advantages in the light of his own conditions. By far the larger proportion of alfalfa sown in Alabama on prairie soils is put in after Christmas, which suggests that this is generally the most convenient time. Some years it is the only practicable time, the ground being too dry and hard in the early fall. Several extensive growers of alfalfa who sow chiefly in the spring, nevertheless express a preference for fall sowing when there is sufficient moisture for thorough preparation and for sowing *early* in the fall.

Fall sowing should occur at a date early enough to permit the roots to penetrate deeply before freezes begin, and thus to anchor the plants against heaving. Not only are young alfalfa plants easily heaved or lifted out of the soil by alternate freezes and thaws, but the very young plants are otherwise and more directly injured by severe cold following mild weather.

In Central Alabama we would recommend that fall sowing be done, if practicable, from September 15 to October 15, with the preference for the earlier part of this period. While a date as late as November 1 occasionally gives success, the risk of winter killing is then too great. If alfalfa cannot be sown before October 15 in central Alabama, we would recommend that sowing be postponed until March.

The safest period for spring sowing is from March 1 to 20. Some sow on prairie land as early as February 20, but from February sowing at least one instance of loss of stand from cold has come under our notice. While seed sown in April sometimes succeed, the success is less uniform than with March sowing. The more weedy the land the stronger the reason for fall sowing.

PREPARATION.

There is no field crop that pays better for thorough preparation than alfalfa. The man who is content to prepare land for alfalfa as he would for oats had best leave this crop to some one else. The plowing for alfalfa should be deep and thorough and it is highly probable that subsoiling on prairie and other stiff land would be more profitable for alfalfa than for any other field crop. Harrowing must be done, not once, but from two to four or more times, according to the condition of the land. Usually two harrowings with a disc harrow and two with a tooth harrow (including the one given after sowing the seed) will suffice.

Harrowing for fall sowing will be most effective if done within a few hours after plowing. For spring sowing this is less imperative. It is important that between the time of plowing and the time of sowing a sufficient interval should elapse for rains to compact or settle the soil. If sufficient rain does not fall to settle the soil, this should be done by repeated use of roller or weighted drag. One of the most common causes of failure to secure a satisfactory stand in alfalfa growing consists in having the soil too loose at planting time. For fall sowing plowing should occur at least several weeks before the seed are to be sown. If alfalfa is to be sown about the first of March the plowing may be done in November or December, or January, more satisfactorily than just before planting. Land plowed before Christmas will only need to have the surface layer freshened with the harrow at the time of sowing. While the above statements embody the general experience, success sometimes attends the sowing of the seed immediately after plowing. A farmer in the northeastern part of Texas who has many hundred acres of alfalfa, describes his method of preparation of black prairie for alfalfa as follows: "I use a disc plow with four good mules, run a subsoil plow drawn by six mules eighteen inches deep behind the disc. Then I follow with a disc harrow with four mules, then float the land with an implement eight or nine feet long and five feet wide, made by 2x6's spiked together; six mules draw this. I can reverse the float, turn it over and use it to level the land in rough places. I am not yet ready to seed this land prepared in this way. I must have a rain on it that will settle it and take the air cells out. Then, with a light toothed harrow I break the surface, sow the seed with a wheelbarrow seeder and cover with a light harrow followed by a heavy steel roller. Good black land seeded in this way will return $40 or $50 per acre every year, at very little cost for labor."

One grower in West Alabama subsoiled his land for alfalfa last fall, but it is too early for the effects of subsoiling to become apparent.. One grower in the same neighborhood harrowed his land seven times, an extreme case. Others report satisfaction from one or two harrowings, a number often insufficient. It should be borne in mind that preparation for alfalfa is expected to suffice for from three to twenty years, and should therefore be thorough.

SOWING BROADCAST VERSUS IN WIDE DRILLS.

It is maintained by some parties that in the Gulf States drilling alfalfa, with such distance between rows as to permit of cultivation, will be more satisfactory than broadcast planting. In three experiments at Auburn and in one at Uniontown, drilling was unsatisfactory. On the station farm at Auburn it was found difficult in planting by hand in drills to avoid covering the seed too deep, and it was found that the amount of cultivation required to keep the grass and weeds subdued in drilled alfalfa was greater than it is practicable to give to a hay field.

On the Canebrake experiment farm at Uniontown, where the drills were about 24 inches apart and no cultivation given, crab grass and weeds crowded the alfalfa more than in the portion of the field sown broadcast.

However, for a small patch of alfalfa kept for feeding green, drilling and cultivation may be necessary and feasible, especially on highly fertilized sandy soils filled with the seeds of crab grass and weeds. Planting in very narrow drills by the use of grain drills is a favorite method in alfalfa-growing states. This of course does not permit of cultivation.

SOWING.

Most of the successful growers of alfalfa in Alabama have used about 20 pounds of seed per acre, and this is the amount that has invariably been used on the station farm at Auburn. Capt. John C. Webb uses 40 pounds The excellent stand obtained in 1903 at the Canebrake station resulted from sowing a little more than 20 pounds per acre. One grower in Alabama reports the use of 30 pounds, or half a bushel of seed. Yet this grower is one who most emphasizes the presence of large amounts of crab grass and fox tail grass, indicating that sowing large amounts of seed is not always effective in crowding out weeds, though it has that tendency.

If ten or more acres are to be sown, it is best to use one of the ordinary patterns of seed sowers instead of sowing by hand. The Cahoon is the one used at this station, and this seems to be in most general use in this State. One grower makes use of the seed attachment to the disc grain drill, a method which is common and satisfactory in states where this machine is in general use. When alfalfa seed are sown by hand, the most even distribution is obtained by dividing the seed into two parts and going over the land twice.

In Alabama alfalfa should be sown alone and not with grain, which is so much used as a nurse crop for alfalfa, clover and grasses in the North and West.

In covering alfalfa the procedure must necessarily differ according to local conditions, the preparation of the land, and the state of the weather. The most common custom in Alabama is to cover with a spike tooth harrow, teeth inclined backward. An equally good or better way employed by a few growers is to cover the seed with a weeder, which affords a more shallow covering than any form of harrow. A carefully made brush drag can also be used, but either of the preceding implements is preferable. We have found it advantageous when the land is dry to use the roller immediately after sowing and then to use the harrow or weeder. This order could be reversed, but at the risk of having the rolled surface transformed into a dense crust, should a heavy rain fall occur before the seed germinate. Coburn, an authority on alfalfa, advises that when from any cause a crust has been formed prior to the appearance of young plants, that this crust should be broken with weeder or harrow, even at the risk of bringing some of the sprouting seed to the surface.

It pays to buy the best alfalfa seed, even though they should cost several cents more than inferior seed. Imported as well as old should be avoided. So far as this information can be obtained, it is desirable to purchase seed grown in regions where love vine (dodder) is not abundant. In any case it is advisable to buy seed that have been run through a machine that is claimed to be able to remove the seed of dodder. As indicating the need of buying the best alfalfa seed, even at an increased price, one of the farmers who is conducting one of our alfalfa experiments in Wilcox county, under the writer's direction, reports as follows, under date of January 23, 1904: "All the seed sent from Washington came up readily to a good stand. * * * The seed we bought did not make a 15 per cent. stand."

To test the germinating power of alfalfa, dampen two small pieces of cloth; place 100 seed between the two pieces of cloth. Then put the whole thing in a plate or saucer, cover it, and leave it in a warm room, repeatedly moistening the cloth before it dries. Count the seed that sprout within ten days.

BEST CROPS TO PRECEDE ALFALFA.

A crop selected to get land in best condition for alfalfa should be one that either leaves the land clean and unusually free from weeds and weed seed, or one that adds vegetable matter, and hence enriches the soil. Cotton fulfills the first requirement, and cow peas or melilotus the second. The land that is to be sown in alfalfa next fall should be sown thickly in a running variety of cow peas in May, 1 1-2 to 2 bushels per acre. The vines should be cured for hay about a month or more before the time for planting alfalfa. On soil very deficient in vegetable matter it may be profitable to plow under the entire growth of cow peas. If the latter plan is followed, this mass of material should be plowed under in ample time for rotting to occur, or from 40 to 60 days before the date of planting. When green vegetation is plowed under at this season it is desirable to compact the soil with the roller or heavy drag, otherwise this vegetable matter before rotting will injuriously dry out the soil by preventing the rise of capillary moisture from the moist subsoil. On soils deficient in lime the lime necessary for alfalfa can be applied before the green growth of cow peas is turned under, thus hastening rotting and obviating the souring effect that might otherwise occur. Melilotus furnishes vegetable matter and nitrogen for alfalfa, and also by means of the decay of its large and deeply penetrating roots assists in the drainage of prairie soils. It is advisable to let one carefully worked cotton crop, intervene between the turning under of the second years' growth of melilotus and the sowing of alfalfa seed. This interval permits the owner to free the land from any volunteer plants of melilotus and from weeds.

JOHNSON GRASS LAND FOR ALFALFA.

One of the important advantages of alfalfa is its ability to grow in land too thickly set with Johnson grass for the profitable cultivation of corn or even of cotton. By the introduction of alfalfa or hairy vetch into a Johnson grass meadow, the soil will be to some extent enriched in nitrogen, the nutritive quality of the hay improved, and the total yield of hay increased.

An effort was made by correspondence with leading growers, to learn whether the successful growth of alfalfa in Johnson grass meadows was conditional upon such preparation of the land as would kill a large part of the Johnson grass. The general experience is that alfalfa thrives in old Johnson grass meadows even when the preparation for alfalfa is such as would ordinarily improve the growth of Johnson grass. The verdict was almost unanimous that Johnson grass did not crowd out the alfalfa in the second or third year after the alfalfa was sown. Those with the longest experience were as emphatic as others in stating that alfalfa was quite equal to a contest with Johnson grass, and some growers even stated that the alfalfa was tending to crowd out the Johnson grass. When alfalfa is sown in land stocked with Johnson grass, fall sowing gives the alfalfa an advantage over its competitor. A still further means of giving the ascendency to alfalfa consists in breaking the Johnson grass land and sowing thickly with cow peas, cutting the cow peas and Johnson grass for hay, and turning under the stubble a month or more before sowing alfalfa seed.

PRINCIPAL ENEMIES OF ALFALFA.

Among these first rank must be given weeds and weedy grasses, chief among which is crab grass. Crab grass and absence of tubercles have been responsible for the majority of failures that have come under the writer's observation. Other weeds that have given trouble in alfalfa on the station farm are evening primrose, morning glories, pepper grass, and even lespedeza or Japan clover. Among weeds most troublesome in prairie regions are crab grass, Bermuda grass, *Sida spinosa*, (a rather low branched weed with small yellow flowers and solid leaves), morning glories, fox tail grass, prairie or wire grass, horse nettle, and cow itch vines.

The only method known for decreasing injury from weeds is one of prevention rather than cure. The injury from weeds is best prevented by growing just before alfalfa, cotton or some other crop requiring careful cultivation. The avoidance of manure made from feeding hay abounding in weed seeds is also advisable. Manure from cattle fed on cotton seed meal and hulls is the best kind for alfalfa. Fall sowing is one of the best means of enabling alfalfa to get a start and triumph over its many enemies among the weeds. Judicious use of the disc harrow and even the use of the weeder when crab grass has just appeared is sometimes helpful.

Dodder, which is often introduced in alfalfa seed, is a thread-like, yellow vine, feeding on and destroying alfalfa. Mowing and burning in place is the most convenient of several remedies.

The most successful method of combatting weeds consists in frequent mowing during the first year, even when the alfalfa plants have not attained sufficient height for hay making. Repeated clipping with the mower during the first summer will do much to repress weeds and to thicken the stand of alfalfa by making the plants throw out a greater number of stems.

Leaf rust on alfalfa, appearing in the form of small black spots on the leaves, has been very destructive to alfalfa on the station farm, especially during damp weather. When it becomes serious, the best thing to do is to mow the alfalfa, the new growth usually escaping injury for quite a while.

A more fatal disease occurring on alfalfa on the station farm is a sclerotial root disease, which, however, the writer has not observed in other alfalfa fields. Indeed this root disease has been the principal cause of failure of our most promising fields of alfalfa, a large proportion of the plants in certain fields being killed by it.

CLIPPING AND DISCING ALFALFA.

After the young plants appear the most effective aid that can be given them is to use the mower frequently. Clip young alfalfa whenever weeds crowd it, and whenever it rusts or turns yellow from any cause. If the growth is slight, leave the mown material on the ground as a mulch and fertilizer, provided it is of a kind that will not give trouble when hay is raked after a later cutting.

Old alfalfa, whose growth has been arrested ,and which has become unthrifty, is often benefited by prompt mowing, even though the growth be too light for harvesting. The next most important treatment usually recommended for alfalfa more than a year old is to run a disc harrow over it when needed. This is sometimes done after each cutting, but judgment is needed in this matter. The discs are set straight so as not to cut off the plants. Discing serves as a cultivation and to thicken the stand of old alfalfa. On sandy land at Auburn we have found the weeder useful in young alfalfa in killing very young grass and weeds just germinated.

At Auburn crimson clover sown early in October in old drilled alfalfa was ready for cutting at the same time as the alfalfa, and the combined yield was large. This combination is not advised except when the stand of alfalfa has become so thin that it is about time for it to be plowed under.

TOLERANCE OF ALFALFA TOWARD OVERFLOWS.

When excessive rains occur and poorly drained soil remains saturated for a long time, alfalfa sometimes take on a pale yellowish, sickly color. This plant is classed as among those least able to endure prolonged saturation of the soil. Yet the large yields obtained on bottom lands make it worth while to take some chances of injury from overflows, especially on soils so drained naturally or artificially that the ground soon dries after the waters subside.

An overflow does not necessarily mean the destruction of the alfalfa plants. Experience in other states indicates that alfalfa may pass safely through a submergence of several days if all conditions are favorable. Its endurance of overflow is greater when the water is moving than when it is stagnant, and greater during the cooler periods of the year than when the plant is in a more active stage of growth. The deposit of much sediment on the plant, and hot, fair weather immediately after the water passes off are conditions unfavorable to recovery. Rains, washing off the sediment, are favorable to recovery.

In a bulletin of the Texas Experiment Station are cited two instances in which alfalfa in the Brazos River bottoms was under water for five or six days in summer without the destruction of the stand, except where the deposit of sediment was great or on poorly drained areas. These are extreme cases, and refer to soil that was well drained. Mr. R. P. McEntire, of Decatur, Ala., gives his experience with overflow as follows: "In the fall of 1901 I sowed 3 acres October 15, and got a good stand. In January we had an overflow from the Tennessee River, which was out over the land for two weeks. In a few days we had a hard freeze. Then on February 15 we had another overflow, which lasted 10 days. As the water went off we had another freeze. When spring opened I had something like half a stand." It would seem that one might raise alfalfa on land naturally well drained and where the overflows occur chiefly in winter, and where it is unusual for the water to remain on the land as long as three or four days in winter or two days in the warmer part of the year.

HARVESTING ALFALFA.

A discussion of the methods of harvesting alfalfa and of the machinery and devices employed would unduly extend this bulletin. In brief, alfalfa should be cured with the shortest practicable exposure in the swarth to the sun. The leaves are the richest portion of alfalfa, and if the hay is sunned too long the leaves drop off. The preferred time for cutting alfalfa is when about one-fourth in bloom, but this varies with the weather and with the thrift of the plants.

SUMMARY.

Alfalfa is a perennial leguminous plant, useful for hay, feeding green, pasturage, and for soil improvement. In nutritive qualities alfalfa stands in the front rank, and when fed to farm teams the ration of corn can be greatly diminished. On suitable soil the yield of hay exceeds that of any other hay plant. On prairie soils in Alabama yields of more than 3 tons per acre were in two instances obtained within seven months after sowing the seed, and the yield continues to increase for several years. Farmers report 3 to 5 tons per acre as the usual yield of hay per acre on prairie soil in Alabama, and in a number of instances these yields are greatly exceeded.

Alfalfa makes an unrivaled hog pasture, and is also recommended as a pasture plant for horses and mules. Cattle and sheep sometimes bloat when grazing on alfalfa. Pasturing, especially during the first year, injures and sometimes kills alfalfa.

Soils for alfalfa should be rich, well drained, well supplied with lime and vegetable matter. Alfalfa has been repeatedly demonstrated to be a success on the best grades of prairie soil on both uplands and lowlands. There is reason to believe that alfalfa will thrive on the lime soils of the Tennessee Valley region and on other calcareous soil in Alabama, and on fertile, well drained, alluvial soils in nearly every part of the State.

A crop of 4 tons of alfalfa hay contains 176 pounds of nitrogen, 40.8 pounds of phosphoric acid (equal to that in 336 pounds of high grade acid phosphate), 134.4 pounds of potash (equal to that in 1,075 pounds of kainit, or in 269 pounds of muriate of potash, and 280 pounds of lime. To replace only the phosphoric acid and potash by commercial fertilizers an expenditure of about $8.75 would be required.

The preparation of the land for alfalfa should be thorough, including plowing as deep as practicable, and repeated use of disc and spike tooth harrow. Generally it is best to plow a number of weeks before the seed are to be sown. A weeder or light harrow is the preferred mode of covering the seed, which are sown broadcast at the rate of 20 pounds or more per acre. Fall planting before October 15, when practicable, gives alfalfa a start ahead of weeds, but spring planting (early in March), is usually more convenient.

Alfalfa, especially that sown in the spring, requires land as free as possible from seeds of weeds, crab grass, etc. Repeated use of the mower during the first year is the preferred method of combatting weeds in alfalfa.

Planting alfalfa in drills and cultivating it may be suitable for a small patch kept for feed ng green, but this system was found impracticable for a hay field.

Usually the best crop to precede spring sown alfalfa is cotton, especially if cotton follows melilotus (sweet clover). The best crop to prepare the land for fall sown alfalfa is cow peas, sown very thick.

Numbers of farmers have found that alfalfa thrives when sown on Johnson grass meadows, holding its own, at least for the first few years, against this aggressive grass.

Dodder, a yellow thread-like growth, is a serious enemy of alfalfa. One of the remedies consists in mowing and burning. Seed merchants often pass alfalfa seed through a machine which is claimed to remove the dodder seed.

On sandy upland soils at Auburn alfalfa has not afforded very profitable yields. On such soils it requires heavy applications of lime or barnyard manure, and it is believed that more profitable use can be made of manure. At Auburn neither nitrate of soda nor cotton seed meal very greatly increase the yield of alfalfa that was properly stocked with root tubercles. Acid phosphate and potash fertilizers are considered indispensible here, and generally advisable on sandy or other soils not rich in lime.

Inoculation with soil from old fields of either alfalfa or bur clover greatly increase the yield of alfalfa growing on sandy land.

The germ that causes tubercles to develop on sweet clover (meliltous) also causes tubercles to develop on the roots of alfalfa. Hence artificial inoculation of alfalfa is not necessary when it is grown on prairie land that has recently borne a crop of melilotus. Artificial inoculation of alfalfa is probably advisable even for prairie soils when it is uncertain whether either the melilotus or alfalfa germs are present in great numbers.

In regions in Alabama where neither alfalfa, melilotus, nor bur clover is extensively grown, inoculation of alfalfa is advisable. For this purpose one may use soil from old fields of either of these plants or inoculating material prepared in the laboratory.

BULLETIN No. 128. JUNE, 1904.

ALABAMA.

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute.

AUBURN.

Feeding and Grazing Experiments with Beef Cattle.

BY

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FEEDING AND GRAZING EXPERIMENTS WITH BEEF CATTLE.

By J .F. DUGGAR, R. W. CLARKE, and JESSE M. JONES.*

Summary.

Using twenty young grade steers of the beef breeds, the following comparisons of foods were made: Cotton seed with cotton seed meal (Lots II and I); sorghum hay with a mixture of cowpea and sorghum hay, (Lots III and II); sorghum hay with shredded corn stover (Lots III and IV).

The feeding period covered 84 days, in addition to preliminary feeding. In all rations a small proportion of corn chop was used. As much grain was fed as the appetites and health of the steers permitted. As much roughness was fed as the steers would eat.

The average daily gain per steer was as follows:

With cotton seed and cotton seed meal.......2.23 lbs.
With cotton seed and mixed cowpea and sorghum hay ....1.93 lbs.
With cotton seed and sorghum hay..........1.19 lbs.
With cotton seed and shredded corn stover.... .98 lbs.

*R. W. Clark was Assistant in Animal Industry from September, 1899, to January, 1903, when he was promoted to a professorship in the Utah A. & M. College. Jesse M. Jones occupied the same position from January, 1903, to April, 1904, when he resigned to engage in farming in Alabama. These gentlemen had immediate charge of the experiments during the periods indicated. The Director is responsible for the plans of the experiments and the preparation of this Bulletin.

To produce one pound of increase in live weight there was required of concentrated food, "grain," with the cotton seed meal rations and sorghum hay, 4.82 lbs.; with the mixed hay and cotton seed ration, 5.41 lbs.; with the sorghum hay and cotton seed ration, 8.12 lbs.; with the corn stover and cotton seed ration, 9.41 lbs.

The amounts of roughness required to produce one pound of gain were, respectively, 6.56, 6.85, 11.09, and 10.23 pounds. The cotton seed meal ration afforded the largest per cent. of dressed meat.

A decline in the price of cattle while the experiment was in progress reduced the margin between the buying and selling prices to less than six-tenths of a cent a pound, a margin usually too narrow for profitable feeding. On the basis of the very high prices of foodstuffs prevailing in the winter of 1903-4, there was with all cotton seed lots a profit during the first 56 days of the experiment, but a loss after this time with all lots, if no account be taken of the manure.

On the basis of moderate prices of feed, Lot II was fed at a profit for 84 days. With low prices of food, Lots I, II, and III afforded a profit, in addition to the manure.

The profit in feeding beef cattle is made, not by producing new growth at less cost per pound than it sells for, but in the increased value of the original weight, due to fattening. A margin of one cent per pound between purchase price and selling price is desirable.

About 7 pounds of raw cotton seed was fed in the daily ration without injury to the health of the average steer.

Account was kept of the cost of food consumed by three grade or crossbred steers. Up to the average age of 24.3 months the average steer consumed $18.39 worth of skim milk, grain, hay, and pasturage, of which amount the first year's food cost $10.45, and that of the second year $7.94. At 24.3 months, the average weight was 867 pounds, worth at 3 cents per pound, $26.01. The average cost of food per pound of gain up to this age was 2.12 cents.

In feeding calves rice meal proved decidedly inferior to corn meal. When inferior shredded corn stover was fed to calves, 37 per cent. of it was refused, and when good shredded corn stover was fed freely to steers, 44 per cent. of it was rejected. The waste in feeding coarse sorghum hay, slightly moulded, to steers, averaged 20 per cent.

A Jersey calf, kept stabled until 6½ months old, produced manure (with accompanying bedding) at the rate of 9.4 pounds per day.

Yearling steers, kept in a barn, averaged a daily production of 20 pounds of manure per day, exclusive of bedding.

Yearling steers on rye pasture alone gained 1.67 lbs. daily per head.

Grade calves made on pasture alone an average daily gain of .72 of a pound, or 151 pounds per season. Grade yearling steers made an average daily gain of 1.43 lbs. per day, or 307 pounds per season, on native pasturage alone, or 91 pounds of live weight per acre. This was equivalent to a rental of $2.73 per acre for the land.

In a co-operative experiment made on an unimproved sandy-land pasture, in Macon county, Alabama, a study was made of the rate of growth of scrub cattle that received no food, even during winter, subsisting entirely on native pasturage and the winter range, and otherwise managed in the most primitive manner.

During a pasturage season of 7 months the average gains in live weight and percentage of increase as compared with weight in the spring, were as follows:

Mature cow, nursing calves, 59 lbs., or 8 per cent.
Heifers (2 years old, etc.), 172 lbs., or 39 per cent.
Yearlings, male and female, 103 lbs., or 38 per cent.
Sucking calves, 141 lbs., or 51 per cent.
Young steers and bulls, 149 lbs., or 35 per cent.

Young steers weighed for two pasturage seasons in succession increased in weight 42 per cent. as yearlings, and 44 per cent. as two-year-olds.

On the winter range, cattle of all ages became very thin, and in the opinion of the writers, it would have been highly profitable for the owner to have supplied them with hay and other food during the winter.

The principal essentials to the profitable production of beef cattle in Alabama are the use of pure-bred bulls of the beef breeds, the economical production of hay, especially from the leguminous plants, the substitution of this hay for a part of the grain ration, and an increased study of the best methods of handling and marketing cattle.

Feeding Experiment With Grade Steers.

The steers used in this experiment consisted of seventeen head, bought at Starkville, Mississippi; and of three head raised on the Station Farm at Auburn. The Mississippi steers were sired by a Shorthorn bull weighing 1700 pounds, and were out of native cows, about one-fourth of the steers showing strong evidence of Jersey blood. These streets were between two and three years old when bought. They reached Auburn November 5, 1903. The three steers raised on the Station Farm consisted of a Red Poll grade, an Angus grade, and a cross-bred Holstein-Shorthorn.

From November 5 to November 20 the entire lot of twenty steers subsisted on a pasture where frost had killed most of the grass on October 24. November 20 they were placed on a bare lot and the feeding of grain, (chiefly cotton seed), and sorghum hay was begun. For the first week they received only two pounds of grain per head daily, which was evidently insufficient. This amount was gradually increased. Throughout this time as much sorghum hay was fed as they would eat.

Our experience with these steers confirms conclusions previously drawn that the feeding of grain to animals intended for slaughter the same winter should begin earlier in the fall than is usual or as soon as the pastures begin to fail. November and December are months in which cattle on pasture shrink rapidly, and doubtless a little grain at this time, even while the cattle are on pasture, will avoid this source of loss.

During the entire time of the experiment each lot of cattle received as much forage as it would consume. The kinds of forage fed to each lot are stated below. An effort was made to make each lot of steers consume approximately the same amount of grain or concentrated food. However, this was found impracticable, but the amounts for the different lots were kept as nearly identical as the appetites and health of the animals would permit.

The forage was fed in racks above the grain trough and was not cut, nor was any of it mixed with the grain ration except such as dropped into the grain trough from the rack above.

It is believed that there would have been an advantage in cutting a small part of the hay and mixing it with the grain. Feeding of both grain and hay was done twice a day. Salt was accessible constantly, and twice a day the steers were driven to a pond for water. The water supply was not satisfactory, and during cold weather the steers would not drink sufficient water. The feeding was done under a rough shed covered with boards and battens, and boarded up on the north side. The south side was left open and each lot of steers had at all times the choice between remaining under shelter or staying in the small lots located on the south side of the feeding pen. The lots were on a steep, dry, sandy and stony hillside, well drained, and never became deep with mud. Even in wet weather the steers seemed to prefer the lot to the shed.

The figures, which are not all on the same scale, show the steers as they appeared at the end of the experiment.

The steers were charged with all of the forage put into the rack, and what they failed to eat was used as bedding. The amount of this refused material was determined at several times and the average results are stated elsewhere.

RATIONS FED.

The object of this experiment was to compare,

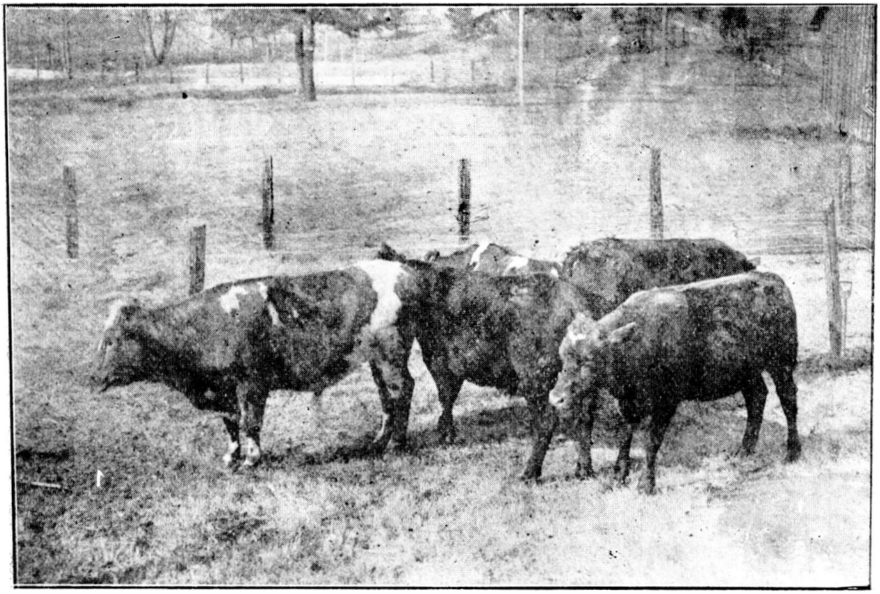
(1) Cotton seed with cotton seed meal. (Lot III and Lot I.)

(2) Sorghum hay with a mixture of cowpea hay and sorghum hay. (Lots III and II.)

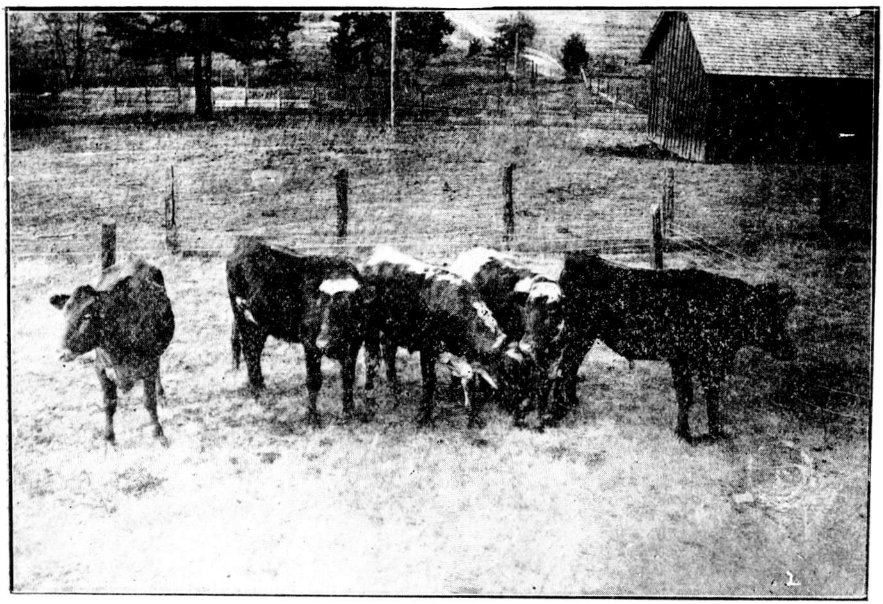
(3) Sorghum hay with shredded corn stover. (Lots III and IV.)

All cotton seed was uncooked.

On December 3 the twenty steers were divided into four lots, each containing five steers. In making this division both the weights of the steers and their individual conformation were used as a basis for the division. It is believed that the lots were very much alike in average quality as well as in weight. The weights of Lots I, II, III, and IV on December 9 were respectively, 3878, 3915, 3858, and 3889 pounds.

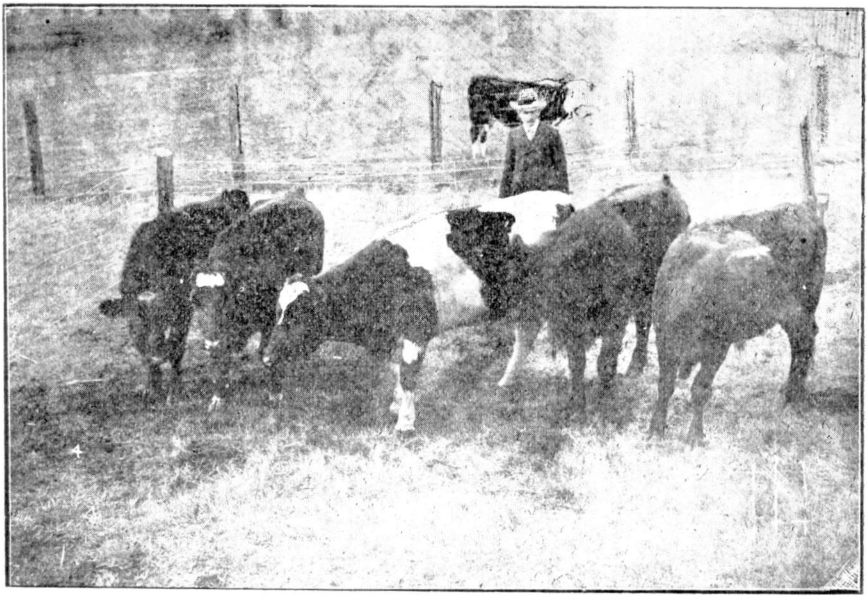


Lot I. Fed cotton seed meal, corn chop, and sorghum hay.



Lot II. Fed cotton seed, corn chop, and a mixture of cowpea and sorghum hay.

Lot III. Fed cotton seed, corn chop, and sorghum hay.



Lot IV. Fed cotton seed, corn chop, and shredded corn stover.

The interval from December 3 to December 9 was considered as a preliminary period, and during this time each lot was fed on the kind of food which it was to receive throughout the experiment.

The experiment proper began on December 9, and continued for 84 days, or three periods of 28 days each. During all periods the feed for any given lot was the same in kind and nearly the same in amount, the latter being determined entirely by the health and appetite of the steers.

The weight of each steer was determined at the beginning of the experiment by three weighings made on three successive days. Similarly, the final weight was the average of three daily weighings, March 1, 2, and 3, 1904.

The rations fed were as follows:

Lot I—Cotton seed meal, two-thirds; corn chop, one-third; sorghum hay.

Lot II—Cotton seed, three-fourths; corn chop, one-fourth: sorghum hay, one-half; pea vine hay, one-half.

Lot III—Cotton seed, three-fourths; corn chop, one-fourth: sorghum hay.

Lot IV—Cotton seed, three-fourths; corn chops, one-fourth: shredded corn stover.

As much of each kind of forage was fed as the animals would consume without excessive waste. The average amount of forage wasted was as follows:

Lot I—Sorghum, 17.1 per cent.
Lot II—Sorghum and cowpea hay, 20.7 per cent.
Lot III—Sorghum, 23.5 per cent.

Lot IV—Shredded corn stover, 44.2 per cent.

It will thus be seen that the waste of hay was about one-fifth of the amount fed, while the waste of shredded corn was more than double that of hay. This wasted food, as well as that consumed, was charged against the steers.

A considerable part of the surghum hay had passed through a heat in the barn, and was somewhat discolored and slightly moulded. It was all coarse, having been grown in drills and cut after the seed had colored. The cow pea hay, which constituted half of the roughness fed to Lot II, was not pure cow pea hay, but consisted of cow pea hay, 61.5 per cent.; crab grass, 24.7 per cent.; weeds, 7.8 per cent.; dirt, (sand, etc. raked up with hay), 6 per cent.

The corn stover was bright and of fairly good quality. It had never been baled. The corn chop was too coarsely ground to serve the principal purpose for which intended, viz., to mix with the cotton seed in order to increase the palatability of the seed. Indeed, the chop used during the last three weeks of the experiment was slightly moulded and not relished, which may partly account for the relatively slow gain made at that time. The foods used were charged at the following prices, which are cost prices for purchased articles, and for home-grown forage a figure somewhat above the cost of production:

Cotton seed, per ton	$14.00
Cotton seed meal, per ton.........	22.00
Corn chop, per ton	26.00
Cow pea hay, per ton	10.00
Sorghum hay, per ton	6.67
Shredded corn stover, per ton....	4.00

The following table gives by periods the average amount of grain and of roughness consumed by the steers in each pen, the average weight per steer at the beginning of each period, the average gain per steer per day and per 28 days, and most important of all, the amount of grain and of roughness required to make one pound of increase in live weight. It also gives a summary of results for the first two periods (56 days) and for the entire experiment (84 days):

Average results of feeding experiment with steers, 1903-04.

Period I—Dec. 9-Jan. 6:

Lot No.	Average daily ration per steer. Grain.	Roughness.	Chief food.	Avg. wt. per steer beginning	Avg. gain per steer in 28 days.	Avg. daily gain per head	Food per lb. of gain. Grain,	Roughness,
				Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
I	10.88	......	C. S. M. & corn	776	83.4	2.97	4.10	5.06
	......	13.3	sorghum.					
II.	10.41	......	Cotton seed,	783	63.2	2.25	5.15	6.36
	......	12.9	sorg. & pea.					
III.	9.72	......	Cotton seed,	772	58.2	2.08	4.66	6.15
	......	12.8	sorghum.					
IV	9.46	......	Cotton seed,	778	55.0	1.96	4.81	4.71
	......	9.3	stover.					

Period II—Jan. 6-Feb. 3:

I	11.2	......	C. S. M.	859	65.4	2.20	4.79	6.38
	......	14.8	sorghum.					
II.	10.4	......	Cotton seed	846	66.4	2.38	4.37	5.45
	......	12.9	sorg. and pea.					
III.	10.1	......	C. Seed.	830	25.6	.91	10.99	14.14
	......	12.9	sorghum.					
IV.	9.3	......	C. Seed	833	14.6	.52	17.91	18.90
	......	9.9	stover.					

Periods I-II—56 days:

I.	11.	......	C. S. Meal	......	148.8	2.51	4.25	5.45
	......	14.	sorghum.					
II.	10.4	......	C. seed,	......	129.6	2.31	4.49	5.57
	......	12.9	sorg. and peas					
III.	9.91	......	C. seed,	......	83.8	1.50	6.60	8.59
	......	12.9	sorghum.					
IV.	9.38	......	C. seed,	......	69.6	1.24	7.57	7.68
	......	9.6	corn stover.					

Period III—Feb. 3-March 3:

I.	10.4	......	C. S. Meal,	920	43.2	1.52	7.19	11.43
	......	15.8	sorghum.					
II.	10.5	......	C. seed,	913	32.2	1.15	9.09	12.02
	......	13.8	sorg & cowpea.					
III.	9.3	......	C. seed,	855	16.4	.58	15.89	23.74
	......	13.9	sorghum .					
IV.	8.9	......	C. seed,	849	12.8	.45	19.43	24.06
	......	11.0	stover.					

Three Periods—84 days:

Lot No.	Average daily ration per steer. Grain.	Rough-ness.	Chief food.	Avg. wt. per steer beginning.	Avg. gain per steer in 28 days.	Avg. daily gain per head.	Food per lb. of gain. Grain.	Rough-ness.
				Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
I.	10.8	......	C. S. meal,	......	192.	2.23	4.82	6.56
	......	14.6	sorghum.					
II.	10.43	......	C. seed,	......	161.8	1.93	5.41	6.85
	......	13.2	sorg. and peas.					
III	1.70	......	C. seed,	......	100.2	1.19	8.12	11.09
	......	13.2	sorghum.					
IV.	9.22	......	C. seed,	......	82.4	.98	9.41	10.23
	......	10.	corn stover					

The most important portion of the above tables is the summary giving the results of 84 days. From this we observe that to produce one pound of increase in live weight required:

	Grain.	Rough-ness.
Lot I, fed cotton seed meal, sorghum hay, etc.	4.82	6.56
Lot II, fed cotton seed, cow pea and sorghum hay, etc	5.41	6.85
Lot III, fed cotton seed, sorghum hay, etc.	8.12	11.09
Lot IV, fed cotton seed, corn stover, etc.	9.41	10.23

This clearly indicates the superiority of cotton seed meal compared with an equal weight of cotton seed; the superiority of mixed cow pea and sorghum hay over sorghum hay; and the great advantage of the ration containing cow pea hay as compared with those in which the roughness consisted of sorghum or corn stover.

In rapidity of gains the rations stand in the same rank. The average daily gain per steer was as follows:

Lot 1, cotton seed meal, sorghum, etc........2.23 lbs.
Lot II, cotton seed, cow pea and sorghum, etc.1.93 lbs.
Lot III, cotton seed, sorghum, etc............1.19 lbs.
Lot IV, cotton seed, corn stover, etc.......... .98 lbs.

EFFECT OF FEED ON QUALITY OF STEERS.

The steers were sold in the lots at Auburn to Phillips & Ungermann, Packers, Birmingham, Alabama.

Naturally there was considerable individual difference between the steers, so that the differences in the price put upon each by the packers are not entirely chargeable to the food used.

The packers' estimate of the value of the steers fed on the different rations is shown by the following table, giving the selling prices.

Prices of steers when sold.

Lot No.	No. worth 3½ cents.	No. worth 3¼ cents.	No. worth 3 cents.	Total value of lot.	Principal foods fed.
1	3	2	..	$164.47	C. S. meal, sorghum.
2	5	..	..	166.25	C. seed, pea, and sorg.
3	..	2	3	134.29	C. seed, sorghum.
4	2	1	2	139.55	C. seed, stover.

When sold Lots I and II were judged to be of nearly equal quality, and in this respect far superior to Lots III and IV. The more nitrogenous (narrower) rations afforded the more rapid fattening and the higher quality as judged by the eye. Judged by percentage of dressed weight or shrinkage during shipping from Auburn to Birmingham, the steers fed on cotton seed meal (Lot I) were superior to Lot III, fed on cotton seed and the same roughness. Taking the weights at Auburn as the live weights, and comparing them with the amount of dressed meat obtained in Birmingham, we find that Lot I, on cotton seed meal and sorghum, netted 54.5 per cent.; Lot

II, on cotton seed and mixed hay, netted 51 per cent.; Lot III, on cotton seed and sorghum hay, netted 50.6 per cent.; Lot IV, on cotton seed and corn stover, netted 51.3 per cent.

In other words, on this basis alone, the packer could have afforded to pay a premium of one-fourth cent per pound gross for Lot I, in comparison with Lot III. It is but fair to add that if live weights in Birmingham could have been ascertained the percentages of dressed meat would doubtless have ranged considerably higher.

Financial Returns.

For 56 days.—The cattle cost 2¾c per pound in November. No charge is here made for freight, since on a fraction of a carload this was a very heavy expense per head, and since, moreover, the few Alabama cattle that could have been had without any freight charges would have cost no more near home than was paid for this larger and more uniform lot of cattle in Mississippi. During the period between the purchase of these cattle, in November, 1903, and their sale, in March, 1904, to a packing house in Birmingham, Alabama, the prices of cattle fell. The estimated decline in the price of cattle of this grade was about ½c per pound. Hence, under normal conditions and with a market neither advancing nor declining, we should have realized ½c more per pound than the cattle actually brought, which would have given a fair profit on each of the four lots.

The price paid in our lots at Auburn was 3½ cents per pound for the best ten steers, 3¼ cents per pound for the five steers ranking next, and 3 cents per pound for the five poorest steers.

Since the gains made by most of the steers were quite unsatisfactory during the third period, and since this is believed to have been largely due to the inferior quality (mouldiness) of the corn chop purchased, we have calculated the financial returns at the end of 56 days' feeding, as well as at the end of 84 days' feeding.

For the 56 days embraced in the first two periods of the experiment, the financial results were as follows:

Lot I:		
To 3878 lbs. live weight, at 2¾c...........	$106.64	
To 3948 lbs. sorghum hay, at $6.67 per ton	13.16	
2054 lbs. cotton seed meal, $22 per ton	22.60	
1025 lbs. corn chop, $26 per ton........	13.33	
	155.73	
By 4602 lbs. live weight, at 3½c and 3¼c		$153.69
Loss on 5 steers in 56 days		1.84

Lot II:		
To 3915 lbs. live weight at 2¾c	$107.58	
To 1805 lbs. cowpea hay, at $10 per ton..	9.02	
1805 lbs. sorghum hay, at $6.67 per ton	6.02	
1940 lbs. cotton seed, at $14 per ton....	10.88	
970 lbs. corn chop, at $26 per ton.....	12.61	
	146.11	
By 4563 lbs. live weight at 3½c.........		159.71
Gain on 5 steers in 56 days...............		*13.60*

Lot III:		
To 3858 lbs. live weight, at 3¾c..........	$106.10	
To 3608 lbs. sorghum hay, at $6.67 per ton	12.03	
1844 lbs. cotton seed, at $14 per ton....	12 91	
923 lbs. corn chop, at $26 per ton....	12.00	
	143.04	
By 4277 lbs. live weight, at 3¼ and 3c..		$132.40
Loss on 5 steers in 56 days		10.64

Lot IV:		
To 3889 lbs. live weight, at 2¾c	$106.95	
To 2676 lbs. shredded corn stover, at $4..	5.35	
1756 lbs. cotton seed, at $14..........	12.29	
878 lbs. corn chop, at $26............	11.41	
	136.20	
By 4237 lbs. live wt., at 3½, 3¼, and 3c		$138.78
Gain on 5 steers in 56 days		2.58

In this period of 56 days there is a profit of $13.60 from the lot fed on a mixture of cowpea and sorghum hay and cotton seed; a profit of $2.58 from the lot fed on corn stover and cotton seed; a slight loss from Lot III, the lot fed an cotton seed meal; and a considerable loss from the lot fed on cotton seed and sorghum hay.

For 84 days.—During the third period of 28 days, the cattle in all lots made very slight gains, largely due, it is believed, to the poor quality of the corn chop fed during the last three weeks of the experiment. Hence the unsatisfactory results of the third period greatly reduce the financial returns for the entire experiment of 84 days.

Financial returns for 5 steers per lot for 84 days with low, medium, and high prices of foodstuffs.

	Low.	Medium.	High.
Cotton seed, per ton	$10.00	$12.00	$14.00
Cotton seed meal per ton	18.00	20.00	22.00
Corn chop, per ton	20.00	23.00	26.00
Cowpea hay, per ton	5.00	7.50	10.00
Sorghum hay, per ton..	4.00	5.00	6.67
Shredded corn stover, ton	2.50	3.25	4.00

	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Lot I.						
By 5 steers, selling price..		164 47	......	164.47	.....	164.47
To 5 steers, bought at 2¾c.	106 64	......	106 64	......	106 64	....
To food fed	55.55	......	64 03	......	74.55	....
Profit or Loss..........	**Profit**	**2.28**	**6.20**	**Loss**	**16.72**	**Loss**
Lot II.						
By 5 steers, selling price..	......	166.25	......	166 25	.....	166.25
To 5 steers, bought at 2¾c.	107 58	......	107.58	....	107.58	....
To food fed...............	39.81		47.94	....	60 31	......
Profit or Loss..........	**Profit**	**19.86**	**Profit**	**10.73**	**0 64**	**Loss..**
Lot III.						
By 5 steers, selling price..	......	134.29	......	134.29	.....	134.29
To 5 steers, bought at 2¾c.	106.10	......	106.10	......	106.10	....
To food fed...............	36.56	....	44.38	......	53.24	....
Profit or Loss	**8.37**	**Loss..**	**16.19**	**Loss..**	**25.05**	**Loss..**
Lot IV.						
By 5 steers, selling price..	......	139 55	......	139 55	.....	139.55
To 5 steers, bought at 2¾c.	106 95	......	106 95		106 95	....
To food fed...............	29.50	......	32.99	....	41.38	......
Profit or Loss	**Profit**	**3.10**	**0.39**	**Loss..**	**8.78**	**Loss..**

At the abnormally high prices of feed prevailing during the past winter, there was a financial loss with every lot of steers fed for 84 days. On a basis of medium prices for food stuffs on the farm, Lot II, fed on mixed cowpea and sorghum hay, cotton seed, and corn chop, afforded a profit of $10.73, in addition to the value of the manure, all other lots entailing a loss. With unusually low prices for food, every lot, except Lot III, afforded a profit, Lot II leading.

Whatever the price of feed the ration of mixed cowpea and sorghum hay, cotton seed, and corn chop, was the most profitable.

As before stated, the fall in the price of fat cattle between the time of purchase and of sale of these cattle was about half a cent per pound. Had there been a stationary, instead of a declining market, there would have been an additional credit of at least $20 for each lot, or sufficient to make a profit on every lot except Lot III, with food stuffs at the highest rating.

The production of beef in the South should be thought of as two distinct lines of business, which may be combined on one farm or which may be entirely separate. These divisions are: (1) The growing of cattle from the time of conception until the animal has reached sufficient size to be fed or finished for market, which is usually when a grade of the beed breeds is between two and three years of age; (2) Feeding or finishing cattle, usually between two and three years.

The first operation to be most highly profitable requires an abundance of good pasturage and the almost exclusive reliance on foods grown on the farm, many of which could not be marketed at all unless first converted into some form of livestock. In feeding operations on the other hand, use can often be made of purchased food, especially of cotton seed meal. But even in feeding cattle in winter there will be, as a rule, most clear profit to the farmer who utilizes crops raised on his own land, for example, such foods as were fed in this experiment to Lot III.

It is generally recognized in states where immense numbers of beef cattle are fed for market from 4 to 5 months, that the profit consists chiefly in buying cattle at a low price per pound and in selling them when fattened at a considerably higher price per pound. It is a common saying that the difference between the buying and the selling price must be at least one cent per pound if the feeder is to obtain a satisfactory profit in addition to the manure.

Readers are cautioned against concluding that a certain feeding operation is unprofitable simply because every pound of increase in live weight has cost more than the same pound will sell for. The profit lies chiefly in the enhanced value of every pound of the animal's weight when feeding was begun, an increase in value due to the superior quality (or degree of fatness) of the finished steer. The following example of a steer weighing 900 pounds when feeding was begun, may make this important statement clearer:

	Dr.	Cr.
To cost of feed, 100 days, at 12c per day..........	$12.00	
By value of 200 lbs. increase in wt., at 3½c........		$7.50
By increased value of original wt. 900 lbs. at 1c....		9.00
		$16.50
Profit	$4.50	
	$16.50	

Here the feed cost more than the value of the increased weight, or one pound of gain cost 6 cents, but sold for only 3½c. Yet this transaction was directly profitable, to say nothing of the indirect profit from the manure and from the utilization of food that would otherwise have been wasted.

The essentials to the highest profit in producing beef in Alabama are:

(1) The use of *thoroughbred* bulls of the beef breeds, and, as soon as practicable, of dams having some beef blood;

(2) Abundance of good pastures;

(3) Economical production on the farm of cowpea, sorghum, and other hay, and other foods needed in wintering cattle;

(4) Intrusting the care of cattle to men who have studied the business both of crop production and of feeding;

(5) Increased attention to marketing, including the raising of such numbers of beeves and of such quality as will be worth shipping in carload lots to the best markets North or South; equitable freight rates; increased appreciation on the part of local butchers of the superior value of well bred and well fattened beeves; and co-operation in selling and shipping.

Health of the Steers.

This was good throughout the experiment, with the exception of an occasional case of scouring. The conclusion was drawn that for these particular lots of steers fed the specified kinds of roughness *ad libitum* it is not safe to feed more than 7.5 pounds of cotton seed meal per day per steer to steers fed as those in Lot I, nor more than 7.8 pounds of raw cotton seed to Lot II, nor more than 7.5 pounds of raw cotton seed to Lot III, nor more than 6.9 pounds of raw cotton seed to Lot IV, which also received corn stover. Although corn stover is considered as constipating, yet cotton seed, a very laxative food, had to be fed in smaller amounts with the above named roughness than when fed with cow pea hay and sorghum, both of which are considered more laxative than the stover. Our experience that between 7 and 8 pounds is the maximum daily ration of raw cotton seed which can be safely fed to steers, without inducing scouring, agrees closely with results at the Oklahoma Station, where the maximum amount recommended was 8 pounds. (Okla. Sta. Bul. No. 58, p. 37).

Manure produced.—As elsewhere stated, the steers spent far more time in the yards than under shelter, and most of the manure dropped in the yards was lost, due to drainage of lots.

About a week after the steers were sold, all the manure lying under the sheds and also the thick layer of manure extending out about six feet from the sheds was weighed before being hauled to the fields. The total amount hauled out from the four sheds aggregated 29,600 pounds of excellent manure. Making allowance for that produced during the preliminary period, it is estimated that about 27,000 pounds was produced during the 84 days of the experiment proper. In other words there was *saved* from the sheltered manure about 16½ pounds of manure per steer daily, and doubtless the amount wasted was much greater. No bedding was used except the rejected stems of the hay and stover. Bedding should have been used. At $2.00 per ton the manure *saved* would average an additional credit of $6.75 per lot.

Cost of Producing Beef.

To afford final conclusions as to the cost of producing beef, it will be necessary to raise a number of animals in different years and under widely different conditions. However, the following data based on the results with three steers is offered as a preliminary contribution to our knowledge on this subject.

An account was kept of the amount of food consumed by each of three calves from the age of two or three weeks until taken from the pasture at the end of the second grazing season, November 1, 1903, when we were offered 3 cents per pound for them by a local butcher. These animals were Dangus, a steer sired by a registered Angus, and out of a large cow that seemed to be about ½ Jersey; Toom, a steer sired by a registered Red Poll bull, and out of a large native cow, apparently a Shorthorn grade; Holstein, a cross-bred Shorthorn Holstein. All of these were dropped between September 21 and December 17, 1901. The history of these individuals is as follows: For the first one or two weeks after birth the calves, then belonging to private individuals, subsisted on the milk afforded by one teat of the dam. One of these calves, Holstein, dropped on the Station Farm, was never allowed to suck, but was fed for the first few weeks on whole milk or part whole milk. The account for food stands as follows:

Dangus—

	Dr.	Cr.
2009 lbs. skimmed milk, at ¼c	$5.02	
172 lbs. bran and corn meal, first winter, at 1c	1.72	
214 lbs. leguminous hay, first winter, at ½c	1.07	
180 lbs. grain, first spring at 1c	1.80	
Eight months' pasturage at 25c	2.00	
294 lbs. cotton seed, second winter, at ⅝c	1.84	
132 lbs. cotton seed meal and wheat bran, second winter, at 1c	1.32	
399 lbs. hay, second winter, at 1-3c	1.33	
86 lbs. green rye, at ⅛c	.11	
8½ months' pasturage, at 30c	2.55	
To cost of food up to age of 25 months	18.76	
By weight at 25 months (Nov. 1, '03) 888 lbs. at 3c		26.64
Excess of value over cost of feed	7.88	
	$26.64	$26.64

Cost of food per pound of live weight, 2.11c.

Toom (½ Red Poll)—

	Dr.	Cr.
2100 lbs. skim milk, at ¼c	$5.25	
131 lbs. wheat bran, first winter, at 1c	1.31	
248 lbs. rice meal, first winter and spring, at ⅝c	1.55	
311 lbs. leguminous hay, first winter, at ½c	1.55	
8 months' pasturage, at 25c	2.00	
361 lbs. cotton seed, second winter, at ⅝c	2.25	
180 lbs. wheat bran and cotton seed meal, second winter, at 1c	1.80	
484 lbs. sorghum hay, second winter, at 1-3c	1.61	
86 lbs. green rye, at ⅛c	.11	
8½ months' pasturage at 30c	2.55	
To total cost of feed to 25 months	19.98	
By 848 lbs. live weight, at 3c		25.44
Excess of value of steer over cost of feed	5.46	
	$25.44	$25.44

Cost of food per pound of live weight, 2.35c.

Holstein-Shorthorn—

1554 lbs. skim milk, at ¼c	3.88	
144 lbs. wheat bran and corn meal first winter, at 1c	1.44	
150 lbs. leguminous hay at ½c	.75	
8 months' pasturage, at 25c	2.00	
374 lbs. cotton seed, second winter, at ⅝c	2.35	
200 lbs. wheat bran and corn meal, 2nd winter, at 1c.	2.00	
393 lbs. corn stover, second winter, at 1-5c	.79	
51 lbs. vetch hay, second winter, at ½c	.26	
84 lbs. green rye, at ⅛c	.11	
8½ months' pasturage at 30c	2.55	
27 lbs. cotton seed meal at 1.1c	.30	
To total cost of feed to 23 months	16.43	
By 865 lbs. live weight at 3c		25.95
Excess of value over cost of feed	9.52	
	$25.95	$25.95

Cost of food per pound live weight, 1.9c.

From the above financial statement, it will be seen that at the high prices of recent years, the total average cost of food eaten by each animal from the age of two to four weeks until 24.3 months old, averaged $18.39, and that the value of the average steer at this age, weighing 867 pounds, was $26.01. This gives an average difference of $7.62 between cost of food and selling price, and must cover the cost of the calf at 2 to 4 weeks old, and other items of expense.

A much more favorable financial showing could have been made had not each of these steers been used in feeding experiments during each of two winters. There was no spcial effort to grow the animals as economically as possible when economy conflicted with experimentation as to the comparative value of foods. It is planned to grow in future a lot of grade beef calves with the primary object of producing beef as cheaply as the conditions at Auburn permit, and we are confident that with this end in view the cost can be greatly reduced below the figures given above by the following changes in the method of handlng the animals:

(1) By decreasing the amount of grain in winter and the substitution for it of leguminous hay and winter pastures.

(2) By the use of cheaper grain food, chiefly cotton seed.

(3) By causing the calves to be dropped after Christmas and keeping them only two winters if they are ready for market.

In order to make it easier for each reader to draw his own conclusions from the data above and to place his own local prices on the foods used, the following summary of the average amounts of food consumed per animal up to the age of 24.3 months, has been prepared.

Average amount of food consumed by grade steers from age of 2 to 4 weeks to age of 24.3 months.

First year—
1888 pounds skim milk.
258 pounds grain.
225 pounds hay
8 months' pasturage.

Second year—
480 pounds grain, chiefly cotton seed.
1276 pounds sorghum hay and corn stover.
8½ months' pasturage.

From the above detailed data previously noted we learn that the average cost of feed and pasturage for a steer up to the age of 24.3 months was $18.39. Of this, the cost incurred during the first year for calves dropped in the fall was $10.45; the cost of food and pasturage the second year was $7.94.

The average cost of food per pound of live weight was 2.12 cents, which cost could have been reduced if the prime object in feeding these animals had continually been the cheapest production of beef.

RICE MEAL VERSUS CORN MEAL FOR CALVES.

Calves dropped in the fall of 1901 were used in this experiment. They were grades of the beef breeds. Each calf was fed a moderate ration of skim milk, as much lespedeza (Japan clover) hay as it would eat, and as much of the grain mixture named below as it would eat without waste. The calves were first fed for nearly two months on the ration which each was to receive during the experiment proper.

During these two months the amount of grain eaten was small, and especially during this time the rice meal proved decidedly inferior in palatability to the corn meal. Indeed, it was impossible to make the calves eat sufficient of the rice meal, so that it became necessary to use wheat bran as one-third of the weight of the rice meal ration, and of course wheat bran likewise constituted one-third of the corn meal mixture.

The experimental period proper extended from January 1 to April 2, 1902, a period of ninety-one days. The detailed records for each calf are given in the table below:

Rice meal versus corn meal for calves.

Name.	Grain, lbs.	Hay, lbs.	Skim milk, lbs.	Live wt. Jan. 1. Lbs.	Gain, lbs.	Breed.
Rice meal lot—						
Toom	153	237	1620	180	152	½ Red Poll
Foxella	252	300	417	195	137	¾ Angus
Total	405	537	2037	375	289	
Corn meal lot—						
Andrew	261	306	475	192	150	¾ Angus
Dangus	138	214	1609	125	200	½ Angus
Total	399	520	2084	317	350	

The calves receiving rice meal made an average daily gain per head of 1.6 pounds, while the lot eating corn meal averaged 1.9 pounds per head.

To make one pound of increase in live weight, the following amounts of food were needed:

	Rice meal.	Corn meal.
Lbs. grain required to make 1 lb. of gain...	1.40	1.24
Lbs. hay required to make 1 lb. of gain....	1.85	1.49
Lbs. skim milk required to make 1 lb. gain.	7.04	5.70

From the figures given above it will be seen that corn meal was decidedly superior to rice meal in giving more rapid growth, and in requiring a smaller amount of food per pound of growth. Corn meal is also superior in composition and palatability. The rice meal used evidently consisted partly of ground rice hulls.

After an experience of five months in feeding rice meal to calves, we are led to the conclusion that it is not an especially desirable food for calves. However, the gains made by these calves on rice meal indicate that when the price is very much cheaper than that of corn that it may be thus used. A briefer experience in feeding rice polish suggests that it may be found to be a very desirable food for calves, as also we have found it for hogs.

Shredded Corn Stover versus Sorghum Hay.

During the winter of 1902-03 an experiment was begun to determine the relative values of shredded corn stover and sorghum hay, using yearling cattle, most of which were grades of the beef breeds. The experiment was interrupted by sickness of two of the animals, which was not due to the feed. In the fifty days before this interruption the rate of daily gain was much greater with the sorghum lot than with those fed the corn stover. The latter was of medium to poor quality and was decidedly unpalatable.

Of the corn stover offered, 37 per cent. remained uneaten in the troughs, although this food was fed in such limited quantities as to make the animals consume as large a proportion of it as possible. During a part of the time the stover was sprinkled with brine, but this did not noticeably increase its palatability.

The sorghum was eaten clean. At first it was cut into short lengths, but this was found to be unnecessary, the yearlings consuming a bright good grade of sorghum hay fed whole as well as when cut. The grain ration fed in connection with both the stover and the sorghum hay consisted by weight of four parts cotton seed, one part cotton seed meal, and one part wheat bran, a very satisfactory combination.

MANURE MADE.

Manure from a young calf.—A Jersey heifer calf, dropped October 15, 1901, was kept in a box stall from November 3 to April 30, 1902, except that for one day every two weeks she was allowed to run in a lot, and the manure for this day was thus lost. Pine leaves were freely used as bedding, and in more liberal quantity than is customary.

The total amount of manure, including bedding, as weighed a week after the close of the experiment was 1645 lbs. produced in 176 days. This is about 9.4 lbs. of manure and bedding per day, which is a larger amount than would be obtained with the usual amount of bedding.

During this time this calf consumed 204 lbs. of wheat bran, 323 lbs. hay (chiefly lespedeza and crimson clover), 92 lbs. of whole milk, and 1191 lbs. of skim milk.

Assuming 6 lbs. of skim milk as equivalent to 1 lb. of grain, we have a total amount of feed eaten, equivalent to about 740 lbs. of grain and hay. Hence for every pound of air-dry food consumed there was produced about 2.2 lbs. of manure.

Manure produced by yearling beef animals.—Beginning January 17th, 1902, the combined liquid and solid manure dropped by six head of yearling cattle, most of which were grades of the beef breeds, was saved and weighed daily. The arrangement for catching the droppings consisted only of the usual wooden manure gutter and the use of pine leaves as bedding. The floors of the stalls were of clay, and hence there was some loss of the liquid manure from the four steers. The cattle had to be taken from the barn for a short time twice a day for water, which represented the loss of such manure as was dropped during a daily period of about one-half hour. From these statements it will be seen that the effort was rather to determine the amount of manure that the farmer could expect to save from cattle of this kind, kept under shelter, than to determine from a scientific standpoint the actual and exact weight of the excreta.

The results for the twenty-day period were as follows:

	Lbs.
Solid and liquid manure saved from 6 yearlings in 20 days, excluding bedding	2402
Bedding used	179
Total manure per head daily, excluding bedding	20
Total manure per head daily, including bedding	21.5
Total cotton seed, cotton seed meal, and wheat bran fed	825
Total sorghum hay and corn stover actually consumed	497
Total food	1322
Pounds liquid and solid manure saved per pound of dry food fed	1.8

At this rate six yearlings in one month would produce 3600 lbs. of manure, or, including bedding, about two tons. In other words, a beef animal weighing about 500 lbs. would produce a ton of manure in about 3 months.

Grazing Yearling Steers on Green Rye.

For three weeks, beginning March 11, 1903, four yearling steers, averaging about 500 pounds in weight, were placed on a field of rye, sown on thin upland on the Station farm at Auburn during the preceding September. Before being placed on this pasture they had for several days been accustomed to eating green rye and had been all allowed to make the fill that usually occurs when cattle are first placed on green food.

The increase in live weight was 1.67 pounds per head per day.

The rye was about two feet high when the cattle were turned on it, and although too old and coarse to be as palatable as at a younger stage, yet it was eaten clean.

To determine the increase in live weight made by thoroughbred and grade cattle of the beef breeds, weighings were made throughout the pasture season for such beef animals in the Station herd as were kept continuously on pasture. The following table gives first, the data for five calves, grades of the beef breeds; and for five mature cows, thoroughbreds and grades of the beef breeds, for the time that they were kept continuously on pasture.

Gains of Station beef cattle on pasture alone.

Name.	Breed.	Weight in spring.	Gain, lbs.	Days.	Average daily gain, lbs.
Toom	½ Red Poll	345	160	214	.74
Dangus	½ Angus	340	152	214	.71
Holstein	Hol. short	315	177	214	.82
Aubelle	Short horn	455	95	214	.44
Foxella	¾ Angus	370	135	214	.63
Dangus 2nd	½ Angus	238	187	184	1.01
Clementina	Red Poll	1050	200	183	1.09
Gazelle	Short-horn	1010	240	183	1.31
Baroness	Grade Angus	1045	185	183	1.01
Fancy	Grade Angus	880	145	183	.78
Sally	Angus	855	245	183	1.34

From the above table it will be seen that the average daily gain of calves having from 50 to 100 per cent. of beef blood, was .72 pound, and that the average daily gain of thoroughbred and grade beef cows was 1.1 pounds.

The pasture was strictly unimproved, or in its natural condition, and consisted chiefly of old poor upland fields, too poor for cultivation, on which the principal growth lespedeza and broom sage.

In order to determine the amount of beef which might be produced from an acre of pasture, a portion of the pasture of the Alabama Experiment Station farm was fenced off and four young steers were kept on it from April 1 to November 1, 1903. The following table gives the breeding of the animals, their weight on April 1, and the gain made during the next seven months.

Gains made by four yearling steers from April 1 to November 1, 1903.

Name.	Breed.	Weight April 1st.	Weight Nov. 1st.	Gain on pasture.	Average daily gain.
Toom	½ Red Poll	590	848	258	1.20
Dangus	½ Angus	535	888	353	1.64
Holstein	Holst-shorthorn	555	865	310	1.44
Cull	Scrub	445	715	270	1.26

The area in this pasture was 13.11 acres, of which about 3.1 acres was covered by a dense growth of alders and other timber. On this area the total increase in live weight made by the four steers was 1191 pounds, or at the rate of 91 pounds of increase in live weight for each acre, including thickets. At 3 cents per pound, this is equivalent to a rental of $2.73 per acre for the entire tract, although, if cultivated, the rental value of the entire tract would not have exceeded half this amount.

Moreover, in the season of 1903, when rains were so favorably distributed for the growth of pasture grasses the steers were not able to consume the entire growth. We estimated that there was food enough for two more similar steers. For three weeks in November this pasture supported seventeen two-year-old steers, without other food.

The average daily gain per head for the three yearling steers with beef blood on pasturage alone was 1.43 lbs. and the average gain for the pasturage season was 307 lbs. per head.

Gains Made by Scrub Cattle on Pastures.

Conditions of the experiment.—It seemed a matter of importance to study the gains made by scrub cattle (unimproved natives) during the grazing season. Hence in the spring of 1901, an experiment was begun in co-operation with a farmer living in Macon county, Alabama, who every year pastures a large number of cattle of scrub or Jersey blood. One of the principal objects in view was to ascertain what class of animals, or rather animals of what age, made the most rapid gains, or brought the most profit to the dealer or stockman pasturing cattle.

The Station furnished the scales and its representative weighed the cattle several times each year. The pasture is so large and the cattle so wild and the stock so frequently changed by sales and new purchases that only for a few of the several hundred animals weighed are the records in any sense complete. However, by combining the results for the three years, we obtained averages which are believed to have some suggestive value. The pasture on which these cattle grazed consisted of old fields and swampy thickets with a small amount of switch cane. The principal growth relished by cattle consisted of lespedeza, broom sage, crab grass, swamp grasses, and switch cane. This is strictly an unimproved pasture, no seed of any kind having been sown in it. It is probably an average native or unimproved pasture on sandy land. Most of it is made up of old fields, some that have been uncultivated for many years, and other areas recently thrown out of cultivation. The soil would rank as poor sandy land, worth, perhaps, if in cultivation, $3 to $6 per acre.

Relative gains during the pasturage season in grazing scrub cattle of different ages.

By averaging the results for the different years, it was found that during the portion of the pasturage season covered by our weighings the daily gain made by the different classes of stock for periods of 138, 183, and 236 days (these being the respective intervals between weighings during the three years, were as follows:

Daily gains made by scrub cattle on native pasturage alone.

9 cows averaged per day	.28 lb.
14 heifers (300 lbs. and above) averaged......	.82 lb.
7 yearlings, male and female, averaged......	.49 lb.
4 sucking calves averaged	.67 lb.
13 steers and bulls (above 300 lbs.) average..	.71 lb.

It was impracticable to make weighings early enough in the spring and late enough in the fall to include the entire pasturage season. However, we are confident that the period during which cattle made average gains was at least seven (7) months, or from April 15th to November 15th. Hence, in order to make the results clearer we have calculated from the figures above the gains for a pasturage season of 210 days and the results are given below:

Gains made by scrub cattle during a season of 7 months on pasture.

	Lbs.	Value of increase at 2½¢
Mature cows, sucking calves	59	$1.48
Heifers above 300 lbs	172	4.30
Yearlings, up to 300 lbs	103	2.58
Sucking calves	141	3.52
Young steers and bulls	149	3.73

It is obviously unfair to compare the mature cows with the other animals, since the slight gains made by them are due in large measure to the fact that they had nursing calves at their sides. Excluding the cows, we find that the largest gains were made by the heifers that at the beginning of the season weighed more than 300 lbs. It is notable that the heifers should have beaten the steers of corresponding weight. The sucking calves made considerably greater gains than did the yearlings, but it cannot of course be said that sucking calves are most profitable stock for grazing, for the reason that the grazing of this class of animals necessitates supporting the dam, whose gain is slow.

A more accurate idea of the relative profit of grazing these different classes of animals may be obtained by ascertaining what per cent of increase, as compared with the weight in the spring, is made by the average animal of each class during the season of abundant pasturage.

Percent increase during pasturage season of 7 months.

	Avg. wt. in spring.	Per cent. increase.
Cows, suckling calves	615	8
Heifers	440	39
Yearlings, male and female	269	38
Sucking calves	272	51
Steers and bulls	428	35

According to this showing, if scrub cattle are bought and sold at the same price, the investment should return a gross profit of 39 per cent. with large heifers, 38 per cent with yearlings and 35 per cent. with steers. Since the selling price per pound is considerably above the purchase price, the showing is still more favorable. Of course, from this must be deducted a number of expenditures, including interest or rent and loss from death. If these figures are representative they indicate that either one of these three classes of scrub cattle may be pastured at practically the same profit.

However, for cattle to be kept over winter without feed except the range the losses by death are greater with the calves and yearlings than with older animals. To form a better idea of the weights of these scrub cattle, the reader is referred to the table in the Appendix.

Annual growth made by scrub cattle under range conditions.—It would be of interest to ascertain the weights from year to year and the average gains for an entire year under this system of maintaining scrub cattle without any food in winter. From causes alluded to above our records on this point are fragmentary, the stock being constantly changed.

Ten head of cows averaged an annual increase in live weight of only twenty-four pounds, this poor showing being attributable, of course, to the calves that they suckled. The history of five young steers, weighed at intervals for two years is of interest as showing the effect of age on the rate of growth of very young cattle. The following table gives the details:

Growth made by young scrub steers in two years.

Steer No.	Weight first spring.	Gain first year.	Gain second year.	Gain two years.	Average yearly gain.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
11	218	120	170	290	145
56	238	128	190	318	159
57	326	168	172	340	170
67	304	88	170	258	129
84	234	64	178	242	121
Average					**145**

From this table we see that the average gain per steer per year was 145 pounds, worth at 2½c per pound, $3.67. The increase made by these young steers was during the first year 42 per cent over their weights in the spring. The same steers made during their second year an increase of 44 per cent. over their weights of the second spring. In other words, there was little difference in the profits during the two years, in spite of the difference in the age.

Loss of weight by range cattle during winter.—The management of this herd of cattle included many matters, which in the opinion of the writers, were at fault, or could have been improved; for example, the almost exclusive purchase of scrub or grade Jersep cattle rather than the raising of calves from the owner's cows and sired by a thoroughbred bull of any of the beef breeds. Another great mistake in management, we belive, consisted in requiring the cattle to subsist throughout the entire winter without any food whatsoever except what they could obtain on the range from canebrakes, cotton stalks, corn stalks, etc. Since our weighing was not made until May of each year, when the cattle had been on pasturage for about a month, it is not possible to estimate exactly the amount of decrease in live weight occurring between the time that the fall pasturage failed and that the grasses put out in the spring.

Of 22 animals of all ages weighed October 1, 1901, at least a month before pasturage greatly deteriorated, and again weighed May 7, about six weeks after the pastures put out in spring, 64 per cent lost in weight during this period of six and a half months.

The losses in weight would have been much greater had our weighings been made about November 15th and April 1st.

It is believed that the shrinkage in live weight during the winter, the utter loss of all food obtained from pasture and range from October to May, and the considerable number of deaths during the winter, more than counterbalance the saving of feed, which is the only point of advantage claimed for this system. Our advice is to winter only so many cattle and those of such quality that it will be feasible and profitable to supply them with hay, if not with both hay and cotton seed, after the pastures or ranges fail in December, January, or February.

APPENDIX.

Individual weights, gains, and percentages of dressed weight of grade steers.

Lot No.	Name or Number of Steer.	Initial weight.	Gain First 28 days.	Second 28 days.	Third 28 days.	Total 84 days.	Average daily gain.	Dressed weight.	Principal Food. Roughness.	Concentrate.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	%		
I	Dangus	803	122	61	47	230	2.74	56.6	Sorghum	Cotton seed meal.
I	Daddy	877	83	90	40	213	2.54	54.3	Sorghum	Cotton seed meal.
I	42	832	88	75	44	207	2.47	55.7	Sorghum	Cotton seed meal.
I	153	733	52	26	19	97	1.15	55.4	Sorghum	Cotton seed meal.
I	308	633	72	55	64	191	2.27	49.3	Sorghum	Cotton seed meal.
I	Average	785	83.4	61.4	42.8	188	2.23	54.5		
II	18.	795	56	40	50	146	1.74	50.9	Sorghum and cowpea	Cotton seed.
II	53.	707	59	81	31	171	2.04	50.7	Sorghum and cowpea	Cotton seed.
II	91.	838	114	73	37	224	2.67	51.7	Sorghum and cowpea	Cotton seed.
II	222	795	70	60	30	160	1.90	50.6	Sorghum and cowpea	Cotton seed.
II	224	780	17	78	13	108	1.29	51.7	Sorghum and cowpea	Cotton seed.
II	Average	783	63.2	66.4	32.2	162	1.93	51.		
III	Holstein	797	21	39	13	73	.90	49.1	Sorghum	Cotton seed.
III	Roan	802	68	37	41	146	1.74	*	Sorghum	Cotton seed.
III	60	735	71	28	—3	96	1.14	51.5	Sorghum	Cotton seed.
III	84.	822	83	11	32	126	1.50	51.3	Sorghum	Cotton seed.
III	237	702	48	13	—1	60	.71	50.6	Sorghum	Cotton seed.
III	Average	772	58.2	25.6	16.4	100	1.19	50.6*		
IV	Toom	746	72	9	26	107	1.27	53.4	Corn stover	Cotton seed.
IV	10.	646	52	—3	13	62	.74	49.8	Corn stover	Cotton seed.
IV	26.	882	71	2	15	88	1.04	52.6	Corn stover	Cotton seed.
IV	217	847	18	40	17	75	.89	50.3	Corn stover	Cotton seed.
IV	236	768	62	25	—7	80	.95	50.4	Corn stover	Cotton seed.
IV	Average	778	55	14.4	12.8	82	.98	51.3	Corn stover	Cotton seed.

***Returns from packer give only 47.6 per cent. for this steer. Yet he was one of the fattest. The possibility of an error in this figure has caused us to omit this figure in making up the average for this lot.**

Weights and gains made during the pasturage season by scrub cattle in Macon County.

		Age, years.	Year.	Days between weighings.	Weights in spring.	Gain in one pasturage season.	Daily gain.
	Cows 4 years and older						
68	....	10	1902	238	652	38	......
46	....	8	1902	238	536	82	......
121	....	4	1902	238	520	80	......
62	....	4	1902	238	586	40	......
68	.......(?)	8	1903	183	666	64	......
196	....	8	1903	183	638	84	......
189	....	4	1903	183	700	46	......
29	....	10	1903	183	626	36	......
	Average	......	....	......	615	59	.28
	Heifers above 300 lbs..						
71	....	2	1901	136	510	146	......
79	....	2	1901	136	360	122	......
58	....	1½	1901	136	310	118	......
81	....	1	1901	136	356	68	......
16	....	3	1902	238	408	112	......
22	....	3½	1902	238	472	146	......
107	....	3½	1903	183	542	232	......
107	....	2½	1902	238	418	152	......
194	....	2½	1903	183	542	88	......
187	....	2½	1903	183	600	188	......
197	....	2	1903	183	482	198	......
193	....	2	1903	183	428	192	......
51	....	2½	1903	183	398	148	......
101	....	1½	1903	183	342	176	......
	Average	......	....	......	440	149	.82
	Yearlings, up to 300 lbs						
76	....	1	1901	136	258	24	......
84	....	1	1901	136	234	86	......
36	....	1	1901	136	256	128	......
81	....	1	1901	136	356	68	......
114	....	1	1902	238	218	88	......
124	....	1½	1902	238	274	94	......
18	....	1½	1902	238	272	118	......
	Average	......	....	......	269	89	.49

Weights and gains made during the pasturage season by scrub cattle in Macon County.

		Age, years.	Year.	Days between weighings.	Weights in spring.	Gain in one pasturage season.	Daily gain.
	Sucking calves.						
40	....	½	1901	136	230	98	......
131	....	......	1902	238	306	54	......
12	....	1	1901	136	262	138	......
51	....	1	1901	136	293	135	......
	Average	......	....	......	273	106	.67
	Steers above 300 lbs.						
96	....	3	1901	136	520	90	......
73	....	2	1901	136	584	126	......
27	....	1½	1901	136	419	67	......
38	....	2	1901	136	426	104	......
41	....	3	1901	136	486	114	......
67	....	1½	1901	136	304	94	......
63	....	1½	1901	136	356	104	......
65	....	2	1901	136	477	111	......
87	....	2	1901	136	470	156	......
69	....	1½	1901	136	361	139	......
11	....	1½	1902	238	338	94	......
40	....	1½	1902	238	304	54	......
82	....	2½	1903	183	522	200	......
	Average	......	....	......	428	112	.71

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Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute.

AUBURN.

The Mexican Cotton Boll Weevil.

BY

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Plant Physiologist and Pathologist.

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*To be filled.

THE MEXICAN COTTON BOLL-WEEVIL.

BY EDWIN MEAD WILCOX.

Introduction.

In twenty years the Mexican cotton boll-weevil (*Anthonomus grandis* Boh.) has developed from a rather obscure species to one of supreme importance with respect to the production of the world's supply of cotton. The infested regions are taking desperate measures to destroy the pest or to adjust and modify the present methods of cultivation in such manner that cotton may still be grown at a fair profit in the infested regions. The recent appropriation of $250,000.00 by the Congress of the United States for the exhaustive study of the boll-weevil problem from all points of view has given to the boll-weevil a national importance.

It seems desirable to present to Alabama cotton growers our present information upon this very important subject together with the suggested methods of controlling the boll-weevil should it ever become established within the borders of our State. This bulletin may therefore be said to result from an application of the old adage, "forewarned is forearmed." No claim for originality is made as to the facts stated, but the reader is referred to the papers mentioned in the Bibliography at the close of the bulletin for the most recent original investigations of this subject. The facts given in the papers cited have been freely drawn upon in the preparation of this bulletin.

INTRODUCTION AND PRESENT DISTRIBUTION OF THE BOLL WEEVIL.

The boll-weevil probably crossed the Rio Grande river into Texas about 1892—at least that is the opinion of the planters in that region. By 1894 it had spread to a half dozen counties in southern Texas bordering upon the Rio Grande river and the Gulf of Mexico. At this time it was brought to the attention of the United States Department of Agriculture; the Division of Entomology commenced late during 1894 the investigation of the weevil and has continued this investigation to the present time. The Department of Entomology of the Texas Experiment Station has also rendered efficient aid in the investigation. The recent appropriation by Congress has made it possible to concentrate upon the boll-weevil problem the efforts of a large number of persons and the weevil is now receiving more attention than probably any other insect pest in the world.

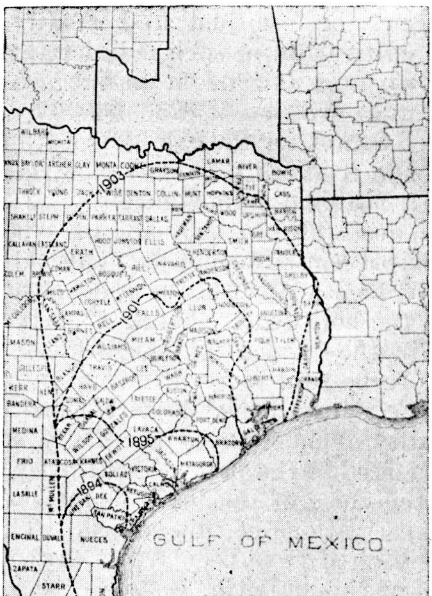

Fig. 1. *Map showing the distribution over Texas and Louisiana of the boll weevil at intervals since its first appearance in Texas. Bull. 45, Div. Ent., U. S. Dept. Agr.)*

The map shown as Fig. I presents graphically the present known distribution of the weevil as well as the advance it has made over the area indicated since its first appearance in 1892. From a study of the insect's means of reaching new territory it has been estimated that the weevil will be at work throughout the entire cotton belt of the South in 15 to 18 years. In Texas during the past ten years the weevil has made an annual advance of about 50 miles.

Having this danger in mind and to prevent the accidental or intentional introduction of the pest into the State the last Legislature passed the following law, which is here quoted in full:

An act to prevent and prohibit the importation of seed from cotton affected with Texas boll weevil.

SECTION 1.—*Be it enacted by the Legislature of Alabama,* That no person shall import or bring into the State of Alabama any seed from any cotton affected with what is known as the Texas boll weevil, nor the seed from any place where the cotton has been affected with said boll weevil.

SEC. 2.—Any person who violates the provisions of Section 1 of this act shall be guilty of a misdemeanor, and, on conviction, shall be fined not less than ten dollars ($10.00) and not more than five hundred dollars ($500.00). [H. 877. No. 559. Approved Oct. 6, 1903.]

Legislation can, after all, however, do nothing more in this case than build up public sentiment and arouse interterest in the weevil problem and if cotton planters permit the weevil to become established in this State it will be the result of their own neglect. Planters and others will confer a great benefit upon themselves and upon the State by promptly reporting and sending specimens of any suspected boll-weevil to the Alabama Experiment Station. All such insects should be killed with chloroform or other means before being forwarded through the mails and then be enclosed in tin or wooden boxes.

Amount of Damage Due to Boll-Weevil.

There is frequently a tendency to greatly exaggerate crop losses, but a very conservative estimate shows that the damage done by boll-weevil in Texas amounts annually to about $15,000,000. The loss in the weevil-infested counties of Texas is certainly fully one-half of the crop. If we assume that the total cotton crop of the United States has a value of $500,000,000 it will be seen that when the boll-weevil is found throughout the whole cotton belt the annual loss will be at least $250,000,000 annually. All these estimates are based upon the failure of the planters to adopt any measures to check the spread of the pest or particularly to reduce the extent of its damage. We shall see that there is much hope that cotton may be grown at a profit in the infested regions if the planters will adopt the modern methods of planting and cultivation suggested and urged by the Bureau of Entomology of the Department of Agriculture.

Life History of Insect.

EGG.

The female weevil deposits the egg in a hole made by eating into either the square or boll. These cavities are made usually between the middle and the tip in the case of squares, but seem to occur at random in the case of bolls. The length of the egg stage in the vast majority of cases varies from 2 to 5 days. It has been observed that but a single egg is usually deposited in a boll if the female is able to find bōlls not punctured. This habit of selecting a fresh boll for the oviposition of each egg accounts for the large number of bolls injured by a single female. It is probable that a single female may deposit as high as 200 eggs during the season.

Larva.

The larva when it escapes from the egg is a delicate white grub about 1-25 of an inch long, and without legs. (See Figs. 2 and 3.) If it were not for the brown head and mandibles the larva would be quite as inconspicuous as is the egg itself. In the squares the larva probably molts but twice while growing, but it is almost certain that in the bolls, and perhaps also in squares, there is also a third molt.

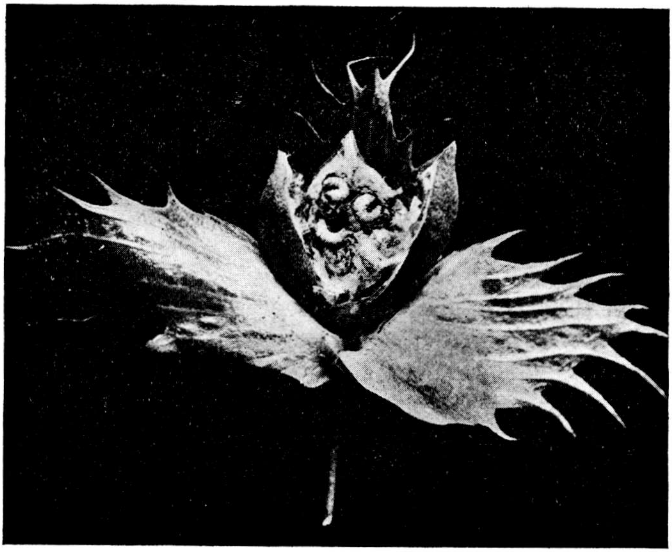

Fig. 2. *Three large larvae in a boll.* $x\frac{3}{2}$. (*Bull. 45, Div. Ent., U. S. Dept. Agr.*)

During the warmer parts of the summer it is probable that the larval stage in the squares lasts not over 6 days, but in colder weather the period is of course longer. Even frosts do not kill the larva in the bolls, and they may continue their growth and complete their development after the occurrence of a frost.

In the bolls the larval stage last probably much longer and here 6 to 7 weeks is near the length of the larval period.

As the boll reaches maturity the mature larva, now 1-4 to 1-3 of an inch long, ceases feeding and becomes surrounded by a sort of cell composed of larval excrement mixed with the lint, etc. Within this cell the pupation and formation of the adult occurs. The cells are shorter and thicker than cotton seeds, with which they are at times confused.

Pupa.

When the insects enters this stage it has much the form of the adult, but its color is pure white or cream. (See Fig. 3.) The pupa stage lasts in squares on the average three to four days in warm weather, but may reach a maximum of 15 days in cold weather. The pupal stage is certainly longer in bolls than in squares, but no definite data are at hand on this point.

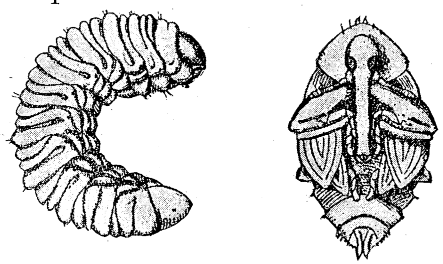

Fig. 3. *Larva, to the left, and pupa, to the right. x6. (Farmers' Bull. 189, U. S. Dept. Agr.)*

The final molt of the pupa requires about a half hour.

Adult.

About 2 or 3 days are required for the adult to assume the color typical of the species and to acquire sufficient strength to enable it to walk. The weevils may vary much in size dependent largely upon the question of available food supply. With the proboscis extended they vary from 1-8 to 1-3 of an inch in length and in the middle of the body are from 1-25 to 1-8 of an inch broad. (See Fig. 4.)

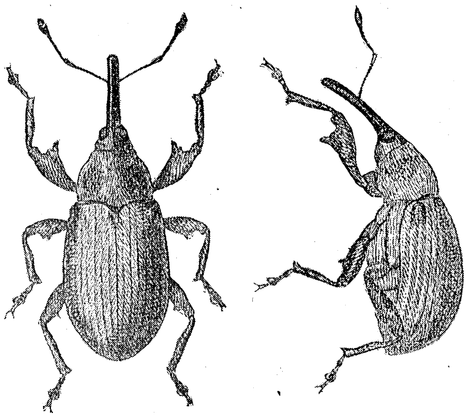

Fig. 4. *Mexican cotton boll weevil* (*Anthonomus grandis*). *x3* (*Bull. 45, Div. Ent., U. S. Dept. Agr.*)

The color of the boll weevil varies with the size—the smaller weevils being darker brown and the larger weevils being light yellowish brown. The average color between these two extremes is a gray brown or dark yellow brown. The yellowish color of the larger specimens is due to the presence of numerous yellowish scales that are more conspicuously formed in large than small weevils. These scales, however, often become rubbed off, leaving the dark brown color of the chitin. The sexes, however, cannot be distinguished as is often supposed by any question of either size or color.

The average length of life of the adult weevils on squares is about 10 weeks for males and 9 weeks for females. On the bolls it is nearly 3 weeks for males, but only about 2 weeks for females.

Feeding Habits.

Until the females begin to oviposit the feeding habits of both sexes are alike. Bolls and leaves are seldom fed upon so long as squares are available. The puncture from the outside is only large enough to admit the proboscis, to the tip of which the mouth parts are attached. The principal part of the square eaten consists of the anthers and pollen sacs. When these are reached the cavity is broadened out to give to the whole cavity much the shape of a flask.

The males are known to make on an average about 3 feeding punctures per day, though during the first few days of adult feeding existence they may make as high as 6 to 9 punctures per day. They average, however, about 3 punctures to a square, and hence really do very little damage. The males, unlike the females, more frequently chose to puncture the square very near the top.

After the females begin to oviposit they eat less on one square or from a single puncture than before. Since as we have said that as a rule a female oviposits but once on a square and since most of her eating is done in connection with oviposition, it becomes clear that the amount of damage done by the females is much greater than that due to the males.

It has been demonstrated by experiment that the American upland cottons are much less subject to attack by the weevils than any others, and that the Egyptian (Mit Afifi) cotton is more subject to attacks than any other variety. It is now known also that the boll weevil has no food plant, native or cultivated, other than the various species and varieties of cotton.

Number of Generations.

No hard and fast line can be drawn between the different broods of the weevil—not even between the hibernated weevils and those of the first spring generation.

It is probable that in the southern part of Texas five broods occur between 1 May and 1 December—this is on the assumption that the average life cycle of a generation from egg to egg is about 42 days. In northern Texas and probably also in this region not more than 4 broods would occur.

Hibernation.

Even after the cotton has been entirely killed by frost adult weevils may be seen moving about in the fields. In southern Texas the weevil may hibernate as either larva, pupa or adult, but they most commonly hibernate in the adult condition. The majority of weevils that successfully hibernate over winter are those developed latest in the fall—whose vitality was consequently not exhausted by oviposition or otherwise before the approach of winter.

The average hibernation period is from 1 December to 1 April, or about 4 months. Given a dry sheltered place and as high as 1-6 of the weevils will live through the winter.

Dissemination.

The search for food or new squares is the principal agency leading to the migration of the weevils from one place to another. Prevailing winds may assist if these occur when the weevils are naturally most active, as does occur in Texas.

Artificial dissemination will take place most commonly along railways and water courses. The shipment of cotton baled or for ginning is nearly certain to mean shipment of the boll weevil. And the same is true of shipments of seed for planting and other purposes. Our State law already quoted (page 93) should receive the support of every person living in the State and having the slightest concern for the welfare of the State. In regard to pests of this and all other types legislative enactment may develop public sentiment, but certainly can never replace it.

Methods of Control.

The methods of control may roughly be divided into two classes (a) natural, and (b) artificial.

Among the first group we mention in the first place climatic control. The factors of highest importance in determining the development, distribution and destructiveness of the boll weevil are temperature, precipitation and food supply. We have stated that the weevil has but a single food plant—the cotton—and it is remarkable how thoroughly adjusted to the condition of the food plant the weevil has become. Conditions favoring the growth of the cotton plant are also favorable to the development of the weevil.

High temperatures and abundant rainfall are the two climatic factors distinctly favorable to weevil development, and hence it is that at such times their injury is most noticeable. Rains tend to increase formation of squares by the cotton plant and the squares, we have seen, are the feeding places and oviposition structures for the weevils. Rains also indirectly favor weevil development by the injury they do to the natural enemies of the weevil.

Too heavy rains during the winter are very apt to kill many of the hibernating weevils and hence following a comparatively dry winter one would expect to see a larger brood of hibernated adult weevils appear in the spring than following a rainy winter.

Experiments have shown that overflows will not injure enough weevils to be of any great service. Even the larvae and pupae in equares that have been under water for some time were found to be uninjured. Adult weevils may float several days in the water and yet not be injured. It is very probable that the floating of adult and infested squares by means of high water will prove one of the most important natural agencies for widely distributing the pest.

PARASITES, PREDATORY INSECTS, AND DISEASES.

The very recent announcement by an officer of the United States Department of Agriculture of the discovery in Guatemala of an ant that preys upon the boll weevil has called forth renewed interest in this subject of parasites or rather predatory insects. However, it seems certain that the ant discovery has already been overworked and its importance much exaggerated. Hunter & Hinds, 1904, say: "There is at present, therefore, no promise of any considerable assistance in the control of the weevil by any parasite now known. * * * Even should one be found which could attack the weevil in some stage, it would probably still fail to be an efficient means of control. * * * "

Certain predatory insects other than the Guatemalan ant may serve to check the weevil, but the work of all such insects combined is comparatively of little importance when compared with the cultural methods mentioned below.

And there seems to be but little hope of securing a fungus parasite that will be of any service in killing weevils. A study of the history and outcome of the use of the "chinch bug" fungus and later the grasshopper fungus shows how utterly impracticable any such method is certain to be.

In connection with the appearance of such an important pest as the boll weevil there is certain to be a host of useless remedial and preventive measures suggested. It would be a waste of space to even mention all these schemes here. Considerable attention has been devoted to devising some method of spraying the cotton plants in hopes of killing the weevils. We may for the present dismiss any spraying scheme with a quotation from Hunter & Hinds, 1904, who say: "Spraying of a field crop has never been a success, and, unless entirely new methods are eventually perfected, never will be of any practical importance."

Of course the suggestion made from time to time that some substance may be mixed with the fertilizer which will be distasteful to the weevil when absorbed by the plant is absurd.

It has proven impossible to devise a machine that will enable one to collect from the ground the fallen squares.

And it is even more absurd to hope to find any sort of cotton that the boll weevil will not care to eat. There is a limit to the profitable variation in the cotton plant to be induced by breeding and selection and there is certainly no hope of securing a strain of upland cotton that will prove resistant to the boll weevil, or to any other insect.

Cultural Methods.

It has been demonstrated that improved methods of cultivation will enable one and does enable many Texas planters now to grow cotton at a fair profit in weevil infested areas. If the weevil can force cotton planters throughout the cotton belt to adopt more civilized and modern methods of cultivation we may be forced to look upon the weevil as a "blessing in disguise."

It is impossible better to present the desirability and certainty of results from the cultivation methods recommended by the Division of Entomology, United States Department of Agriculture, than to quote the recommendations given by W. D. Hunter, the official agent in charge of the cotton boll weevil investigation.

"1. Plant early. If possible plant seed of the varieties known to mature early, or at least obtain seed from as far north as possible. It is much better to run the risk of replanting, which is not an expensive operation, than to have the crop delayed. The practice of some planters of making two plantings to avoid having all the work of chopping thrown into a short period is a very bad policy from the weevil standpoint.

Under identical conditions early cotton if improved varieties has invariably yielded from two to three times as much as native cotton under the same conditions, and in many cases much more. Planted at the same time the early varieties begin to bloom from twelve to eighteen days sooner than native cotton.

Early planted fields of either native or improved varieties have almost invariably yielded twice as much as late planted ones.

The early varieties in general, having a small stalk and a short tap root, are adapted only for rich soil. They also fail to grow well in the very light sandy loams of many of the river valleys of Texas which, in long seasons before the advent of the boll-weevil, often produced the largest yields. In these situations early varieties will yield but little more than native cotton.

2. Cultivate the fields thoroughly. The principal benefit in this comes from the influence that such a practice has upon the constant growth and consequent early maturity of the crop. Very few weevils are killed by cultivation. Much of the benefit of early planting is lost unless it is followed by thorough cultivation. In case of unavoidably delayed planting, the best course for the planter to pursue is to cultivate the fields in the most thorough manner possible. Three choppings and five plowings constitute as thorough a system of cultivation as is necessary in cases where the land has previously been kept reasonably clear.

3. Plant the rows as far apart as experience with the land indicates is feasible, and thin out the plants in the rows thoroughly. On land which in normal seasons will produce from 35 to 40 bushels of corn the rows should be 5 feet apart. Even on poor soil it is doubtful if the distance should ever be less than 4 feet.

4. Destroy, by plowing up, windrowing, and burning, all the cotton stalks in the fields as soon as the weevils become so numerous that practically all the fruit is being punctured. This will generally not be later than the first week in October. Merely cutting off the stalks by means of the triangular implement used for that purpose throughout the south is by no means as effective as plowing, because the stumps remaining give rise to sprouts which furnish food until late in the season to many weevils that would otherwise starve. The plowing, moreover, serves to place the ground in better condition for early planting the following spring. In some cases turning cattle into the fields is advisable. Aside from amounting to a practical destruction of the plants, grazing of the cotton fields furnishes considerable forage at a time when it is generally much in demand. Nevertheless, cattle should never be turned into cotton fields in which Johnson grass has become started.

5. It is known that at present fertilizers are not used to any considerable extent in cotton producing in Texas. There is, nevertheless, no doubt that they should be; not that the land is poor, but that earlier

crops may be procured. At present it is sufficient to call attention to the fact that it has been the uniform experience of experiment stations and planters in the eastern part of the belt that certain fertilizers, especially those involving a large percentage of phosphoric acid, have a strong tendency towards hastening the maturity of the plants."

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BULLETIN NO. 130. JANUARY, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN

Tests of Varieties of Cotton

IN 1904

BY

J. F. DUGCAR

Director and Agriculturist.

Opelika, Ala.:
The Post Publishing Company.
1905.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

VARIETY TESTS OF COTTON IN 1904.

BY J. F. DUGGAR.

The season of 1904 presented some trying conditions for the cotton plant. The rainfall for March was below normal. April was exceedingly dry and the drought was not broken until late in May. The total rainfall for March was 2.80 inches; for April 1.02 inches; and for the first four weeks in May, less than .75 of an inch. These conditions resulted in stands by no means as uniform as is desirable in experimental work.*

The wet weather of July and the heavy rains of the early part of August resulted in a vigorous growth of the cotton plant and a promise of a large crop. From the latter part of August until the date of the first light frost there was practically no rain. At Auburn the rainfall for September was only .26 of an inch; for October .02, and for November 2.28 inches.

The extreme of wet weather in August, followed by very dry weather in September, resulted in the shedding of an unusually large proportion of forms. The shedding of forms by different varieties, and under different conditions, has been the subject of a co-operative investigation both at Auburn and in Montgomery county begun jointly in 1904 by this station and the Division of Vegetable Pathological and Physiological Investigations of the United States Department of Agriculture. Of course a repetition of that

*The writer desires to express here his grateful appreciation of the valuable assistance in these experiments afforded by Dr. J. T. Anderson, who furnished the rainfall record; Mr. C. M. Floyd, who had charge of the field work at Auburn; Mr. C. H. Billingsley, of the United States Department of Agriculture, who furnished the data for indicating the relative earliness of varieties, and to Mr. C. R. Hudson, who is responsible for most of the calculations.

experiment for several seasons will be needed before conclusive data for publication can be expected.

A light frost occurred late in October and the first killing frost occurred November 14, the latter killing a number of small bolls.

YIELDS OF VARIETIES IN PLOTS AT AUBURN.

The field on which these tests were made is known as the ten-acre field. It has a reddish loam soil with a considerable proportion of flinty stones. It is regarded as upland of somewhat better than average quality because of the occasional growing of a crop of cow peas for hay. Every fifth plot throughout most of the field was planted with the Culpepper variety to ascertain if there were any decided inequalities in the fertility of the land.

The land was plowed broadcast with a two-horse plow late in March, and bedded and fertilized just before planting, which occurred April 20th.

The fertilizer per acre consisted of:

64 lbs. nitrate of soda.
120 lbs. cotton seed meal.
240 lbs. acid phosphate.
64 lbs. muriate of potash.

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488 lbs., total per acre.

For three or four weeks after planting only an occasional seed sprouted, the ground being loose and very dry. Then a roller was run over the field to press the seed into closer contact with the soil, and this was immediately followed by the weeder, a light form of harrow, used to check evaporation. Within a week, and as a result of this rolling and harrowing, a fairly good stand of cotton was in sight, although the weather continued very dry. The plants were so thinned that they averaged, on the plots with perfect stands 18 1-2 inches apart with rows 3 1-2 feet wide. Only one variety, Gold Standard, had such a poor stand as to seriously affect its yield and to necessitate its exclusion from the following table. A careful study of the detailed records led to the conclusion that the yields were not materially affected by the slight deficiencies in stand, though it is possible that the varieties Doughty, with 76 per cent. of a stand, Texas Burr, with 84 per cent., and Truitt, with 86 per cent., might have stood a few points higher if the stand had been perfect. It was concluded that any effort to calculate the probable yields with perfect stands, would, in this case, involve a greater error than is incurred in giving the actual yields without this correction for slight deficiencies in stand.

The following table gives the actual yield of seed cotton, lint, and seed, all these weights being taken at the gin house a number of weeks after the two heaviest pickings had been made, thus permitting all varieties to dry out to a somewhat uniform degree. In the same table are two columns giving the value of the total product of seed and lint per acre, based, in one column, on a price of ten cents per pound for lint, and in the other column on a price of seven cents per pound, the seed in both columns being valued at seventy cents per 100 pounds. These may be called high and low prices. Readers who prefer other prices can substitute their own figures and make their own calculations.

Yields of lint and seed of 38 varieties of cotton on Station Farm at Auburn in 1904 and value of the crop per acre.

Rank in value of product	VARIETY.	Stand of plants	Actual yield per acre of Seed cotton	Lint	Seed	Value of seed and lint per acre. 10c for lint.*	Value of seed and lint Per acre. 7c for lint.*
		%	*Lbs.*	*Lbs.*	*Lbs.*	$	$
1	Peterkin	100	1624	628	993	$69.75	$50.91
2	Layton Improved	92	1632	620	1011	69.07	50.47
3	Jackson	100	1584	607	974	67.51	49.31
4	Alex. Allen	92	1673	581	1088	65.71	48.28
5	Wise	94	1481	556	905	61.93	45.25
6	Cameron Early	100	1558	546	1009	61.66	45.28
7	Simms Long Staple	100	1675	539	1065	61.35	45.18
8	Pullnot	97	1542	543	963	61.04	44.75
9	Cook Improved	100	1403	548	852	60.76	44.32
10	Doughty Improved	76	1336	522	997	59.18	43.52
11	Allen Long Staple	94	1610	498	1120	57.64	42.70
12	Culpepper	96	1486	508	965	57.56	42.32
13	Texas Burr	84	1488	502	980	57.06	42.00
14	Willett Red Leaf	95	1352	503	840	56.18	41.09
15	Hawkins	100	1332	487	839	54.54	39.93
16	King	100	1396	484	861	54.42	39.90
17	(Lewis) Prize	92	1297	486	804	54.22	39.76
18	Russell	100	1431	473	952	53.96	39.77
19	Nancy Hanks	98	1401	474	916	53.81	39.59
20	Drake	100	1412	467	942	53.29	39.37
21	Mascot	100	1292	476	811	53.27	38.99
22	Shine	94	1368	465	895	52.76	38.81
22	Sam Woodfin Prolific	97	1400	463	924	52.76	38.87
23	Jones Improved	100	1392	462	927	52.68	38.82
24	Truitt	86	1348	462	872	52.30	38.44
25	Schley	100	1324	457	862	51.73	38.02
26	Grier's King	96	1248	459	774	51.31	34.54
27	Edgeworth	100	1288	453	829	51.10	37.51
28	Garrard	89	1225	453	765	50.65	37.06
29	Johnson's Excelsior	100	1230	442	785	49.69	36.43
30	Pride of Georgia	100	1276	436	839	49.47	36.39
31	Meredith	92	1288	434	846	49.32	36.30
32	Mortgage Lifter	100	1288	433	841	49.18	36.19
33	Floradora	100	1296	420	875	48.12	35.52
34	Parker	100	1196	408	785	46.29	34.05
35	Blue Ribbon (fuzzy seed)	100	1225	401	813	45.79	33.76
36	Sunflower	100	1228	401	812	45.78	33.75
37	Blue Ribbon (black seed)	100	1203	379	818	43.62	32.27
38	Lealand	95	1144	378	765	43.15	31.81

*Seed 70 cents per 100 lbs. or $14.00 per ton.

The largest yield was made by Peterkin, closely followed by Layton, Jackson and Alex. Allen. Wise occupies fifth place.

Grouping together such of the varieties as the writer has up to this time definitely classified in accordance with the classification outlined by him in Bulletin No. 107 of the Alabama Experiment Station, and neglecting groups of varieties having few representatives in this test, we have average results that are significant, as below:

Average yields of Classes of varieties at Auburn in 1904.

	Lint per acre	Seed per acre	Value per acre at 10c and $14.00	Relative yields of lint
		Lbs.		
Semi-Cluster Group				
Hawkins	487	839	$54.54	
Drake	467	942	53.29	
Woodfin	463	924	52.76	
Garrard	453	765	50.65	
Average	468	867	$52.81	78
Peterkin Type.				
Peterkin	628	993	$69.75	
Layton	620	1011	69.07	
Wise	556	905	61.93	
Average	601	936	$66.91	100
King Type.				
King	484	861	$54.42	
Mascot	477	811	53.27	
Shine	465	895	52.76	
Grier's King	459	774	51.31	
Average	471	835	$52.94	78
Big Boll Type.				
Culpepper	508	965	$57.56	
Texas Burr	502	980	57.06	
Russell	473	952	53.96	
Jones Improved	462	927	52.68	
Truitt	462	872	52.30	
Schley	457	862	51.73	
Pride of Georgia	436	839	49.47	
Mortgage Lifter	433	841	49.18	
Average	466	905	$54.79	77
Long Staple Group.				
Floradora	420	875	$48.12	
Sunflower	401	812	45.78	
Blue Ribbon (fuzzy seed)	401	813	45.79	
Blue Ribbon (black seed)	379	818	43.62	
Average	400	829	$46.08	66

From the above table it will be seen that the Peterkin and varieties having similar qualities were decidedly in the lead at Auburn in 1904 in the production of lint. Taking the yield of lint made by the Peterkin group as 100, we find that the average relative yield of the semi-cluster group may be represented by 78; of the King type by 78; of the big boll group by 77; and of the long staple group by 66. This throws some light on the question of the difference in productiveness on upland soils of the long staple varieties as compared with the other groups. The varieties Allen long staple and Simms long staple are not included in this average for the reason that they grew on the lowest, and doubtless the richest, plots in the field.

The local markets usually pay little or no premium for the long staple varieties, which, however, command a premium of several cents a pound in the larger southern seaport markets. This year at Auburn for the four long staple varieties to have nearly equaled the Peterkin group in value per acre it would have been necessary for long staple lint to sell for 15 cents per pound when Peterkin was 10 cents, or for 10 1-2 cents when Peterkin was worth 7 cents. If we compare the long staple with either of the other groups a much smaller premium would equalize the values. Long staple cotton should have rich bottom land for its best development.

While the Peterkin group is ahead this year, it by no means follows that it will maintain its lead when seasonal conditions and soils are different.

Per Cent. of Lint in Varieties Tested in Plots at Auburn in 1904.

During a study of cotton varieties extending over a number of years a large amount of data have been obtained regarding the proportions of seed and lint of 175 or more varieties which have recently been grown. The following table gives only so much of this data as was obtained in 1904, by ginning the cotton on these plots of which the yields are reported in the first table of this bulletin.

Per cent of lint in plot tests at Auburn in 1904.

	Variety	*Per Cent Lint*	*Variety.*	*Per Cent Lint*
1	Cook Improved	39.1	Parker	34.1
2	Gold Standard	38.9	Doughty	34.0
3	Peterkin	38.7	Pride of Georgia	34.0
4	Jackson	38.3	Shine	34.0
5	Wise	37.6	Nancy Hanks	33.8
6	Prize	37.4	Meredith	33.7
7	Willett Red Leaf	37.2	Texas Burr	33.7
8	Garrard	37.0	Mortgage Lifter	33.4
9	Grier's King	36.8	Jones Improved	33.2
10	Mascot	36.8	Sunflower	33.1
11	Hawkins	36.5	Drake	33.1
12	Johnson's Excelsior ..	36.0	Russell	33.1
13	King	35.9	Lealand	33.0
14	Alex. Allen	35.3	Sam Woodfin Prolific	33.0
15	Edgeworth	35.2	Blue Ribbon (fuzzy seed)	32.8
16	Pullnot	35.2	Floradora	32.4
17	Cameron Early	35.0	Simms Long Staple	32.1
18	Schley	34.6	Blue Ribbon (black seed)	31.5
19	Culpepper	34.3	Allen Long Staple	30.8
20	Truitt	34.3		

It will be noted that the proportion of lint to seed is unusually high. This was also the case in the variety tests at the Georgia station in 1904, as indicated in a recent newspaper article by Director R. J. Redding. This concordance of results suggests that something in the climatic conditions of 1904 was favorable to the increase of lint or to the relative decrease of seed.

It will be noted that the long staple varieties have much lower percentages of lint than most of the short staple varieties.

Variety Tests on Prairie Soil in Montgomery County in 1904.

Through co-operation with the United States Department of Agriculture as before stated, we are this year enabled to print the results of a variety test made on the A. H. Clarke plantation about half a mile northeast of the depot at McGehee's Switch station, Montgomery county.

The soil is gray prairie upland of about average quality, not recently fertilized, so far as is known, until the present year. Planting was done April 29-30. On June 1, fertilizers as below were applied on the side of the row in the shallow furrow made by the first cultivation. The fertilizer was then covered by the throwing out of the middles. The fertilizer used consisted of:

200 lbs. acid phosphate per acre.
200 lbs. kainit per acre.
100 lbs. nitrate soda per acre.

This date of application was doubtless too late for good results for this season and on this soil, as shown not only in variety tests, but in fertilizer tests on another part of the same field. Through a misunderstanding the plots were not thinned to a uniform stand, but it was found that the yield of three plots of Truitt did not vary greatly with variations in the stand. As it was impracticable to gin the seed cotton of each plot separately at McGehee's, the yield of lint is obtained by multiplying the weight of seed cotton by the per cent. of lint found in the variety test at Auburn in 1904.

Yields of varieties of cotton at McGehee's Switch, Ala., in 1904.

Plot No.	Rank in value of products	Variety.	No. of plants per acre.	Yield per acre. Seed cotton.	Lint	Seed.	*Value of seed and lint per acre. 10c for lint.	*Value of seed and lint per acre. 7c for lint.
				Lbs.	*Lbs*	*Lbs.*	$	$
18	1	Schley	7070	830	287	543	32.50	23.89
14	2	Peterkin	6390	750	290	460	32.22	23.52
22	3	Drake	6500	690	228	360	31.23	24.39
23	4	Crossland	5750	770	277	493	31.15	22.84
17	5	Toole	6410	790	270	520	30.72	22.62
1	6	King	5630	730	262	468	29.47	21.61
21	7	Bancroft Herlong ...	6800	800	256	544	29.41	21.73
Av. 5, 10 and 15	8	Truitt	5947	746	256	492	29.03	21.35
20	9	Simms	7630	750	241	509	27.66	20.43
16	10	Floradora	6100	720	233	487	26.70	19.71
11	11	Hawkins	5910	620	226	394	25.35	18.57
2	12	Russell	5670	650	215	435	24.54	18.09
12	13	Cook Long Staple....	5830	680	207	473	24.05	17.84
19	14	Doughty Long Staple	6910	600	204	396	23.17	17.05
7	15	Jackson	5800	540	207	333	23.03	17.82
4	16	Parker	6000	560	190	370	21.59	15.89
3	17	Sunflower	6360	560	185	375	21.12	15.57
6	18	Pride of Georgia	5520	530	180	350	20.45	15.05
8	19	Mortgage Lifter	5000	500	167	333	19.03	14.02
13	20	Allen Long Staple ..	6040	500	154	346	17.82	13.20

*Seed valued at 70 cents per 100 pounds or $14.00 per ton.

The varieties affording the largest value of seed and lint were Schley and Peterkin, closely followed by Drake and Crossland. Toole stands fifth. In this test, as at Auburn, the varieties of the Peterkin type, namely, Peterkin and Crossland stand well to the front with an average yield of 283 1-2 pounds of lint per acre. Taking this yield of lint as 100 per cent., the groups of varieties hitherto classified average as follows:

Peterkin group (Peterkin and Crossland) .... 100.
Big boll group (Russell, Schley, Truitt, Pride of Georgia, and Mortgage Lifter) .... 78.

Relative Earliness of Varieties.

The invasion of the cotton states by the cotton boll weevil renders more important than ever before careful studies of the early varieties. It has been found that only the earliest varieties can be profitably grown in infested regions, even when all other known methods of combatting the weevil are employed.

The rapid spread of the weevil eastward in Louisiana during the past season makes it important that the farmers of Alabama should be ready for this invasion as promptly as possible. It would be well for every neighborhood, and perhaps for every farm, to have at least a small portion of its crop in one of the very early varieties so that seed of early varieties may be everywhere available when urgently needed.

It is easy to determine at a glance that one variety is early and another late, but it is less easy to indicate the relative earliness of intermediate varieties. In the two tables which follow the figures show how many bolls had opened on a given date early in September out of every 100 bolls maturing during the entire season.

These figures are based on counts of bolls on five selected plants of each variety made by Mr. C. H. Billingsley, of the United States Department of Agriculture.

Relative earliness of varieties at Auburn in 1904, *as shown by per cent of bolls open on September* 1 *on counted plants.*

Variety.	*Per cent bolls open Sept. 1*	*Variety.*	*Per cent bolls open Sept. 1*
King	82	Jones Improved	20
Mascot	77	Schley	19
Meredith	49	Sunflower	19
Garrard	47	Gold Standard	19
Grier's King	46	Parker	18
Lealand	44	Blue Ribbon (wooly seed)	17
Nancy Hanks	44	Alex. Allen	16
Shine	42	Woodfin	16
Jackson	41	Culpepper	15
Hawkins	35	Blue Ribbon (black seed)	15
Layton	34	Peterkin	15
Johnson Excelsior	33	Doughty	14
Edgeworth	32	Russell	14
Texas Burr	32	Pullnot	14
Pride of Georgia	31	Floradora	14
Cameron Early	31	Mortgage Lifter	13
Cook Improved	30	Simms Long Staple	13
Drake	25	Allen Long Staple	12
Wise	22	Truitt	10
Prize	21	Cook Long Staple	7
		Willett Red Leaf	6

Relative earliness of varieties at McGehee's as shown by per cent of bolls open on September 7, 1904.

Variety.	*Per cent bolls open Sept. 7*	*Variety.*	*Per cent bolls open Sept. 7*
Toole	81	Truitt	23
King	66	Crossland	23
Simms	39	Pride of Georgia	23
Mortgage Lifter	33	Cook Long Staple	18
Allen Long Staple	32	Peterkin	17
Sunflower	27	Floradora	15
Jackson	27	Doughty	14
Parker	25	Hawkins	13
Russell	25	Drake	12
Schley	24	Bancroft	7

The above tables are based on careful counts made on five plants of each variety. Since individual peculiarities of some of these plants have greatly affected the positions in the table, it is in place to say that judging only by the general appearance of the plots the varieties matured more nearly together than indicated by the table and at Auburn the following varieties especially appeared earlier than is indicated by their positions in the tables: Alex. Allen, Woodfin, and Culpepper.

Where to Get Seed.

The experiment station is unable to supply seed of any of these varieties. In order to enable farmers to obtain seed of such of these varieties as they desire, addresses are given below of parties from whom our seed were obtained in 1904:

Culpepper from J. E. Culpepper, Luthersville, Ga.

Drake from R. W. Drake, Laneville, Ala.

Cook Improved from J. R. Cook, Schley, Ga.

Edgeworth from J. C. Little, Louisville, Ga.

Blue Ribbon from S. C. Experiment Station, Clemson College, S. C.

Gold Standard from Excelsior Seed Farm, Bennettsville, S. C.

Sam Woodfin Prolific from S. V. Woodfin, Marion, Ala.

Parker, Sunflower, Russell, Mortgage Lifter, King and Jackson from Unitel States Department of Agriculture, Washington, D. C.

Truitt and Peterkin from Harvey Seed Co., Montgomery, Ala.

Simms, Allen Long Staple, Willett Red Leaf, Doughty Long Staple, Cook Long Staple, Floradora, Hawkins, Jones Improved and Schley from N. L. Willett Drug Co., Augusta, Ga.

Pride of Georgia, Cameron Early, Layton Improved, Meredith, Nancy Hanks, Garrard, Grier's King, Mascot, Shine, Texas Burr, Prize, Wise, Alex. Allen, and Pullnot from the Georgia Experiment Station, Experiment, Ga.

Lealand from H. P. Jones, Herndon, Ga.

Johnson Excelsior from C. R. Baird & Co., Chattanooga, Tenn.

OTHER EXPERIMENTS IN PROGRESS WITH VARIETIES OF COTTON.

This bulletin relates to only about half of the varieties grown on the experiment station farm at Auburn in 1904. The space available was not sufficient for the remaining varieties to be grown on areas large enough to afford accurate determinations of the yields.

The remaining varieties, grown on very small areas, as well as the varieties here reported, constitute part of an experiment, the main object of which is to obtain accurate descriptions and photographs of every variety obtainable east of the boll weevil region. It will require at least another year before results can be published; meantime, this experiment will be continued in 1905, and for use in this experiment the writer will be glad to obtain by mail from growers or originators small packages of seed of the well established variety which each is growing. The senders are requested to exercise care in fully labeling the package on the outside, giving the name and postoffice of the sender and the true establishel name of the variety.

Our thanks are hereby extended to all of those who in the past few years have furnished small lots of seed for this experiment. I would repeat here the statement which I have made every spring in the circular letters sent to growers. *From the nature of the experiment no report can be made by letter as to how any variety stands.* However, it is the intention to send to each contributor of seed a copy of the bulletin that will be published when the investigation is completed.

BULLETIN NO. 131. FEBRUARY, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

Co-operative Fertilizer Experiments With Cotton

IN 1901, 1902, 1903, AND 1904.

By

J. F. DUGGAR,

Director and Agriculturist.

Opelika, Ala.:

The Post Publishing Company.

1905.

The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CO-OPERATIVE FERTILIZER EXPERIMENTS WITH COTTON IN 1901, 1902, 1903, AND 1904.

BY J. F. DUGGAR.

A brief summary of the average results of these experiments may be found on page 67.

For a number of years this station has conducted numerous local fertilizer experiments, furnishing material and instructions to farmers agreeing to make the tests.

The number of local fertilizer experiments with cotton, of which reports were received, was as follows: In 1901, ten; in 1902, thirteen; in 1903, ten, and in 1904, twenty-one. This does not include a number of experiments that were made, but of which the experimenters made no reports or reported accidental loss of results. In all of these years fertilizer experiments were also made on corn and other crops, the results of which will be published in future years.

The chief object of these local fertilizer experiments or soil tests has been to ascertain the best fertilizer or combination of fertilizers for cotton, growing on each of the principal soils of Alabama.

Small lots of carefully weighed and mixed fertilizers were supplied to each experimenter. Detailed instructions as to how to conduct the experiments and blank forms for reporting results, were also furnished.

The following list gives the name and address of each experimenter who has reported the results of fertilizer experiments made under our direction during the last four years, with page of this bulletin where the results may be found:

COUNTY.	POST OFFICE.	NAME.	DATE.	PAGE.
Barbour	Louisville	J. D. Veal	1904	58 & 60
Bibb	Vick	W. T. Chism	1901, '2, '3	49
Blount	Tidmore	Jno. W. Staab	1901	36
Bullock	Union Sp'gs	N. Gachet	1904	74
Butler	Garland	G. L. McLure	1901	60 & 62
Butler	Greenville	D. H. Rouse	1901	55 & 56
Butler	Georgiana	J. C. Lee	1904	60 & 61
Chambers	Fredonia	E. W. Smartt	1904	73
Chilton	Clanton	W. A. Chandler	1904	73
Choctaw	Naheola	W. G. Bevill	1901, '02	54
Coffee	Enterprise	C. A. Hatcher	1904	59 & 60
Conecuh	Evergreen	J. W. Stewart	1902	55 & 57
Coosa	Hanover	J. M. Logan	1902, '03	50, 51 & 73
Cullman	Cullman	L. A. Fealy	1903	36 & 38
Dale	Midland City	W. H. Simmons	1904	63
DeKalb	Collinsville	W. F. Fulton	1902, '3	30
Elmore	Wetumpka	5th Dist. Agr. School	1901, '2, '3	44, 47 & 73
Elmore	Tallassee	J. D. Billingsley	1903	45 & 47
Fayette	Newtonville	G. W. Gravlee	1904	73
Franklin	Russellville	G. R Pass	1904	33 & 36
Geneva	Geneva	M. P. Metcalf	1901, '2, '3, '4	64 & 74
Hale	Greensboro	T. K. Jones	1902, '4	74
Lauderdale	Florence	W. A. Parish	1904	51 & 52
Lawrence	Town Creek	A. A. Owens	1904	73
Lee	Auburn	Ala. Expt. Sta.	1902, '4	47
Limestone	Athens	P. G. Williams	1903	51 & 53
Macon	Notasulga	J. P. Slaton	1904	46
Madison	Huntsville	C. Davis	1901	24
Madison	Huntsville	H, D. N. Wales	1902, '3, '4	24 & 26
Marion	Hamilton	6th Dist. Agr. School	1903	43
Perry	Long	L. Long	1902	34 & 36
Pickens	Gordo	J. W. French	1901	39
Pickens	Gordo	D. W. Davis	1902	40
Shelby	Montevallo	J. W. Wyatt	1904	31 & 32
Talladega	Silver Run	C. L. Jenkins	1902, '3, '4	28
Tallapoosa	Camp Hill	Lyman Ward	1902	50 & 51
Tuscaloosa	Tuscaloosa	E. J. Daffin	1901	41
Washington	Carson	R. D. Palmer	1904	74

The directions sent required each plot to be one-eighth of an acre in area. Rows were 3 1-2 feet apart, and each experimenter was advised to so thin the cotton as to leave the same number of plants on each plot, preferable at distances of 18 inches between plants.

The directions stated that land employed for this test should be level and uniform, not manured in recent years, and not new ground, or subject to overflow, and that it should be representative of large soil areas in its vicinity. The need of perfect uniformity of treatment for all plots (except as to kinds of fertilizers used) was emphasized.

Fertilizers were applied in the usual manner—that is, drilled.

THE RAINFALL.

The following data are taken from the records of the Alabama section of the Weather Bureau and show the average rainfall for the State:

	INCHES RAINFALL.				
	1901	1902	1903	1904	
January	5.32	3.86	3.56	4.17	......
February	4.13	6.52	10.95	3.80	......
March	6.30	8.76	5.91	3.69	......
April	5.27	2.34	2.72	2.22	......
May	5.08	2.34	6.05	2.98	......
June	2.80	1.28	4.88	2.94	......
July	3.40	2.50	3.98	4.80	......
August	8.86	3.48	3.57	5.55	......
September	4.19	4.28	1.41	1.36	......
October	1.04	3.58	1.82	0.34	......
November	1.85	4.22	2.12	2.98	......
December	7.80	5.77	2.93	4.38	......
Average	55.97	49.09	50.22	39.21	......
Average yearly normal	....	....	....	....	51

In the summer of 1902 occurred a drought of unprecedented duration. This was general and in many localities there was little or no rain from April to August. Hence results of that year should be given less weight than those for the other years. In 1904 there was a deficiency of rain in spring and an injurious drought beginning about the middle of August.

THE FERTILIZERS USED.

The following prices are used, as representing approximately the average cash price in local markets during the last few years:

	Per Ton.
Acid phosphate (14 per cent. available)	$14.00
Cotton seed meal	22.00
Kainit	15.00

Prices naturally vary in different localities. Any one can substitute the cost of fertilizers in his locality for the price given above.

In each experiment two plots were left unfertilized, these being plots 3 and 8. The following table shows what kinds and amounts of fertilizers were used on certain plots; the number of pounds of nitrogen, phosphoric acid, and potash supplied per acre by each fertilizer mixture; and the percentage composition and cost per ton of each mixture, the latter being given in order that these mixtures may be readily compared with various brands of prepared guanos:

Pounds per acre of fertilizers, nitrogen, phosphoric acid, and potash used and composition of each mixture.

Plot No.	FERTILIZERS. Amount per acre.	FERTILIZERS. KIND.	MIXTURE CONTAINS Nitrogen.	MIXTURE CONTAINS †Available phosphoric acid.	MIXTURE CONTAINS Potash.	COST OF FERTILIZERS Per ton.	COST OF FERTILIZERS Per acre.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*		
1	200	Cotton seed meal	13.58	5.76	3.54	$22.00	$2.20
		In 100 *lbs. c. s meal.**	**6.79**	**2.88**	**1.77**		
2	240	Acid phosphate	......	36.12	.....	14.00	1.68
		In 100 *lbs. acid phos.*	......	**15.05**	.....		
4	200	Kainit		......	24.60	15.00	1.50
		In 100 *lbs. kainit.*	......	......	**12.30**		
5	200	Cotton seed meal ...	13.58	41.88	3.54	17.63	3.88
	240	Acid phosphate					
		In 100 *lbs. above mixt.*	**3.09**	**9.52**	**.80**		
6	200	Cotton seed meal ...	13.58	5.76	28.14	17.50	3.70
	200	Kainit					
		In 100 *lbs. above mixt.*	**3.39**	**1.44**	**7.03**		
7	240	Acid phosphate	.....	......	......	14.45	3.18
	200	Kainit					
		In 100 *lbs. above mixt.*	...	**8.21**	**5.59**		
9	200	Cotton seed meal ...	13.58	41.88	28.14	16.81	5.38
	240	Acid phosphate					
	200	Kainit					
		In 100 *lbs. above mixt.*	**2.12**	**6.54**	**4.39**		
10	200	Cotton seed meal ...	13.58	41.88	15.84	17.15	4.63
	240	Acid phosphate					
	100	Kainit					
		In 100 *lbs. above mixt.*	**2.59**	**7.75**	**2.93**		

*Average of many analysis.

†Counting all the phosphoric acid in cotton seed meal as available.

Those farmers who are more accustomed to the word ammonia than to the term nitrogen, can change the figures for nitrogen into their ammonia equivalents by multiplying by $1\frac{3}{14}$.

In determining the increase over the unfertilized plots, the yield of the fertilized plots, Nos. 4, 5, 6 and 7, is compared with both unfertilized plots, lying on either side, giving to each unfertilized plot a weight inversely proportional to its distance from the plot under comparison. This method of comparison tends to compensate for variations in the fertility of the several plots.

Price Assumed For Seed Cotton.

The price assumed is 8 cents per pound for lint and $12.00 per ton for seed. Deduct from this the cost of picking and ginning, ½ cent per pound of seed cotton, and we have 2$\frac{6}{10}$ cents as the *net* value per pound of increase of seed cotton; this last figure is used in all calculations of profits in this bulletin.

Huntsville experiments with cotton.

Plot No.	FERTILIZER. Amount pre acre.	FERTILIZER. KIND.	HUNTSVILLE (Davis) 1901 Yield of seed cotton per acre.	HUNTSVILLE (Davis) 1901 Increase over unfertilized plots.	HUNTSVILLE (Wales) 1902 Yield of seed cotton per acre.	HUNTSVILLE (Wales) 1902 Increase over unfertilized plots.	HUNTSVILLE (Wales) 1903 Yield of seed cotton per acre.	HUNTSVILLE (Wales) 1903 Increase over unfertilized plots.	HUNTSVILLE (Wales) 1904 Yield of seed cotton per acre.	HUNTSVILLE (Wales) 1904 Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Los.*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*
1	200	Cotton seed meal	332	—96	416	56	640	216	416	64
2	240	Acid phosphate	524	96	384	24	712	288	472	120
3	00	No fertilizer	428		360		424		352	
4	200	Kainit	512	78	353	00	600	192	344	—5
5	200 240	Cotton seed meal ... Acid phosphate	592	154	384	37	712	320	872	526
6	200 200	Cotton seed meal ... Kainit	420	—22	408	67	656	280	704	362
7	240 200	Acid phosphate .... Kainit	616	169	368	33	552	192	520	181
8	00	No fertilizer	452		328		344		336	
9	200 240 200	Cotton seed meal ... Acid phosphate .... Kainit	792	340	416	88	648	304	696	360
10	200 240 100	Cotton seed meal ... Acid phosphate .... Kainit	880	428	448	120	594	250	688	352

EXPERIMENT MADE IN 1901 BY CLARENDON DAVIS, HUNTSVILLE.

Red upland soil and subsoil, characteristic of the Tennessee valley.

Ths field had been in cultivation for many years. The preceding crop was wheat, itself preceded by cowpeas. Excessive shedding of forms, due to continued heavy rains in August, and the occurrence of light but damaging frost September 18th, reduced the yield on all plots, but more on the plots fertilized heavily and on those receiving cotton seed meal. The early frost and the residual fertilizing effects of the cowpeas probably explain the slight effects of cotton seed meal, to which in combination with acid phosphate, cotton usually responds profitably on this grade of soil. For yield of seed cotton see page 24. That table shows that the increase in seed cotton per acre was as follows:

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	—96 lbs.
To acid phosphate plot	58 lbs.
To kainit plot	—100 lbs.
To acid phosphate and kainit plot	171 lbs.
Average increase with cotton seed meal	**8 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	96 lbs.
To cotton seed meal plot	250 lbs.
To kainit plot	91 lbs.
To cotton seed meal and kainit plot	362 lbs.
Average increase with acid phosphate	**199 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	78 lbs.
To cotton seed meal plot	74 lbs.
To acid phosphate plot	73 lbs.
To cotton seed meal and acid phosphate plot	186 lbs.
Average increase with kainit	102 lbs.

The chief need of cotton on this soil was for acid phosphate. Although there was no rust, the addition of kainit to the phosphate was profitable. The conditions in this test did not give to cotton seed meal a fair opportunity to show the favorable effects that may usually be expected of it on this soil. Yet a complete fertilizer was the most profitable, plot 10 leading with a net profit of $6.90 per acre after paying for fertilizers and for picking and ginning the increase, on the basis of lint at 8 cents and cotton seed at 60 cents per hundred pounds.

Experiments Made in 1902, 1903, and 1904 by H. D. N. Wales, Huntsville.

Red clay soil and subsoil.

The excessively long dry period from April to August rendered all fertilizers ineffective in 1902. For yields and increase of crop see table on page 24. The 1903 experiment was preceded by two corn crops in succession. That year the largest yield resulted from the use of a mixture of acid phosphate and cotton seed meal. Kainit was of little or no use in combination, but on plot 4 it seemed useful when used alone. There was no rust. Mr. Wales thinks that early frost cut off one-half of the expected yields on plots 9 and 10, and did less injury on other plots.

In 1904 the experiment was on similar soil, that had borne a crop of cowpeas three years before and then had been uncultivated for two years. The largest yield was again obtained from plot 5, fertilized with 200 pounds of cotton seed meal and 240 pounds acid phosphate. Mr. Wales added an eleventh plot fertilized with 200 pounds acid phosphate and 100 pounds cotton seed meal, the yield of which was 684 pounds, or practically as good as plots 9 and 10, containing kainit and a larger amount of cotton seed meal. Cotton seed meal was highly profitable when employed in combination, but less useful alone. Kainit was generally useless. In view of results recorded in this bulletin and in those obtained in previous experiments on typical red upland Tennessee valley soil, I would suggest as a general fertilizer for cotton on that soil

80 to 120 lbs. cotton seed meal per acre.
160 to 240 lbs acid phosphate per acre.

240 to 360 lbs. total per acre.

If the cotton stalks grow very small it might be advisable to increase the proportion of cotton seed meal to one-half of the mixture.

Increase of seed cotton per acre when cotton seed meal was added:

	1902	1903	1904
To unfertilized plot	56 lbs.	216 lbs.	64 lbs.
To acid phosphate plot	13 lbs.	32 lbs.	405 lbs.
To kainit plot	67 lbs.	88 lbs.	367 lbs.
To acid phosphate and kainit plot	55 lbs.	112 lbs.	179 lbs.
Average increase with cotton seed meal	**47 lbs.**	**112 lbs.**	**253 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	24 lbs.	288 lbs.	120 lbs.
To cotton sed meal plot	—19 lbs.	104 lbs.	462 lbs.
To kainit plot	—33 lbs.	0 lbs.	186 lbs.
To cotton seed meal and kainit plot	21 lbs.	24 lbs.	—2 lbs.
Average increase with acid phosphate	**14 lbs.**	**104 lbs.**	**167 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	0 lbs.	192 lbs.	—5 lbs.
To cotton seed meal plot	11 lbs.	64 lbs.	298 lbs.
To acid phosphate plot	9 lbs.	96 lbs.	61 lbs.
To cotton seed meal and phosphate plot	51 lbs.	16 lbs.	—160 lbs.
Average increase with kainit	17 lbs.	92 lbs.	19 lbs.

EXPERIMENTS MADE BY C. L. JENKINS, NEAR SILVER RUN, TALLADEGA COUNTY.

Most of the soil on this farm, six miles south of Oxford, is light reddish to yellowish loam, apparently fairly well supplied with lime.

In 1902. The preceding crop was wheat. No cowpeas had been grown in recent years. The early part of the season was very dry. All three fertilizer materials were useful, a complete fertilizer giving the largest yield.

In 1903. The largest yield was obtained by the use of a complete fertilizer consisting of

200 lbs. cotton seed meal per acre.
240 lbs acid phosphate per acre.
100 lbs kainit per acre.

In 1904. Again the largest yield was obtained by the complete formula just mentioned. Plot 5 this year, without kainit, yields almost as much as the plots with complete fertilizers. The first need of this soil seems to be for phosphate but nitrogen and potash were added with effect.

Silver Run experiments with cotton.

Plot No.	Amount per acre.	KIND.	Silver Run 1902: Yield of seed cotton per acre.	Silver Run 1902: Increase over unfertilized plots	Silver Run 1903: Yield of seed cotton per acre.	Silver Run 1903: Increase over unfertilized plots	Silver Run 1904: Yield of seed cotton per acre.	Silver Run 1904: Increase over unfertilized plots.
	Lbs		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	144	40	200	—80	576	48
2	240	Acid phosphate	184	80	392	112	544	16
3	00	No fertilizer	104		280		528	
4	200	Kainit	240	129	480	187	568	37
5	200 240	Cotton seed meal ... Acid phosphate	324	207	672	366	880	345
6	200 200	Cotton seed meal ... Kainit	356	233	568	249	696	158
7	240 200	Acid phosphate ..... Kainit	304	175	744	412	648	107
8		No fertilizer	136		344		544	
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	492	356	776	432	880	336
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	455	320	920	576	944	400

Increase of seed cotton when cotton seed meal was added:

	1902	1903	1904
To unfertilized plot	40 lbs.	80 lbs.	48 lbs.
To acid phosphate plot	127 lbs.	254 lbs.	329 lbs.
To kainit plot	104 lbs.	62 lbs.	121 lbs.
To acid phosphate and kainit plot	181 lbs.	20 lbs.	229 lbs.
Average increase with cotton seed meal..	**95 lbs.**	**64 lbs.**	**181 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	80 lbs.	112 lbs.	16 lbs.
To cotton seed meal plot	167 lbs.	446 lbs.	297 lbs.
To kainit plot	46 lbs.	225 lbs.	70 lbs.
To cotton seed meal and kainit plot....	123 lbs.	183 lbs.	178 lbs.
Average increase with acid phosphate..	**106 lbs.**	**242 lbs.**	**140 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	129 lbs.	187 lbs.	37 lbs.
To cotton seed meal plot	193 lbs.	329 lbs.	110 lbs.
To acid phosphate plot	95 lbs.	300 lbs.	91 lbs.
To cotton seed meal and acid phos. plot	149 lbs.	66 lbs.	—9 lbs.
Average increase with kainit	141 lbs.	221 lbs.	57 lbs.

Experiments Made by W. F. Fulton, one Mile South of Colllinsville, DeKalb County.

Soil reddish or mullatto, subsoil red.

For table showing yields see page 31.

Both in 1902 and in 1903 the largest increase resulted from the use of cotton seed meal and acid phosphate together. Plainly kainit was not needed. Neither was cotton seed meal alone, nor phosphate alone, sufficient. This is the fifth fertilizer experiment with cotton that Mr. Fulton has made on the red soils of Big Wills Valley, the first at Larimore and the later tests at Collinsville. Each year the description of the soil is about the same, reddish valley soil, underlaid by red clay, and all apparently calcareous. These tests all agree in showing:

(1) That the chief need of cotton on this soil is for phosphate.

(2) That the addition of cotton seed meal to the acid phosphate is profitable.

(3) That in the presence of phosphate and meal kainit is useless.

The results suggest that the best fertilizer for these valley soils is one containing more phosphate than meal. I suggest 200 pounds acid phosphate and 100 pounds cotton seed meal. Earlier results are recorded in bulletins 102, 107 and 113 of this station. The following analysis shows the increase attributed to fertilizers in 1902 and 1903:

In none of the five experiments made by Mr. Fulton was there any injury by rust.

The average increase for the two years was on plot 5, receiving phosphate and meal, 348 pounds, affording a net profit per acre of $5.77 after paying cost of fertilizer and of ginning and picking the increase.

Collinsville and Montevallo experiments.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. KIND.	COLLINSVILLE 1902 Yield of seed cotton per acre.	COLLINSVILLE 1902 Increase over unfertilized plots.	COLLINSVILLE 1903 Yield of seed cotton per acre.	COLLINSVILLE 1903 Increase over unfertilized plots.	MONTEVALLO 1904 Yield of seed cotton per acre.	MONTEVALLO 1904 Increase over unfertilized plots.
	Lbs		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	440	144	376	48	1056	192
2	240	Acid phosphtae	416	120	560	232	1000	146
3	00	No fertilizer	296		328		864	
4	200	Kainit	336	30	336	3	1056	144
5	200 240	Cotton seed meal ... Acid phosphtae	624	307	728	390	1072	112
6	200 200	Cotton seed meal ... Kainit			528	185	1208	300
7	240 200	Acid phosphtae .... Kainit	496	158	616	268	1384	328
8	00	No fertilizer	348		352		1104	
9	200 240 200	Cotton seed meal ... Acid phosphtae .... Kainit	544	196	712	360	1568	464
10	200 240 100	Cotton seed meal ... Acid phosphtae .... Kainit	512	164	712	360	1560	456

Increase of seed cotton per acre when cotton seed meal was added:

	1902	1903
To unfertilized plot	144 lbs.	48 lbs.
To acid phosphate plot	187 lbs.	158 lbs.
To kainit plot	—	182 lbs.
To acid phosphate and kainit plot	38 lbs.	92 lbs.
Average increase with cotton seed meal..........	**123 lbs.**	**120 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	120 lbs.	232 lbs.
To cotton seed meal plot	163 lbs.	342 lbs.
To kainit plot	128 lbs.	265 lbs.
To cotton seed meal and kainit plot	—	175 lbs.
Average increase with acid phosphate	**137 lbs.**	**253 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	30 lbs.	3 lbs.
To cotton seed meal plot	—	137 lbs.
To acid phosphate plot	38 lbs.	36 lbs.
To cotton seed meal and acid phosphate plot	—111 lbs.	—31 lbs.
Average increase with kainit	**—14 lbs.**	**36 lbs.**

Experiment Made by J. W. Wyatt, Five Miles East of Montevallo, Shelby County.

Dark, reddish, sandy upland with red clay subsoil.

This field had been cleared of its second growth of timber for about fifteen years, and for about ten years in succession had been planted in cotton.

The original growth is reported to have been oak, hickory, chestnut and dogwood, and the second growth springing up when the land was thrown out of cultivation after the civil war was short leaf pine and sumac. No mention is made of rust.

The complete fertilizer raised the yield to more than a bale per acre, an increase of 464 pounds. The complete fertilizer with 100 pounds of kainit was more profitable than the one with a larger amount of kainit, the former affording a profit of $7.23 per acre after paying for fertilizer and picking and ginning of the increase.

Increase of seed cotton when cotton seed meal was added:

To unfertilized plot ....192 lbs.
To acid phosphate plot ....—34 lbs.
To kainit plot .... 56 lbs.
To acid phosphate and kainit plot ....136 lbs.

Average increase with cotton seed meal...... 87 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....146 lbs.
To cotton seed meal plot ....—80 lbs.
To kainit plot ....184 lbs.
To cotton seed meal and kainit plot...........264 lbs.

Average increase with acid phosphate ....128 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot ....144 lbs.
To cotton seed meal plot .... 8 lbs.
To acid phosphate plot ....182 lbs.
To cotton seed meal and acid phosphate plot..352 lbs.

Average increase with kainit ....171 lbs.

Experiment Made by G. R. Pass, Russellville, Franklin County.

This test was made on dark reddish clay upland with clay subsoil.

The original growth is described as oak and hickory with some wild cherry and walnut. Unfortunately for showing the full effects of cotton seed meal, the preceding crop was cowpeas, the entire growth being plowed under in the fall of 1903. The stand was good.

For yields and increase see table on page 36. The largest yield and the greatest profit per acre were obtained on plot 5, where only cotton seed meal and acid phosphate were employed. With this fertilizer the increase was 595 pounds per acre and the net profit, after paying for fertilizer and picking and ginning of increase, was $11.59. Cotton seed meal was highly profitable in spite of the fact that the preceding pea crop had supplied a large amount of nitrogen. Kainit was useless, if not indeed injurious.

Increase of seed cotton when cotton seed meal was added:

To unfertilized plot	448 lbs.
To acid phosphate plot	323 lbs.
To kainit plot	163 lbs.
To acid phosphate and kainit plot	142 lbs.
Average increase with cotton seed meal	**244 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	272 lbs.
To cotton seed meal plot	147 lbs.
To kainit plot	208 lbs.
To cotton seed meal and kainit plot	187 lbs.
Average increase with acid phosphate	**203 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	42 lbs.
To cotton seed meal plot	—243 lbs.
To acid phosphate plot	—22 lbs.
To cotton seed meal and acid phosphate plot	—203 lbs.
Average decrease with kainit	**106 lbs.**

Experiment Made by L. Long, Long P. O., Perry County, in 1902.

Worn red prairie with some sand.

For yields and increase see table on page 36.

This soil had been uncultivated for several years, but had borne two crops of cotton just before the experiment was made. With a mixture of cotton seed meal and phosphate (plot 5) the increase was 360 pounds, affording a net profit of $5.48 per acre. Acid phosphate seems to have been the fertilizer chiefly needed, and the addition of cotton seed meal to the phosphate was highly profitable. Kainit was unprofitable.

These results suggest that a suitable fertilizer for this soil might well contain more phosphate than meal, say two-thirds acid phosphate and one-third cotton seed meal. Mr. Long added an additional plot fertilized only with four 2-horse loads unweighed stable manure per acre. From this the increase over the nearest unfertilized plot was 188 pounds of seed cotton per acre.

Increase of seed cotton when cotton seed meal was added:

To unfertilized plot	104 lbs.
To acid phosphate plot	64 lbs.
To kainit plot	144 lbs.
To acid phosphate and kainit plot	112 lbs.
Average increase with cotton seed meal	**106 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	296 lbs.
To cotton seed meal plot	256 lbs.
To kainit plot	300 lbs.
To cotton seed meal and kainit plot	268 lbs.
Average increase with acid phosphate	**278 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	4 lbs.
To cotton seed meal plot	44 lbs.
To acid phosphate plot	8 lbs.
To cotton seed meal and acid phosphate plot	56 lbs.
Average increase with kainit	**28 lbs.**

Russellville, Long, Tidmore and Cullman experiments.

Plot No.	Fertilizer: Amount per acre.	Fertilizer: Kind.	Russellville 1904: Yield of seed cotton per acre.	Russellville 1904: Increase over unfertilized plots.	Long 1902: Yield of seed cotton per acre.	Long 1902: Increase over unfertilized plots.	Tidmore 1901: Yield of seed cotton per acre.	Tidmore 1901: Increase over unfertilized plots.	Cullman 1904: Yield of seed cotton per acre.	Cullman 1904: Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs*	*Lbs*	*Lbs.*
1	200	Cotton seed meal	1112	448	296	104	32	32	536	104
2	240	Acid phosphate	936	272	488	296	52	232	576	144
3	00	No fertilizer	664		192		292		432	
4	200	Kainit	768	42	192	4	276	4	528	82
5	200 240	Cotton seed meal Acid phosphate	1384	595	544	36	688	436	896	435
6	200 200	Cotton seed meal Kainit	1056	205	328	148	488	256	816	341
7	240 200	Acid phosphate Kainit	1096	250	480	304	400	188	784	294
8	00	No fertilizer	976		172		192		504	
9	200 240 200	Cotton seed meal Acid phosphate Kainit	1308	392	588	416	752	560	864	360
10	200 240 100	Cotton seed meal Acid phosphate Kainit	1424	448	468	296	796	604	904	400

EXPERIMENT MADE BY JNO. W. STAAB, TWO MILES NORTH OF TIDMORE, BLOUNT COUNTY.

Light, gray, sandy soil with red loam subsoil 4 to 6 inches below the surface.

This upland field had been in cultivation about fifty years. The original growth is reported as shortleaf pine, gum, mountain oak, persimmon, and hickory. All plots were thinned to the same number of plants. For yields and increase see table on page 36. A complete fertilizer containing 100 pounds of kainit gave the largest increase, and a net profit of $11.07 per acre. A mixture of cotton seed meal and phosphate was also highly profitable.

The conclusions drawn by Mr. Staab from this experiment and from previous experience are here quoted:

"1. That 50 to 100 pounds of fertilizer per acre is not sufficient to mature a full crop.

2. That even the heavy applications do not pay unless the ground contains considerable humus.

3. That phosphatic fertilizers in connection with cotton seed meal or cowpeas, or weeds turned under green will pay better than nine-tenths of the fertilizers commonly used.

4. That heavy applications help crops into quick germination and more rapid growth, lessening expense for hoeing.

5. That a reduction of acreage and adequate increase of manures are advisable.

6. I do not find kainit of nearly the value it is advertised; in times of drought it shows for itself by the wilting of foliage. This is ameliorated by a mixture of cotton seed meal and acid phosphate."

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	32 lbs.
To acid phosphate plot	204 lbs.
To kainit plot	252 lbs.
To acid phosphate and kainit plot	372 lbs.
Average increase with cotton seed meal	**215 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	232 lbs.
To cotton seed meal plot	404 lbs.
To kainit plot	184 lbs.
To cotton seed meal and kainit plot	304 lbs.
Average increase with acid phosphate	**282 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	4 lbs.
To cotton seed meal plot	224 lbs.
To acid phosphate plot	—44 lbs.
To cotton seed meal and acid phosphate plot	124 lbs.
Average increase with kainit	77 lbs.

Experiment Made at Cullman in 1904.

This experiment was conducted by Mr. Feirtag for Mr. L. A. Fealy. The land is described as very poor and the test as entirely fair. The soil is not described but was probably the characteristic sandy soil of that region. For yields and increase see table on page 36. The largest increase and the greatest profit were obtained on plot 5 from a mixture of acid phosphate and cotton seed meal, the net profit there being $7.43 per acre.

Increase of seed cotton when cotton seed meal was added:

To unfertilized plot	104 lbs.
To acid phosphate plot	291 lbs.
To kainit plot	259 lbs.
To acid phosphate and kainit plot	66 lbs.
Average increase with cotton seed meal	180 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	144 lbs.
To cotton seed meal plot	331 lbs.
To kainit plot	212 lbs.
To cotton seed meal and kainit plot	19 lbs.
Average increase with acid phosphate	176 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	82 lbs.
To cotton seed meal plot	237 lbs.
To acid phosphate plot	150 lbs.
To cotton seed meal and acid phosphate plot	—75 lbs.
Average increase with kainit	98 lbs.

Experiment Made by J. W. French, 3½ Miles North of Gordo, Pickens County, in 1901.

Gray, sandy upland with yellow clay subsoil.

The original growth is reported as shortleaf pine and sweet gum, which had been removed about twenty years before. On this soil cotton sometimes rusts, but there was no rust on plots fertilized with kainit in 1901. The season was dry.

Gordo, Tuscaloosa, and Hamilton experiments.

Plot No.	FERTILIZER. Amount per acre	FERTILIZER. KIND.	GORDO 1901 Yield of seed cotton per acre.	GORDO 1901 Increase over unfertilized plots.	GORDO 1902 Yield of seed cotton per acre.	GORDO 1902 Increase over unfertilized plots.	TUSCALOOSA 1901 Yield of seed cotton per acre.	TUSCALOOSA 1901 Increase over unfertilized plots.	HAMILTON 1903 Yield of seed cotton per acre.	HAMILTON 1903 Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	512	144	656	120	552	104	745	155
2	240	Acid phosphate	448	80	680	144	592	144	780	190
3	00	No fertilizer	368		536		448		590	
4	200	Kainit	432	87	536	00	416	—39	600	10
5	200 240	Cotton seed meal Acid phosphate	568	458	808	272	812	351	870	280
6	200 200	Cotton seed meal Kainit	592	272	640	104	702	532	840	250
7	240 200	Acid phosphate Kainit	536	91	800	64	696	223	810	220
8	00	No fertilizer	256		536		480			
9	200 240 200	Cotton seed meal Acid phosphate Kainit	616	360	896	360	960	480	980	390
10	200 240 100	Cotton seed meal Acid phosphate Kainit	608	352	848	312	792	231	870	280

A complete fertilizer gave the best yield. In a complete fertilizer 100 pounds of kainit was sufficient, plot 10 affording a net profit of $4.52.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	144 lbs.
To acid phosphate plot	165 lbs.
To kainit plot	185 lbs.
To acid phosphate and kainit plot	69 lbs.
Average increase with cotton seed meal	**181 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	80 lbs.
To cotton seed meal plot	101 lbs.
To kainit plot	204 lbs.
To cotton seed meal and kainit plot	88 lbs.
Average increase with acid phosphate	**118 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	87 lbs.
To cotton seed meal plot	121 lbs.
To acid phosphate plot	211 lbs.
To cotton seed meal and acid phosphate plot	115 lbs.
Average increase with kainit	**133 lbs.**

Experiment Made by D. W. Davis, 1½ Miles Northeast of Gordo, Pickens County, in 1902.

Snuff colored, sandy clay loam with dark reddish clay subsoil.

This upland field had been in cultivation for many years, the two preceding crops being corn with a scant growth of cowpeas between the rows. The original growth was red oak, black jack oak, hickory and pine. The stand was uniform. For yield and increase see table on page 39.

A complete fertilizer gave the largest yield and a net profit on plot 9 of $3.96 per acre. While all three fertilizers were beneficial, the chief need was for phosphate. Preceding crops of cowpeas obscured the results from cotton seed meal. Kainit, though useful, was less needed than it was the preceding year on the apparently lighter soil of Mr. French's farm.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	120 lbs.
To acid phosphate plot	128 lbs.
To kainit plot	104 lbs.
To acid phosphate and kainit plot	96 lbs.
Average increase with cotton seed meal	**112 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	144 lbs.
To cotton seed meal plot	152 lbs.
To kainit plot	264 lbs.
To cotton seed meal and kainit plot	256 lbs.
Average increase with acid phosphate	**204 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	00 lbs.
To cotton seed meal plot	—16 lbs.
To acid phosphate plot	120 lbs.
To cotton seed meal and acid phosphate plot	88 lbs.
Average increase with kainit	**64 lbs.**

Experiment Conducted by E. J. Daffin, 3½ Miles South of Tuscaloosa, in 1901.

Gray, sandy soil, with yellow subsoil.

This field had been cleared about sixty years. The original growth is reported as oak, hickory, shortleaf pine, sweet gum, elm, mulberry, poplar and beech.

Black rust was severe on all plots. The season was dry until August, when excessive rains occurred.. The stands were very thin, but uniform on each plot.

The largest yield was made with the complete fertilizer. Six hundred and forty pounds of a complete fertilizer on plot 9 increased the yield 480 pounds of seed cotton, affording (at 8 cents for lint) a net profit of $7.10 per acre after paying for fertilizers and cost of ginning and picking the increase. Cotton seed meal was important, and phosphate equally so; kainit was useful, but less needed than the other two, and was effective only when combined with one or both of the others.

The results of the 1901 test are in accord with similar experiments made by Mr. Daffin in 1900 on the same farm, (property of Hon. F. S. Moody) and with those obtained by him in 1897 and 1898 on the county Poor-house farm.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	104 lbs.
To acid phosphate plot	207 lbs.
To kainit plot	292 lbs.
To acid phosphate and kainit plot	257 lbs.
Average increase with cotton seed meal	**215 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	144 lbs.
To cotton seed meal plot	247 lbs.
To kainit plot	262 lbs.
To cotton seed meal and kainit plot	227 lbs.
Average increase with acid phosphate	**220 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	—39 lbs.
To cotton seed meal plot	149 lbs.
To acid phosphate plot	79 lbs.
To cotton seed meal and acid phosphate plot	129 lbs.
Average increase with kainit	**79 lbs.**

We may safely conclude that on soils of this character near Tuscaloosa cotton requires a large proportion of phosphate, considerable cotton seed meal, and less of kainit than of either meal or phosphate.

For yields and increase see table on page 39.

Experiment Conducted by the Sixth District Agricultural School at Hamilton, Marion County, in 1903.

Soil dark loam with light red subsoil.

This upland soil had been cleared many years, then thrown out of cultivation, and again taken into cultivation five years before the test began.

On plots 7, 9 and 10 the stand was imperfect. The largest yield was made with the complete fertilizer, but potash was less needful than either cotton seed meal or phosphate.

The largest net profit, on plot 9, was $3.46.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	155 lbs.
To acid phosphate plot	90 lbs.
To kainit plot	240 lbs.
To acid phosphate and kainit plot	170 lbs.
Average increase with cotton seed meal	**163 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	190 lbs.
To cotton seed meal plot	125 lbs.
To kainit plot	210 lbs.
To cotton seed meal and kainit plot	140 lbs.
Average increase with acid phosphate	**166 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	10 lbs.
To cotton seed meal plot	95 lbs.
To acid phosphate plot	30 lbs.
To cotton seed meal and acid phosphate plot	110 lbs.
Average increase with kainit	**61 lbs.**

Experiment Made by Fifth District Agricultural School, Wetumpka, in 1901.

Dark gray loam soil with reddish subsoil.

This upland field is reported as having been cleared about twenty years before of its growth of longleaf pines and small water oaks.

For the three years preceding the experiment it was uncultivated and grew up in grass and briers.

There was little or no black rust. The stand was uniform.

The average results indicate that the chief need was for phosphate. Neither kainit nor cotton seed meal was of much use the first year after the plowing in of large amounts of vegetable matter,. The need for phosphate is also suggested by the results of the 1903 inconclusive experiment on the same farm. See pages 47 and 71.

The largest net profit was from plot 5, $4.65.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	64 lbs.
To acid phosphate plot	116 lbs.
To kainit plot	63 lbs.
To acid phosphate and kainit plot	—93 lbs.
Average increase with cotton seed meal	**37 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	170 lbs.
To cotton seed meal plot	222 lbs.
To kainit plot	234 lbs.
To cotton seed meal and kainit plot	78 lbs.
Average increase with acid phosphate	**176 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	67 lbs.
To cotton seed meal plot	66 lbs.
To acid phosphate plot	131 lbs.
To cotton seed meal and acid phosphate plot	—78 lbs.
Average increase with kainit	**46 lbs.**

EXPERIMENT MADE BY J. D. BILLINGSLEY, FIVE MILES WEST OF TALLASSEE, IN ELMORE COUNTY, IN 1903.

Black sandy upland; light colored subsoil.

The original growth of longleaf pine and oak had been removed about thirty years before. There was no rust and very little shedding. All plots were thinned to the same number of plants, namely, 5,760 per acre.

The rainfall was favorable. For yields see page 47.

The largest yield was obtained from the complete fertilizer which afforded an increase of 552 pounds of seed cotton per acre, or a net profit on plot 6 of $8.97, and on plot 10 of $9.67. The principal need was for potash and nitrogen, this being one of the few soils where, in the absence of rust, kainit was more important than acid phosphate.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	136 lbs.
To acid phosphate plot	204 lbs.
To kainit plot	470 lbs.
To acid phosphate and kainit plot	225 lbs.
Average increase with cotton seed meal	**258 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	40 lbs.
To cotton seed meal plot	108 lbs.
To kainit plot	301 lbs.
To cotton seed meal and kainit plot	56 lbs.
Average increase with acid phosphate	**126 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	26 lbs.
To cotton seed meal plot	360 lbs.
To acid phosphate plot	287 lbs.
To cotton seed meal and acid phosphate plot	308 lbs.
Average increase with kainit	**245 lbs.**

Experiment Made by J. P. Slaton, Seven Miles South of Notasulga.

This test was made on gray sandy hillside with stiffer reddish subsoil.

The original growth was longleaf pine, oak, hickory and gum, cleared eight years before. For two years preceding the experiment the land was pastured. Unfortunately the land was not plowed until May 17th, which delay reduced the yields. The stand was good on all plots. For yields and increase see table on page 47.

The complete fertilizer was most profitable, plot 9 giving an increase of 544 pounds of seed cotton per acre, equivalent to a net profit of $8.76 per acre.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	256 lbs.
To acid phosphate plot	105 lbs.
To kainit plot	173 lbs.
To acid phosphate and kainit plot	210 lbs.
Average increase with cotton seed meal	**186 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	276 lbs.
To cotton seed meal plot	129 lbs.
To kainit plot	128 lbs.
To cotton seed meal and kainit plot	165 lbs.
Average increase with acid phosphate	**174 lbs**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot ....206 lbs.
To cotton seed meal plot ....123 lbs.
To acid phosphate plot .... 58 lbs.
To cotton seed meal and acid phosphate plot..163 lbs.

Average increase with kainit ....137 lbs.

Wetumpka, Tallassee, Notasulga and Auburn fertilizer experiments.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. KIND.	WETUMPKA 1901. Yield of seed cotton per acre.	WETUMPKA 1901. Increase over unfertilized plots.	TALLASSEE 1903. Yield of seed cotton per acre.	TALLASSEE 1903. Increase over unfertilized plots.	NOTASULGA 1904. Yield of seed cotton per acre.	NOTASULGA 1904. Increase over unfertilized plots.	AUBURN 1902. Yield of seed cotton per acre.	AUBURN 1902. Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	424	64	480	136	528	256	594	178
2	240	Acid phosphate	536	170	384	40	548	276	477	63
3	00	No fertilizer	360		344		272		416	
4	200	Kainit	432	67	376	26	472	206	629	201
5	200 240	Cotton seed meal ... Acid phosphate	656	286	600	244	640	381	580	140
6	200 200	Cotton seed meal ... Kainit	504	130	832	469	632	379	662	211
7	240 200	Acid phosphate ..... Kainit	680	301	696	327	580	334	648	185
8	00	No fertilizer	384		376		240		475	
9	200 240 200	Cotton seed meal .... Acid phosphate ..... Kainit	592	208	928	552	784	544	741	266
10	200 240 100	Cotton seed meal ... Acid phosphate .... Kainit	664	280	926	550	564	324	729	254

EXPERIMENT ON STATION FARM AT AUBURN, IN 1902.

Light, sandy soil with porous sandy subsoil.

This test was made on the poorest hilltop on the station farm where no leguminous crop had grown for a number of years. The absence of any considerable rain between April and August ruined the yield.

The stand was uniform on all plots. The chief need of this sand bank this excessively dry year was for kainit, but the largest yield was from complete fertilizer.

Experiment Conducted by W. T. Chism, in 1901, 1902 and 1903, at Vick, Bibb County.

Grayish, sandy, second bottom with yellow subsoil.

This land has been long in cultivation. On adjacent, similar land the forest growth consists of shortleaf pine, white and red oaks, gum, cucumber tree, dogwood, hickory and beech. For yields and increase see table on page 49.

In 1901. All plots were reduced to the same number of plants, 6,400 per acre. The two preceding crops had been cotton. The largest increase, 388 pounds of seed cotton per acre, or a net profit of $5.31 per acre, was obtained where a complete fertilizer was used. This year nitrogen was apparently the plant food chiefly needed, but both phosphoric acid and potash were advantageous. There was practically no rust on any plot.

In 1902. Dry weather, almost continuous from April till August, made the yields on all plots low and all fertilizers practically useless.

In 1903. The two preceding crops had been cotton. The spring was late and cold. No rust occurred. As in 1901 cotton seed meal greatly increased the yield while phosphate and kainit were less important, but advantageous. Plot 10 afforded the largest increase, 446 pounds, or a net profit of $6.19 per acre.

The results suggest that the phosphate in the complete fertilizer might have been much reduced without injury to the crop.

Mr. Chism also made similar experiments in 1899 and 1900. In those years cotton seed meal was the only fertilizer that was of material advantage. The results as a whole indicate that on this second bottom a fertilizer of unusual composition is required and that it should contain more of cotton seed meal than of any other fertilizer.

Experiments at Vick, Bibb county.

	FERTILIZER.		VICK 1901		VICK 1902		VICK 1903	
Plot No.	Amount per acre.	KIND.	Yield of seed cotton per acre.	Increase over unfertilized plots	Yield of seed cotton per acre.	Increase over unfertilized plots	Yield of seed cotton per acre.	Increase over unfertilized plots
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	676	122	352	48	864	242
2	240	Acid phosphate	612	128	360	56	572	—50
3	00	No fertilizer	484		304		622	
4	200	Kainit	636	156	364	57	700	75
5	200 240	Cotton seed meal ... Acid phosphate	732	256	412	102	970	348
6	200 200	Cotton seed meal ... Kainit	740	268	400	86	940	310
7	240 200	Acid phosphate ..... Kainit	716	248	432	115	752	119
8	00	No fertilizer	464		320		636	
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	852	388	432	112	1024	388
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	728	264	428	108	1052	416

Increase of seed cotton per acre when cotton seed meal was added:

	1901	1903
To unfertilized plot	192 lbs.	242 lbs.
To acid phosphate plot	128 lbs.	398 lbs.
To kainit plot	112 lbs.	235 lbs.
To acid phosphate and kainit plot	140 lbs.	262 lbs.
Average increase with cotton seed meal	**143 lbs.**	**284 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	128 lbs.	50 lbs.
To cotton seed meal plot	64 lbs.	106 lbs.
To kainit plot	92 lbs.	44 lbs.
To cotton seed meal and kainit plot	120 lbs.	84 lbs.
Average increase with acid phosphate	**101 lbs.**	**46 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	156 lbs.	75 lbs.
To cotton seed meal plot	76 lbs.	68 lbs.
To acid phosphate plot	120 lbs.	189 lbs.
To cotton seed meal and acid phosphate plot	132 lbs.	40 lbs.
Average increase with kainit	**121 lbs.**	**88 lbs.**

Experiment Made by the Southern Industrial Institute, Camp Hill, Tallapoosa County, in 1902.

Gray, sandy soil, with sandy subsoil.

A protracted drought made all fertilizers practically useless, the average increase from cotton seed meal being only 18 pounds, from phosphate 31 pounds, and from kainit 17 pounds. The most favorable result, on plot 7, entailed a loss on account of fertilizers of 94 cents per acre.

Experiments Made 2½ Miles South of Hanover, Coosa County, by J. M. Logan, in 1902.

Dark gray sandy soil with some rock; yellowish subsoil.

The original growth, removed about 40 years before, consisted of longleaf pine, hickory and oak. Recent crops have all been cotton. The largest increase, 392 pounds of seed cotton per acre, was obtained from the use of a complete fertilizer, affording a net profit of $5.56 per acre. Phosphate used alone or with kainit, was of little value, but combined with both it was highly advantageous.

Camp Hill, Hanover, Florence and Athens experiments.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. KIND.	CAMP HILL 1902 Yield of seed cotton per acre.	CAMP HILL 1902 Increase over unfertilized plots.	HANOVER 1903 Yield of seed cotton per acre.	HANOVER 1903 Increase over unfertilized plots.	FLORENCE 1904 Yield of seed cotton per acre.	FLORENCE 1904 Increase over unfertilized plots.	ATHENS 1904 Yield of seed cotton per acre.	ATHENS 1904 Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	200	Cotton seed meal	576	32	360	120	732	284	560	208
2	240	Acid phosphate	536	—8	264	24	1144	696	600	248
3	00	No fertilizer	544		240		448		352	
4	200	Kainit	528	—15	376	137	784	334	656	295
5	200 240	Cotton seed meal ... Acid phosphate	584	43	352	116	1416	965	728	357
6	200 200	Cotton seed meal ... Kainit	656	27	368	132	1024	571	760	379
7	240 200	Acid phosphate ..... Kainit	624	86	384	151	1272	828	592	201
8	00	No fertilizer	536		232		456		400	
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	576	40	536	304	1492	1036	816	416
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	536	00	624	392	1200	744	872	472

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot ....120 lbs.
To acid phosphate plot .... 92 lbs.
To kainit plot .... 4 lbs.
To acid phosphate and kainit plot ....153 lbs.

Average increase with cotton seed meal .... 90 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 24 lbs.
To cotton seed meal plot ....—4 lbs.
To kainit plot .... 11 lbs.
To cotton seed meal and kainit plot ....171 lbs.

Average increase with acid phosphate .... 50 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	136 lbs.
To cotton seed meal plot	13 lbs.
To acid phosphate plot	127 lbs.
To cotton seed meal and acid phosphate plot	188 lbs.
Average increase with kainit	**113 lbs.**

Experiment Made by W. A. Parish, Ten Miles West of Florence, Lauderdale County.

Light, gray soil with pale reddish subsoil.

This field had been cleared 40 or 50 years. The original growth is reported as postoak and black jack oak.

The experimenter reports that there was no black rust, but that "red rust" was present, but did little damage. The season was dry. The stand was good and uniform.

The complete fertilizer more than trebled the yield of the unfertilized plots, raising the yield to about a bale per acre. This is an increase of 1,036 pounds of seed cotton, equal to a net profit of $21.56 per acre after paying for fertilizer and picking and ginning of increase. Every fertilizer, whether applied singly, by twos, or all three together, profitably increased the yield. The fertilizer most needed was phosphate. The one least needed was kainit which, however, was profitable.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	284 lbs.
To acid phosphate plot	269 lbs.
To kainit plot	237 lbs.
To acid phosphate and kainit plot	208 lbs.
Average increase with cotton seed meal	**249 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....696 lbs.
To cotton seed meal plot .... 681 lbs.
To kainit plot ....494 lbs.
To cotton seed meal and kainit plot ....465 lbs.

Average increase with acid phosphate ....584 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot ....334 lbs.
To cotton seed meal plot ....287 lbs.
To acid phosphate plot ....132 lbs.
To cotton seed meal and acid phosphate plot.. 71 lbs.

Average increase with kainit ....212 lbs.

Experiment Made by P. G. Williams, 1½ Miles West of Athens, Limestone County.

Dark brown loam or clay with red subsoil.

This field had been cleared many years. The original growth is reported as oak, black jack oak, gum and popuar.

There was no rust, but drought and early frost cut short the yield. The most profitable fertilizer was the complete one containing 100 pounds of kainit. With this the increase was 472 pounds of seed cotton per acre, thus affording a net prôfit above the cost of fertilizer and picking and ginning of increase of $7.64 per acre. However, all fertilizers whether applied singly, by twos, or by threes, profitably increased the yield.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot ....208 lbs.
To acid phosphate plot ....109 lbs.
To kainit plot .... 84 lbs.
To acid phosphate and kainit plot ....215 lbs.

Average increase with cotton seed meal ....154 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	284 lbs.
To cotton seed meal plot	149 lbs.
To kainit plot	—34 lbs.
To cotton seed meal and kainit plot	37 lbs.
Average increase with acid phosphate	**85 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	295 lbs.
To cotton seed meal plot	171 lbs.
To acid phosphate plot	—47 lbs.
To cotton seed meal and acid phosphate plot	59 lbs.
Average increase with kainit	**119 lbs.**

Experiments by W. G. Bevill, Naheola, Choctaw County, in 1901 and 1902.

"Mulatto" upland with clay subsoil.

The land had been long in cultivation. The original growth was reported as both long and shortleaf pine. The immediately preceding crops were cotton.

For yields see table on page ——

Rust was worst on plot 5, but there was little of it on the kainit plots. Dry weather from June to August, followed by a violent storm, greatly reduced the yield. The stand was good.

In 1901. The largest increase, 448 pounds of seed cotton per acre, was from a complete fertilizer. However, in a complete fertilizer, 100 pounds of kainit was sufficient; plot 9 afforded a net profit of $8.13 per acre.

In 1902. In spite of the drought from April till August, cotton seed meal and acid phosphate profitably increased the yield. Plot 5 afforded an increase of 247 pounds, or a net profit of $2.54, or a few cents less than plot 10 and a few cents less than plot 9.

Nahcola, Greenville, and Evergreen experiments.

	FERTILIZER.		NAHEOLA 1901		NAHEOLA 1902		GR'ENVILLE 1901		EVERGREEN 1902	
Plot No.	Amount per acre.	KIND.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.
	Lbs		*Lbs*	*Lbs*	*Lbs*	*Lbs*	*Lbs*	*Lbs*	*Lbs*	*Lbs*
1	200	Cotton seed meal	648	120	400	-32	632	304	384	80
2	240	Acid phosphate	664	136	504	72	616	288	384	80
3	00	No fertilizer	528		432		328		304	
4	200	Kainit	664	130	296	-141	352	24	224	-64
5	200 240	Cotton seed meal ... Acid phosphate	760	220	688	247	696	268	672	400
6	200 200	Cotton seed meal ... Kainit	856	310	616	170	664	326	696	440
7	240 200	Acid phosphate ..... Kainit	696	143	600	149	528	200	688	448
8	00	No fertilizer	560		456				224	
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	1008	448	744	288	632	304	800	592
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	1000	440	744	288	784	456	768	576

Increase of seed cotton per acre when cotton seed meal was added:

	1901	1902
To unfertilized plot	120 lbs.	—32 lbs.
To acid phosphate plot	84 lbs.	175 lbs.
To kainit plot	180 lbs.	311 lbs.
To acid phosphate and kainit plot	305 lbs.	139 lbs.
Average increase with cotton seed meal..........	**172 lbs.**	**145 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	136 lbs.	72 lbs.
To cotton seed meal plot	100 lbs.	279 lbs.
To kainit plot	13 lbs.	290 lbs.
To cotton seed meal and kainit plot	138 lbs.	118 lbs.
Average increase with acid phosphate	**96 lbs.**	**189 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	130 lbs.—	141 lbs.
To cotton seed meal plot	190 lbs.	202 lbs.
To acid phosphate plot	7 lbs.	75 lbs.
To cotton seed meal and acid phosphate plot	228 lbs.	41 lbs.
Average increase with kainit	**138 lbs.**	**44 lbs.**

EXPERIMENT BY D. H. ROUSE, GREENVILLE, IN 1901.

Worn, red land.

The average increase is the greatest with cotton seed meal, 172 pounds of seed cotton per acre, and next with acid phosphate. Kainit was ineffective. This test is not entirely conclusive.

For table of yields see page 55.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	304 lbs.
To acid phosphate plot	—20 lbs.
To kainit plot	302 lbs.
To acid phosphate and kainit plot	104 lbs.
Average increase with cotton seed meal	**172 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	288 lbs.
To cotton seed meal plot	—36 lbs.
To kainit plot	176 lbs.
To cotton seed meal and kainit plot	—22 lbs.
Average increase with acid phosphate	**101 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertiized plot	24 lbs.
To cotton seed meal plot	22 lbs.
To acid phosphate plot	—88 lbs.
To cotton seed meal and acid phosphate plot	36 lbs.
Average decrease with kainit	**1 lbs.**

EXPERIMENT BY J. W. STUART, AT EVERGREEN, IN 1902.

Gray sandy upland with reddish subsoil.

For yields see page 55.

There was no rust. The stand was uniform. In spite of the severe drought every combination of fertilizers effected a highly profitable increase in the crop. However, when used separately, no fertilizer material exerted its full effect.

The largest increase, 592 pounds of seed cotton per acre, resulted from the use of a complete fertilizer, but in the complete fertilizer 100 pounds of kainit was nearly as effective as a larger amount. Plot 10 afforded a net profit of $10.34 per acre after paying for fertilizer and for picking and ginning the increase.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	80 lbs.
To acid phosphate plot	320 lbs.
To kainit plot	504 lbs.
To acid phosphate and kainit plot	144 lbs.
Average increase with cotton seed meal	**264 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	80 lbs.
To cotton seed meal plot	320 lbs.
To kainit plot	512 lbs.
To cotton seed meal and kainit plot	152 lbs.
Average increase with acid phosphate	**266 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	—64 lbs.
To cotton seed meal plot	360 lbs.
To acid phosphate plot	368 lbs.
To cotton seed meal and acid phosphate plot	192 lbs.
Average increase with kainit	**214 lbs.**

Experiment Conducted by J. D. Veal, Three Miles North of Louisville, Barbour County.

Gray, sandy soil, with stiffer gray subsoil.

This upland field had been cleared of its growth of oak and hickory and longleaf pine about thirty years before. For the two years preceding this experiment corn was grown on this land, but whether cowpeas were grown between the corn rows was not stated.

The stand on all plots was good. A complete fertilizer afforded the largest increase in yield, 474 pounds of seed cotton per acre, a net profit of $6.94 per acre. The complete fertilizer with 200 pounds of kainit was a little more profitable than the one containing 100 pounds of kainit. This is a case in which the increased yield from kainit was not due to its influence on rust, for Mr. Veal reports that there was no rust on any plot. See table page 66.

The combination of acid phosphate and cotton seed meal was highly profitable, but less so than the complete fertilizers.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertiized plot	48 lbs.
To acid phosphate plot	253 lbs.
To kainit plot	301 lbs.
To acid phosphate and kainit plot	242 lbs.
Average increase with cotton seed meal	**211 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	120 lbs.
To cotton seed meal plot	325 lbs.
To kainit plot	268 lbs.
To cotton seed meal and kainit plot	209 lbs.
Average increase with acid phosphate	**230 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	—34 lbs.
To cotton seed meal plot	219 lbs.
To acid phosphate plot	114 lbs.
To cotton seed meal and acid phosphate plot	103 lbs.
Average increase with kainit	100 lbs.

Experiment Made by C. A. Hatcher, Two Miles Southeast of Enterprise, Coffee County.

Gray, sandy loam, with stiff gray subsoil.

The longleaf pines had been cut on this field about 18 years before. There were 7,360 plants per acre on all plots. For yields and increase see table on page 60. The crop preceding the experiment was corn with cowpeas in the drill and peanuts between the corn rows. It is not stated whether the peanuts were consumed as usual by hogs on the land, or removed.

In spite of these preceding leguminous crops and of the fact that the corn had been fertilized with eight bushels of cotton seed per acre, the application of cotton seed meal to cotton was decidedly profitable. The material most needed was acid phosphate. The greatest increase in yield, 616 pounds of seed cotton worth $16.01 net, resulted from the use of 640 pounds of a complete fertilizer, and this complete fertilizer afforded a net profit of $10.63 per acre.

Kainit was distinctly advantageous and profitable whenever combined with acid phosphate. The complete fertilizer combining 200 pounds of kainit was more profitable than the one with 100 pounds.

No mention is made of rust.

Louisville, Enterprise, Georgiana, and Garland experiments.

	FERTILIZER.		LOUISVILLE 1904		ENTERPRISE 1904		GEORGIANA 1904		GARLAND 1901	
Plot No.	Amount per acre.	KIND.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.	Yield of seed cotton per acre.	Increase over unfertilized plots.
	Lbs		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	200	Cotton seed meal	240	48	552	272	976	64	808	296
2	240	Acid phosphate	312	120	536	256	1112	200	960	448
3	00	No fertilizer	192		280		912		512	
4	200	Kainit	184	—34	304	24	976	70	560	51
5	200 240	Cotton seed meal .... Acid phosphate	616	373	680	400	1264	364	952	446
6	200 200	Kainit .... Cotton seed meal	536	267	528	248	1184	291	640	137
7	240 200	Acid phosphate ...... Kainit	528	234	768	488	1096	210	936	437
8	00	No fertilizer	320		280		880		496	
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	796	476	896	616	264	384	1056	560
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	724	404	800	520	240	360	1016	520

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot ....272 lbs.
To acid phosphate plot ....144 lbs.
To kainit plot ....224 lbs.
To acid phosphate and kainit plot ....128 lbs.

Average increase with cotton seed meal ......192 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot ....256 lbs.
To cotton seed meal plot ....128 lbs.
To kainit plot ....464 lbs.
To cotton seed meal and kainit plot ....368 lbs.

Average increase with acid phosphate ....304 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	24 lbs.
To cotton seed meal plot	—24 lbs.
To acid phosphate plot	232 lbs.
To cotton seed meal and acid phosphate plot	216 lbs.
Average increase with kainit	112 lbs.

Experiments Made by J. C. Lee, 1904, 1 1-4 Miles North of Georgiana.

Gray "pineywoods" upland with red clay subsoil.

The land had been cleared about ten years. The original growth was longleaf pine with some oak, hickory, and dogwood.

There had been no cowpeas on this land in recent years.

There was no rust, but shedding was severe. The stand was good and uniform. For yields see page 60. The most profitable increase, 364 pounds of seed cotton per acre, resulted from the use of cotton seed meal and acid phosphate. This mixture gave a net profit of $5.58 per acre. The addition of kainit to this mixture was not notably helpful. The chief need of this soil was for phosphate and not ful. The chief need of this soil was for phosphate and next

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	64 lbs.
To acid phosphate plot	164 lbs.
To kainit plot	221 lbs.
To acid phosphate and kainit plot	174 lbs.
Average increase with cotton seed meal	155 lbs.

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	200 lbs.
To cotton seed meal plot	300 lbs.
To kainit plot	140 lbs.
To cotton seed meal and kainit plot	193 lbs.
Average increase with acid phosphate	**208 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	70 lbs.
To cotton seed meal plot	227 lbs.
To acid phosphate plot	10 lbs.
To cotton seed meal and acid phosphate plot	20 lbs.
Average increase with kainit	**81 lbs.**

Experiment Made in 1901, by G. L. McLure, Two Miles East of Garland, Butler County.

This gray upland pine soil had been cleared about ten years. The original growth was longleaf pine and black jack oak. The preceding crop was oats. Acid phosphate was highly profitable and cotton seed meal effective. Kainit was effective only when combined with the other two. The largest increase, 560 pounds of seed cotton per acre, was obtained from the use of a complete fertilizer. This, on plot 9, gave a net profit of $9.46 per acre. For yield see table on page 60.

Two experiments previously made by Mr. McLure and two made near by at Lumber Mills, accord with the results here recorded in showing that the pineywoods soils of that region are highly responsive to a mixture of acid phosphate and cotton seed meal, and that kainit is highly beneficial only when rust is severe.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	296 lbs.
To acid phosphate plot	—2 lbs.
To kainit plot	86 lbs.
To acid phosphate and kainit plot	123 lbs.
Average increase with cotton seed meal	**125 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot	448 lbs.
To cotton seed meal plot	150 lbs.
To kainit plot	386 lbs.
To cotton seed meal and kainit plot	423 lbs.
Average increase with acid phosphate	**351 lbs.**

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	51 lbs.
To cotton seed meal plot	—159 lbs.
To acid phosphate plot	—11 lbs.
To cotton seed meal and acid phosphate plot	114 lbs.
Average decrease with kainit	**1 lbs.**

Experiment Made by W. H. Simmons, Midland City, Dale County.

Alone none of the fertilizers was very advantageous, but in a complete fertilizer all three were decidedly beneficial. The largest increase, 296 pounds of seed cotton per acre, resulted from the use of the complete fertilizer on plot 9. This afforded a net profit of $2.32 per acre, which is nearly nine cents more than the profit on plot 10, where less kainit was used. See table on page 64.

Increase of seed cotton per acre when cotton seed meal was added:

To unfertilized plot	88 lbs.
To acid phosphate plot	127 lbs.
To kainit plot	86 lbs.
To acid phosphate and kainit plot	139 lbs.
Average increase with cotton seed meal	**110 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

To unfertilized plot .... 56 lbs.
To cotton seed meal plot .... 95 lbs.
To kainit plot ....113 lbs.
To cotton seed meal and kainit plot ....166 lbs.

Average increase with acid phosphate ....107 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot .... 44 lbs.
To cotton seed meal plot .... 42 lbs.
To acid phosphate plot ....101 lbs.
To cotton seed meal and acid phosphate plot ..113 lbs.

Average increase with kainit .... 75 lbs.

Midland City and Geneva experiments.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. KIND.	MIDLAND CITY 1904 Yield of seed cotton per acre.	MIDLAND CITY 1904 Increase over unfertilized plots.	GENEVA 1901 Yield of seed cotton per acre.	GENEVA 1901 Increase over unfertilized plots.	GENEVA 1902 Yield of seed cotton per acre.	GENEVA 1902 Increase over unfertilized plots.	GENEVA 1903 Yield of seed cotton per acre.	GENEVA 1903 Increase over unfertilized plots.
	Lb.		Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs	Lbs.
1	200	Cotton seed meal	312	88	488	112	763	8	712	—8
2	240	Acid phosphate	280	56	672	295	880	120	768	48
3	00	No fertilizer	224		376		768		720	
4	200	Kainit	264	44	424	48	1088	359	856	166
5	200 240	Cotton seed meal ... Acid phosphate	400	183	600	224	1000	323	784	125
6	200 200	Cotton seed meal ... Kainit	344	130	448	72	1008	373	976	348
7	240 200	Acid phosphate .... Kainit	368	157	608	232	1016	423	840	242
8	00	No fertilizer	208		376		552		568	
9	200 240 200	Cotton seed meal ... Acid phosphate .... Kainit	504	296	640	264	1040	488	1096	528
10	200 240 100	Cotton seed meal ... Acid phosphate .... Kainit	472	264	600	224	912	360	928	360

Experiments by P. M. Metcalf, 4½ Miles North of Geneva.

Gray or light sandy upland with stiffer red subsoil, eight inches from surface.

For yields see table on pages 64 and 74.

In 1901. This was the fourth crop after clearing, all previous crops being corn with cowpeas and peanuts between. No mention is made of rust.

On this fresh land where leguminous crops had grown for several years, phosphate was the only material of marked value. Phosphate alone increased the yield 296 pounds of seed cotton per acre, affording a net profit of $6.02 per acre, after paying cost of fertilizer and picking and ginning of increase.

In 1902. The immediately preceding crop was oats, which in turn had been preceded by two crops of corn, probably with cowpeas or peanuts between, as is customary in that locality.

The time since clearing is not stated.

Protracted drought and abundance of cotton caterpillars in October reduced the yields. No mention is made of black rust, but Mr. Metcalf writes that "Plots 1, 2, 3, 4 and 8 had much of what we know as red rust." In this unfavorable year kainit was by far the most effective single fertilizer, increasing the yield when used alone 369 pounds. The complete fertilizer containing a full ration of kainit increased the yield 488 pounds of seed cotton, affording a net profit of $6.31 per acre.

Mr. Metcalf writes: "I learn from this experiment that it pays to use lots of guano and of high quality."

In 1903. This was the sixth year since the clearing of this land. The crops in 1902 were oats, followed by Spanish peanuts. There was no rust. This experiment is rendered inconclusive by the wide variation in the yields of the two unfertilized plots and by the contradictory results on plots 9 and 10, hence it is recorded in the table on page 74.

In 1904. Cotton in this experiment constituted the fourth crop since clearing. The two preceding crops had been corn and peanuts, the peanuts not picked. The summer was dry. The largest increase, 528 pounds of seed cotton per acre, was made by the complete fertilizer, affording a net profit above cost of fertilizer, ginning and picking of $9.38 per acre.

Again the chief need seems to have been for kainit, acid phosphate being almost as important, and cotton seed meal somewhat less important by reason of recent crops of peanuts.

Increase of seed cotton per acre when cotton seed meal was added:

	1901	1902	1904
To unfertilized plot	112 lbs.	8 lbs.	—8 lbs.
To acid phosphate plot	—72 lbs.	203 lbs.	77 lbs.
To kainit plot	24 lbs.	4 lbs.	182 lbs.
To acid phosphate and kainit plot	32 lbs.	65 lbs.	286 lbs.
Average increase with cotton seed meal	**24 lbs.**	**70 lbs.**	**136 lbs.**

Increase of seed cotton per acre when acid phosphate was added:

	1901	1902	1904
To unfertilized plot	296 lbs.	120 lbs.	48 lbs.
To cotton seed meal plot	112 lbs.	315 lbs.	133 lbs.
To kainit plot	184 lbs.	54 lbs.	76 lbs.
To cotton seed meal and kainit plot	192 lbs.	25 lbs.	180 lbs.
Average increase with acid phosphate	**196 lbs.**	**128 lbs.**	**109 lbs.**

Increase of seed cotton per acre when kainit was added:

	1901	1902	1904
To unfertilized plot	48 lbs.	369 lbs.	166 lbs.
To cotton seed meal plot	—40 lbs.	365 lbs.	356 lbs.
To acid phosphate plot	—64 lbs.	303 lbs.	194 lbs.
To cotton seed meal and acid phos. plot	40 lbs.	165 lbs.	402 lbs.
Average increase with kainit	**—4 lbs.**	**300 lbs.**	**270 lbs.**

Do Fertilizers Pay?

Let the figures answer. The following table gives the average of all the 41 conclusive experiments recorded in this bulletin. It shows the average increase in seed cotton, due to fertilizers, throughout Alabama and the net profit due to fertilizers, after paying liberal prices for fertilizers and after paying 50 cents per hundred pounds of seed cotton for picking and ginning the increased yields.

Average increase in 41 experiments in seed cotton per acre and net profit per acre from fertilizers, after deducting cost of fertilizer and cost of picking and ginning the increase.

Plot No.	FERTILIZER. Amount per acre.	FERTILIZER. KIND.	Increase in seed cotton from fertilizers.	Net profit per acre from fertilizers with seed at 60c per 100 lbs. and Lint at 6c.	Lint at 8c.	Lint at 10c.
	Lbs.		Lbs.	$	$	$
2	240	Acid phosphate	55	1.26	2.35	3.36
5	200 240	Cotton seed meal .... Acid phosphate	302	1.85	3.97	5.87
9	200 240 200	Cotton seed meal ... Acid phosphate ..... Kainit	91	2.04	4.78	7.25
10	200 240 100	Cotton seed meal ... Acid phosphate ..... Kainit	365	2.30	4.86	7.26

The above table deserves careful study. Even with cotton calculated at six cents per pound, fertilizers were profitable, the average net profit per acre ranging from $1.26 to $2.30.

With eight-cent cotton the average net profits from fertilizers assume important proportions, ranging from $2.35 and $4.86 per acre.

With ten cent cotton the average profits range between $3.36 and $7.26 per acre.

Whether cotton be priced at six, eight, or ten cents per pound, the average profit per acre was greater with a mixture of cotton seed meal and phosphate than with phosphate alone, and still greater when 100 pounds of kainit was added to this mixture, thus making a complete fertilizer.

CONCLUSIONS AND SUGGESTIONS.

These are based on these experiments and on results published in former bulletins of this station.

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1. In all soil belts, except perhaps on certain grades of rich prairie soil, where tests have been made with cotton under the direction of this station acid phosphate has been almost universally beneficial.

2. Kainit is less frequently needed than either acid phosphate or cotton seed meal, and a considerable proportion of the soils on which it has been most advantageous lie in the southern part of the State. On soils where cotton is especially liable to "black rust" and in all parts of the State in seasons when that disease is especially injurious, kainit is at its best. On most soils, containing much clay, it can be profitably dispensed with. Where needed, an application of 100 pounds per acre is usually sufficient for cotton.

3. Cotton seed meal is highly beneficial to cotton on a large proportion of the cultivated area of every soil belt in Alabama. Apparently it is universally needed on uplands except on (1) new grounds and (2) on soils containing considerable vegetable matter.

4. On old soils, as a rule, it is more profitable to employ for cotton a mixture of acid phosphate and cotton seed meal or of these two and kainit, than to use an equal money value of any one of them alone.

5. The usual basis for a fertilizer formula for cotton

in regions where commercial fertilizers are generally employed should be acid phosphate, of which 100 to 240 pounds should be used per acre, in addition to cotton seed meal or other nitrogenous fertilizer as necessary.

6. The proper proportion of cotton seed meal to acid phosphate in a fertilizer formula for cotton depends largely on the recent cropping and manuring of the field.

(a) Small stalks, (if not due to climatic influences, poor cultivation, etc.) are usually an indication that nitrogen (as in cotton seed meal), is needed.

(b) Excessive stalk or "weed growth" of cotton is an indication that nitrogen can be dispensed with wholly or partially.

(c) Phosphate hastens maturity.

(d) The fresher the land the less the need for nitrogen.

(e) A luxuriant growth of cowpeas just preceding cotton dispenses with the necessity for cotton seed meal, as does a recent heavy dressing with stable manure or cotton seed.

7. Nitrogen costs about three times as much as phosphoric acid or potash and hence most of it should be produced on the farm by growing soil-improving plants, (as cowpeas, velvet beans, vetch, crimson clover, etc.) and by increasing the number of livestock and the amount of stable manure saved.

8. In response to requests for recommendations of definite fertilizer formulas for cotton on different soils, the writer would tentatively suggest the following to be modified somewhat when the facts mentioned in paragraph 6 seem to require it:

(a) For red lime lands in North Alabama; for the red clay lands occupying a triangular area in the central portion of East Alabama—for the most part north of the Western Railway and east of the Coosa River—and for the stiffer non-calcareous soils of the northwestern and western part of the State:

80 to 120 lbs. cotton seed meal per acre.
160 to 240 lbs. acid phosphate per acre.

——— ———

240 to 360 lbs. total per acre.

(b) For sandy soils in the eastern and central parts of the State:

80 to 120 lbs. cotton seed meal per acre.
160 to 240 lbs. acid phosphate per acre.
40 to 60 lbs. kainit per acre.

——— ———

280 to 420 lbs. total per acre.

(c) For the level lands of the southern Longleaf Pine Region:

60 to 120 lbs. cotton seed meal per acre.
120 to 240 lbs. acid phosphate per acre.
60 to 80 lbs. kainit per acre.

——— ———

240 to 440 lbs. total per acre.

(d) For any well drained soil in any part of the State on which cotton is known to be especially liable to black rust:

120 to 160 lbs. cotton seed meal per acre.
80 to 120 lbs. acid phosphate per acre.
80 to 120 lbs. kainit per acre.

——— ———

280 to 400 lbs. total per acre.

9. The formulas suggested above contain approximately the following percentages of nitrogen (and its larger equivalent in ammonia), available phosphoric acid, and potash, using phosphate containing 12 1-2 per cent. of available phosphoric acid. A phosphate of higher grade is advisable.

FORMULA.	Per Cent. Nitrogen.........	Per Cent. Ammonia.........	Per Cent. Available Phosphoric Acid......	Per Cent. Potash........
(a) For certain red lands	2.3	2.8	9.3	0.6
(b) For certain sandy lands	2.0	2.4	8.0	2.3
(c) For low longleaf pine lands	1.9	2.3	7.6	2.8
(d) For "rusting" soils	3.0	3.6	4.8	4.3

10. On the lime soils of the Central Prairie Region commercial fertilizers are not generally used. Prairie soils are often in poor mechanical condition and need vegetable matter and drainage more than commercial fertilizers. The poorer soils often need both cotton seed meal and phosphate.

Inconclusive Experiments.

These sometimes afford suggestions or hints which may serve to strengthen the conclusions derived from the more positive experiments previously recorded.

At Town Creek, one-quarter of a mile southeast of the town, Mr. A. A. Owens made the test on what he describes as white sandy land with yellowish subsoil. There was no rust, but drought. This experiment was undertaken by Mr. R. R. Reed, who turned the fertilizers over to Mr. Owens. The test is inconclusive for the reason of the tearing of one of the fertilizer sacks, probably that for plot 9.

The Newtonville experiment in Fayette county was made by G. W. Gravlee, but was vitiated by late germination and irregular stands.

The experiment at Hanover, Coosa county, was made by J. M. Logan on gray gravelly or rocky land with red clay subsoil. The results suggest that kainit was not needed.

The test one mile east of Fredonia, Chambers county, was made by E. W. Smart on dark upland with red subsoil. Inequalities in stand, due, he reports, to disease of the young plants, vitiated the experiment. The results suggest that a mixture of cotton seed meal and acid phosphate was sufficient. Cowpeas in corn or after oats, and grazed, grew on the land in each of two years preceding the experiment.

Mr. W. A. Candler, Clanton, Chilton county, made the experiment on land where the preceding winter he had plowed in a very rank growth of cowpea vines, affording conditions unsuitable for a test of commercial fertilizers.

At Wetumpka, the test was made on the farm of the District Agricultural Schools with conflicting results both in 1902 and 1903.

At Greensboro the tests were made by T. K. Jones, 1 1-2 miles south of town on poor red upland, originally covered with hardwood. In 1902 manure was accidentally added to certain plots, and in 1904 the growth of grass ruined the experiment.

Four miles north of Union Springs Mr. N. Gachet made a test on light, reddish loam with red clay subsoil, where the original growth had been hardwoods. Variations in the stand destroyed the value of the experiment.

The test at Carson, Washington county, was consigned to Mr. R. D. Palmer. It was made on gray upland, pine land with yellow clay subsoil, two miles north of Carson. The results are somewhat conflicting.

For the Geneva experiment, see page 66.

Credit is due Mr. C. R. Hudson for making or checking all calculations in this bulletin.

BULLETIN NO. 132. APRIL, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

Diseases of the Apple, Cherry, Peach, Pear and Plum; With Methods of Treatment.

BY

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

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INTRODUCTION.

The rapid increase in the fruit growing industry in this State within recent years has made it necessary that more and more attention should be given to the diseases of these plants by the Experiment Staation and the fruit-growers themselves. A large number of letters reach this department during the year asking for information regarding these diseases and the best method of controlling them and these letters cannot in most cases be properly replied to by letter alone. They indicate also a growing interest in these matters and seem to indicate that the time has arrived to place before our people such information as is now available regarding these matters. To supply this evident need this Bulletin has been prepared.

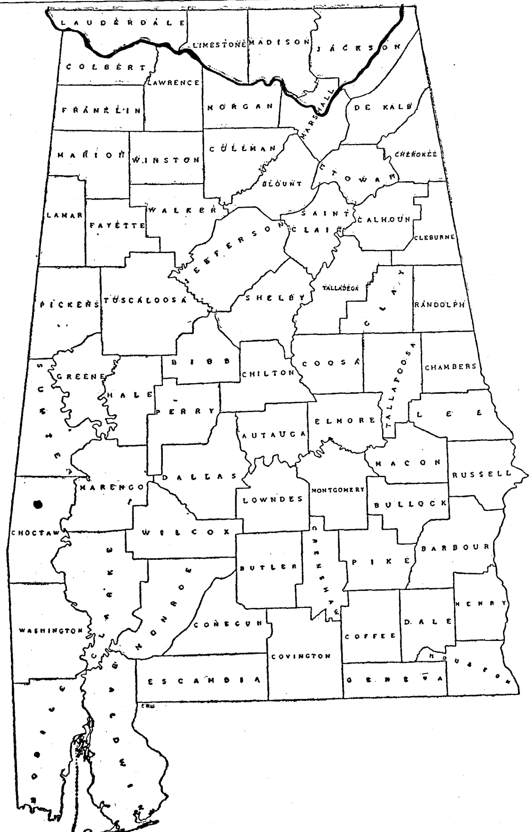
We have thought it best to depart somewhat from the common method of presenting such matters and have made the attempt to arrange the facts and suggestions under such definite headings as will best serve to indicate what sort of information must be had before one can hope to successfully control diseases of cultivated plants. More than this we have looked upon the diseases from the standpoint of the diseased plant and have included, therefore, no statements regarding the organism causing the diseases where this would not conduce to a clearer understanding of the disease itself and particularly of the methods of treatment suggested. The science of plant pathology owes much to mycology but its future advance and recognition depends upon its rather more sharp differentiation from "economic mycology."

The plants are arranged in alphabetical order by their common names and under each are given, also in alphabetical order, the most important diseases of these plants in our region. We have introduced no new common names for any of these diseases, but have employed the common names now in most common use or that are sanctioned by the leading authorities upon this subject. In cases where the same disease is known on more than one of the plants mentioned reference to the disease will be made under each, but its full description will be presented under the first plant mentioned or in connection with the plant in which the disease is here best known. If the disease shows specific differences in the different plants attacked mention of the facts will be recorded under each plant concerned. Methods of treatment are discussed under each disease and no "spray calendar" is given. It is believed the plan here adapted has several and peculiar advantages over the other method.

We have placed at the close of the discussion of each disease a bibliography of the disease. This bibliography is in no case complete, but is simply a select list of the more original and recent literature dealing with this subject. The majority of these references are to the literature of the State Experiment Stations and the Department of Agriculture. To these and other sources I am indebted for information here presented and the references to this literature are here included to show readers of this Bulletin that further reading and study of this matter of plant diseases may readily be made in the publications mentioned that may in most cases be had for the asking.

One of the principal purposes of this Bulletin is to enable fruit growers to recognize some of the common diseases of the plants mentioned in order that they may assist this department in securing data each year of the distribution and severity of the diseases in the various counties of the State. The method employed here in recording this information is well shown by the figures on pages 82 and 83. The first one shows the front and the last one the back of a record form so made as to be employed in a regular loose leaf holder. We wish specimens and information regarding each disease from every county of the State where it is to be found and shall be glad to afford any who care to assist us in gathering this information any special directions they may desire. Specimens of diseased conditions of any plant are at all times desired and these and letters regarding such subjects should be directed to the Department of Plant Physiology and Pathology of the Experiment Station.

CROP DISEASE YEAR



(Devised by E. Mead Wilcox, 1904.)

NOTES.

REPORTED BY	COUNTY	POSTOFFICE	DATE	FILE and COPY

APPLE.

BITTER ROT.

History and Distribution.

The bitter rot of apples, known also as the ripe rot or anthracnose of the fruit, certainly made its appearance in America previous to 1867 and has attracted much attention from that time to date. In the United States the disease is found in practically every State east of and including Kansas, Oklahoma and Texas; the most serious outbreaks of the disease have occurred in Oklahoma, Indian Territory; southern Illinois, Ohio and Indiana; Kentucky, West Virginia, Virginia, eastern North Carolina, western New York; Delaware, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey and Alabama.

The fungus causing this disease may be fairly said to be found the world over wherever the apple is grown and, in addition to the apple, has been found on the following hosts: pear, tomato, grape, peach, nectarine, apricot, pepper, egg plant and squash. It remains to be determined whether the fungus occurring on these various hosts is identical.

Symptoms.

The bitter rot or ripe rot of apples is a fungus disease of the ripening fruit producing in another form a canker of the smaller limbs of the apple tree.

The first sign of the disease is to be found in the form of a small discoloration just beneath the skin of the apple. This spot, as it enlarges, becomes more and more sunken and the rotting of the apple proceeds towards the core. When the spots reach a size of about a half inch in diameter small blackish bodies appear in a circular arrangement beneath the skin of the apple (Plate I, Fig. 1.). These blackish bodies are the fruiting bodies of the fungus and soon project from the surface of the diseased spot. As these fruiting bodies break through the surface of the apple the spores produced in them are allowed to escape. The spores are held together in the form of stringy pinkish masses which are quite conspicuous, particularly on dry quiet nights when the spore masses are oozing out.

As the disease progresses other rings of fruiting bodies will appear outside of the one first formed and in time there may be a half dozen or more of these concentric rings. If the climatic conditions are unfavorable to the rapid development of the fungus the rings of the fruiting bodies will not be so definite or may be absent entirely. From the original point of infection the fungus may grow out until the whole apple is rotted—though there is at all times a rather sharp line of separation between the healthy and diseased portions of the fruit. If infection occurs at more than one point the rings of fruiting bodies from the several infections will ultimately unite with one another.

The general effect of the fungus is to hasten the maturity of the apple and lead to the well known falling of the apples. This falling may occur at any stage in the development of the disease. In fact the premature falling of the fruit is one of the most conspicuous symptoms of this disease.

During the summer of 1902 a Mr. Simpson, of Illinois, a large fruit grower of that State, noticed that in many cases there was to be found a canker on the limb that he suspected of being the source of infection from the fact that the canker was often found at the top of an inverted cone formed by the diseased apples on the tree. A careful investigation of this matter by Blair and Burrill and by Von Schrenk and Spaulding has established this suspicion of Mr. Simpson as a fact. They were able to produce the typical bitter rot by inoculation of healthy apples with spores produced in these limb cankers and also to produce the limb canker through inoculation with spores obtained from diseased apples. This very important discovery introduced into the treatment of the disease a new factor of immense importance.

These cankers appear most generally on the smaller limbs and their general appearance is well shown in Fig. 2 on Plate II. There are other cankers of apple trees and of other trees due to various causes, but whenever the bitter rot of apples is found on trees on which cankers like those shown in the above figure occur the removal of the cankers would be advisable even in advance of a demonstration of the connection between the two troubles.

Relationship of Disease to Climatic Conditions.

The first appearance of the trouble on the apple may be expected during July in this latitude, though in the northern apple growing districts this is generally delayed until August. The exact time depends much upon the climatic conditions that prevail at the time and during the spring.

The green fruit is generally quite immune, a fact that may be due to the larger amount of malic acid in immature fruits as compared with ripe fruits. And it is this rapid destruction of the ripe fruit just when the owner is about ready to gather in the crop that makes the trouble so much dreaded!

Warm and sultry weather affords the best chance for the rapid development of the fungus and the appearance of a regular bitter rot epidemic. On the contrary in cool dry summers the trouble need not be much feared. Nights with much dew alternating with hot days will greatly promote the development of the fungus.

The time of first appearance of the trouble on the fruits may also be much influenced by the condition of the spores, as to ripeness, in the cankers and the mummies, to be described later. If a cold spring has delayed the formation of these spores then the rot will be late appearing on the fruit itself.

Economic Importance.

We cannot do better to emphasize the importance of this disease than to mention the statement of the President of the National Apple Shippers' Association who said, "the damage to the apple crop of the United States in 1900 from bitter rot was $10,000,000.00." The destruction of 75 per cent. of the crop by this disease is not very unusual and in many cases the owners of apple orchards have preferred to lease the orchard for a mere trifle than to run the risk of getting no returns at all. Von Schrenk and Spaulding say, in speaking of this disease, that "It has probably done more to discourage apple growing in many regions than all other troubles, including both fungus and insect diseases combined." In our State the disease has caused great losses in many places, but so far no very systematic attempt has been made to control the disease or to determine its exact distribution.

Aetiology.

The bitter rot of apples and the associated canker of apple limbs are produced by the fungus now known as *Glomerella rufomaculans* (Berk.) Spaulding and Von Schrenk.

Remedial Measures.

The treatment against this disease may, in the light of our present knowledge, be grouped under three headings: (1) removal and destruction of all diseased apples from the tree and from the ground, (2) removal of the cankered limbs, and (3) spraying with the regular Bordeaux mixture as directed below.

The spores formed on the apples that fall to the ground during the season and those on the apples that dry up to form mummies on the tree may live over the winter and thus constitute sources of new infection during the following spring. If only a few trees are infected it will certainly pay well to watch the spread of the disease and immediately pick and destroy by burning or burying in the ground every apple as soon as the disease appears upon it. In this way the further spread of the disease to other trees in the orchard will be largely prevented. And then all rotten apples on the ground should be gathered up and destroyed.

The limb cankers should be removed during the late fall or winter as they can then be seen more readily than they can when the trees are in leaf. If cankers are found on the smaller limbs as is generally the case, these limbs may be removed entire, but if found on the trunk or very large limbs it may be best to carefully cut out the cankered portion and paint over the wound carefully with white lead paint of tar. It seems certain now that the removal of all these cankers will do much to lessen the spread of the disease in the orchard by removing one of the sources of new infection.

In addition to the two above named precautions the trees should be carefully sprayed with Bordeaux mixture at least once before the buds open and then at intervals of ten days until the fruit is about ripe.

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*This Bulletin bears the date November, 1902, on its cover, but within contains the statement "Issued February 20, 1904."

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BLACK ROT.

This disease has been known for some time being reported from Illinois for example as early as 1878. It probably occurs in every apple orchard and is often confused with the bitter rot.

SYMPTOMS.

Brownish decayed spots appear on the apple generally near the stem and often near the flower end. This rotted area soon turns black and the rotting proceeds towards the center of the apple. There is no such sharp demarkation between the rotten and healthy portions of the apple as exists in the case of the bitter rot and this is one method of distinguishing the two diseases from each other. The surface of the decayed spot becomes somewhat depressed.

Finally the apple shrivels up more or less and becomes a small and hard "mummy."

This disease does not occur as a rule on green apples except in cases of injury to the apple by wounds or insects. It is often abundant on "windfalls." It is also one of the chief causes of rotting of apples in the market.

On the leaves the same fungus often causes rather serious damage through the formation of rather large and irregular brownish spots.

The old dead twigs on unpruned trees may often become breeding places for this fungus from which spores may be scattered by the wind. The fungus was once thought to live on the twigs merely as a saprophyte but is now known to cause a serious canker of apple twigs. (See Canker of Apple on page 91.)

Aetiology.

It is produced by the fungus *Sphaeropsis malorum*, Berk. The fruiting stage consists of numerous rather small black pustules that develop on the surface of the diseased apple. The pustules develop as a rule only after the rotting is fairly well advanced.

These pustules are roundish conceptacles, with black or purplish walls, containing the spores. The spores ooze out as small white threads. The spores are at first white, but soon become deeply colored.

Treatment.

The disease may be controlled by spraying with Bordeaux mixture, making the first application before the leaves appear and subsequent ones at intervals of about two weeks. (See Fig. 6 on Plate II.) Decayed fruit should be removed from the trees and the ground and destroyed and "mummy" fruits should not be allowed to remain on the tree over winter.

Since the fungus causing this disease is also shown to be the cause of a canker, care should be taken to remove or treat cankered limb as suggested under the bitter rot.

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CANKER.

HISTORY AND DISTRIBUTION.

This disease was first reported from New York State, but is now known to have a much wider distribution. The fact of its being caused by the fungus producing the well known black rot of the apple, pear and quince fruits would naturally lead one to suspect that the distribution of the canker would be coextensive with the black rot.

SYMPTOMS.

In general a canker may be said to be the result of any "injury that destroys the bark and lays bare portions of wood." (Bull. 170 N. Y.) This particular canker is due to the action of a parasitic fungus that attacks principally the larger limbs. The trouble may be detected from the swollen appearance of the limbs and the rough dark colored bark. (Plate VII. Fig. 19.) Frequently in severe cases of canker the wood itself may be exposed and thus decay of the wood itself begins. The extent to which the canker affects the bark varies apparently with various conditions, but may be several feet.

The effect upon the tree is due to the interference with the circulation of the sap and the amount of injury will of course be in proportion to the surface area of the cankers. The tree may be simply weakened or may be killed outright.

AETIOLOGY.

This canker is caused by the fungus *Sphaeropsis malorum* Pk.

TREATMENT.

Cankered limbs should, if possible, be removed and burned. Where the cankers are found on the trunk or very large limbs it may be advisable to cut out the diseased spot and paint over the wound with some sort of paint or wash.

When spraying with Bordeaux mixture for other apple diseases if canker be present it would be advisable to thoroughly cover the limbs with the spray mixture.

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FLY SPECK.

History and Distribution.

This disease, aften referred to as "flies" and "blackbirds," was first reported in scientific literature in 1896 from Delaware. It is at present no doubt to be found practically wherever the apple is cultivated.

Symptoms.

This fruit disease is marked by the appearance upon the fruit of a number of small spots of specks (Plate II. Fig. 5.) in areas that may be 1-4 of an inch or more in diameter. The skin of the apple around this area may become rather cloudy in color and if many of the areas unite with each other the whole surface of the apple may become sooty in appearance. The effects of the fungus do not extend below the surface of the apple, but in the most severe cases the apple may become somewhat shrivelled owing to the action of the fungus causing the disease.

The claim is made that the disease will spread upon apples in storage.

Aetiology.

The disease is due to the fungus known as *Leptothyrium pomi* (Mont. & Fr.) Sacc.

Resistance of Varieties.

This disease appears in ordinary seasons most severely upon the fruit of trees planted in low damp situations. During a very wet season, however, all sorts of trees will be apt to be affected without reference to their situation or resistance. Rhode Island Greening, Rome Beauty and Peck's Pleasant are very frequently badly injured by this disease.

Treatment.

One thorough spraying with the ordinary Bordeaux mixture when the apples are half grown or less will prevent the injury from this disease. In the case of smooth skinned apples this spraying should be done somewhat earlier to prevent the so-called "russetting" of the apples caused by the fungicide itself. See also treatment for sooty blotch.

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HAIRY ROOT.

History and Distribution.

This disease was first reported by Stewart, Rolfs and Hall from Western New York in 1900, but is no doubt much more widely distributed than our records in the literature show. We have here in Alabama a very similar if not identical disease of apple and peach.

Symptoms.

The affected trees have few or no large branch roots. The root system of the tree instead consists of a number of groups of hair-like fine roots springing from the main tap root. Fig. 16 on Plate VI shows one of the common forms of the disease.

Aetiology.

The cause of the disease is at present unknown. It may be associated with attacks of wooly aphis or with the crown gall, but may occur independent of both of these troubles. It does not seem with us to be found associated with any type of soil. Specimens of this disease are much wanted.

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RUST.

History and Distribution.

Apple rust is widely distributed and may be expected wherever apples and cedar trees are growing in close proximity to each other. In Alabama the rust is in many sections one of our most serious apple troubles.

Symptoms.

The disease may readily be detected by the circular yellowish spots (See Fig. 4 on Plate II.) that appear on the leaves in May or June. Similar spots may also appear on the fruit.

AETIOLOGY.

The apple rust here is produced by one stage of *Gymnosporangium macropus,* the other stage of which lives on the red cedar causing there the so-called "cedar apples, shown in Fig. 3 on Plate II. The spores produced in the gelatinous out growths from these gallls in early spring are the source of infection of apple leaves.

TREATMENT.

Spraying seems to be of no value in controlling this disease. Since cedar trees harber one stage of the fungus causing this disease it is of course advisable to remove the "cedar appless" or if possible the cedar trees themselves. A little attention to this matter will dispose of he rust problem in apple orchards.

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SCAB.

History and Distribution.

It has been known as a serious apple disease since the early part of the 19th century. For example Curtis recorded it as common on apples in North Carolina in 1867. In this country its greatest injury seems to be in the Mississippi Valley. In this State no definite attempt has ever been made to the writer's knowledge to control it by spraying and in fact it has never attracted any great attention.

Symptoms.

Scab first makes its appearance early in the spring soon after the first leaves begin to unfold. It is during this time that the greatest amount of infection occurs, though there is a second period of infection in the fall which is largely responsible for the production of the mature winter stage. The scab may often be seen on the leaves and fruit of the lower branches showing that the probable source of infection was to be found in the leaves on the ground on which the fungus had wintered over. The first spots on the leaves are often on the lower side near the midrib—this being the first part of the leaf to be exposed while the leaf is unfolding.

On the Leaves.

The scab here is found in the form of roundish spots about 1-4 inch in diameter. Frequently several of these spots may unite with one another—particularly if they are near a large vein or the midrib where the fungus seems to grow more rapidly than elsewhere on the leaf. The spots have an olive green color.

On the Fruit.

The scab spots are roundish 1-8 to 1-2 inch in diameter and of an olive green color—frequently with a lighter colored margin. These spots may coalesce to some extent if conditions are such as to favor the growth of the fungus. The scab fungus grows more rapidly on young fruits than on older ones—due no doubt to the fact that the cuticle of the younger apples is more delicate. Old fruits for the same reason are not very apt to become infected. The cuticle over the "scab" may later in the season become broken and flaked off, exposing the dead tissues of the apple and giving the scabbed area a reddish brown color. The fungus also frequently causes the formation of a considerable amount of corky tissue—which in turn protects the apple from becoming infected at the scab spot by other fungi.

Winter Stage.

When the diseased leaves fall to the ground in the fall the mycelium that during the summer was confined to the space just beneath the cuticle, grows down into the tissues of the leaf. The deeper penetration into the leaf is made possible by the death of the leaf and the consequent partial decay of its tissues. These hyphae take on a reddish olive color and the cells composing them are larger than those formed during the summer. The fruiting bodies, perethecia, of the fungus are formed within the leaf. The spores are ripe by April or May and ready to produce the spring infection. Perethecia are often formed near the small spots on leaves produced by the autumn infection. The pustules are scattered or more generally gathered together in groups on a grayish spot that may mark the spot of the summer's scab. This stage of the fungus is not found elsewhere but on the leaves.

Treatment.

The scab may be prevented by spraying with Bordeaux mixture as follows:

(1.) Spray with Bordeaux mixture just before the flower buds open.

(2.) Spray again just after the blossoms fall.

(3.) Spray 1, 2 or 3 more times at intervals of about 10 days.

The following results secured by Jones & Orton in Vermont, show the immense profits in spraying for the apple scab. They sprayed as follows:

1. April 27. Buds not open; with solution of copper sulfat 1 lb. to 20 gallons.
2. May 18. Leaves out—flowers not open; Bordeaux "1—10" to which was added 1-3 lb. paris green.
3. June 15. Blossoms fallen.
4. July 18.
5. August 3.

Comparison was made of trees sprayed five times and those sprayed three times (the last two sprayings being here omitted) and trees not sprayed at all. The following table shows the results clearly:

	Per cent. on the tree.	Per cent. fallen.	Total value of crop per tree.
Sprayed 5 times	60	40	$15.44
Sprayed 3 times	51	49	7.38
Not sprayed	33	67	2.15

When account is taken of the fact that the fungus causing the disease may winter over on the fallen leaves it appears advisable to rake up and burn fallen leaves at the close of the season.

The gain from spraying may fall into the following classes:

(1.) Actual gain in yield per tree.

(2.) An increased percentage of "selects" and No. 1." apples.

(3.) Prevention of falling due to scab.

(4.) Increase in vigor of the tree itself.

(5.) Reduction of the loss, often very serious, resulting from the attacks of various fungi causing a rotting about the scab spots of storred apples.

Influence of Weather.

The greatest injury from the scab may be expected during seasons having a cold damp spring. The amount of the injury in any given season is also no doubt in a measure dependent upon the amount of the mature *Venturia* stage produced on the fallen apple leaves—this in turn being influenced by the climatic conditions prevailing during the preceding fall and winter.

Aetiology.

Apple scab, a disease affecting the leaves and fruits of the apple, is caused by the parasitic, summer stage, *Fusicladium dendriticum,* of the fungus *Venturia inaequalis.*

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SOOTY BLOTCH.

History and Distribution.

This was first reported by Sturgis in Connecticut in 1898 on Rhode Island Greenings and Newton Pippins. It is now very widely distributed and together with the fly-speck disease, with which often associated, causes much damage to apples particularly during wet seasons or where trees are planted in low damp soil.

Symptoms.

The disease appears as irregular blotches (Plate II. Fig. 5.) upon the surface of the apple—these blotches are at first pale, but soon become sooty black in color and under a lens show a radiating appearance due to the manner of growth of the fungus causing the disease. No rotting of the fruit occurs since the fungus works entirely upon the surface of the fruit. It may with the fly-speck disease greatly reduce the market value of the fruit.

Treatment.

Both fly-speck and sooty blotch will be controlled by the spraying against the scab. It may be necessary, however, to give one or two sprayings later in the season, say in July.

Aetiology.

The fungus causing this disease is generally referred to *Phyllachora pomigena,* though this matter demands further study.

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(In addition to the following consult the Bibliography given under Fly Speck.)

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CHERRY.

BLACK KNOT.

History and Distribution.

Black knot has long been known and the extent of its injuries has frequently been brought home to plum and cherry growers in no uncertain manner. The plum industry of the famous Hudson river valley (N. Y.) was practically wiped out by this disease. Farlow, 1876, was the first to determine its exact cause concerning which the most various opinions had previously been entertained.

Its most serious injury has frequently been to plums, but cherries are by no means exempt. DeSchweinitz mentions an epidemic of this disease that destroyed the cherry trees about Bethlehem, Pa., in 1790.

Symptoms.

The black knot is a rough wart-like outgrowth (Plate VII. Fig. 18,) from the bark of twigs and branches in severe cases extending along the trunk for several feet. The first symptom is the swelling of the tissue just beneath the bark. This enlargement increases during the fall or growing season until the bark is ruptured. This exposed portion of the twig is soon covered with an olive green velvety coating composed of the reproductive hyphae of the fungus. A microscopical examination of the diseased portion at this time would show numerous erect hyphae bearing spores—the so-called summer spores. These are readily carried about by the wind and other agencies and serve to spread the disease during the growing season.

Later in the season the production of summer spores ceases and the velvety covering gradually disappears. The surface of the wart gradually becomes hardened and altered in color to a dark brown and finally to a dead black.

Pimples may be seen late in the fall covering the wart. In these are developed the winter spores called ascospores. These ascospores only develop during the winter and are capable of germination in February and March.

Aetiology.

The disease is due to the fungus *Plowrightia morbosa.*

Treatment.

The diseased twigs should be removed after leaf-fall or before the winter spores are formed. Twigs that show in the spring or early summer the beginning of a "knot" should be removed and burned to prevent the formation of the summer spores. If such knots are simply cut off and allowed to remain on the ground the summer spores may ripen and then be scattered to other trees.

Co-operation of entire neighborhoods must be secured to render the campaign against the black knot effective. Legislation has been resorted to in several States, but a healthy and intelligent public opinion is necessary in this as in many cases.

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GUMMOSIS.

Among the stone fruits such as cherry, peach and plum a "gum-flow" or gummosis is frequent and may become a serious menace to the life of the trees affected. This disintegration of the tissues of the affected plant may be brought about by a variety of causes. Hence gummosis is a generic term applied to the condition here described whatever be the cause. Massee has described a gummosis of the common flowering almond (*Prunus japonica*) due to the action of a parasitic fungus, and this seems to be the only case of gummosis so far demonstrated to be due to a parasitic fungus.

Excessive gum flow frequently leads to the formation of a canker. (See plum canker, page —.) Reports of outbreaks of gummosis in any of the trees mentioned will be gladly received.

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LEAF SPOT.

History and District.

This disease occurs widely distributed on the leaves of cherry, plum and apricot and is frequently referred to as leaf blight.

Symptoms.

Minute spots at first appear soon after the first leaves are full grown and these are often only 1-6 inch or less in diameter. On cherry and plum leaves the spots may have a reddish margin. The spots enlarge to 1-8 inch or more in diameter, (See Fig. 21 on Plate VIII,) becoming at the same time dark and with a pale center. Often the diseased spots fall out of the leaf causing a shot-hole effect and then called "shot hole" disease. (See Plate VIII.)

The tree may become defoliated through the action of this disease and in that case may be much weakened so that it is more apt to be injured during the following winter. The damage in this direction is much greater if the defoliation occurs, as it is apt to in the plum, when the tree is in fruit.

Aetiology.

This disease is caused by *Cylindrosporium padi.*

Treatment.

The leaf spot may be controlled by the proper spraying with Bordeaux mixture, but in the case of the cherry the application of the spray at the time the tree is in fruit, the best time to control the disease, may cause the fruit to be stained with the spraying mixture so as to reduce its market value. However, it is well to apply Bordeaux just before the blossoms open and again just after they fall to partially control the leaf spot and fruit rot.

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PEACH.

BROWN ROT.

History and Distribution.

It has been known as a serious enemy of the peach in the United States for over 20 years and in Europe for even longer. Whenever peaches, plums or cherries are grown in this country the brown rot is a most serious pest. During certain years the loss is made most noticeable by favorable weather conditions. Thus in 1900 the loss to the peach crop in Georgia was estimated to be 40 per cent. or from $500,000 to $700,000. Similar losses are reported from other places. In Kentucky it has been reported as a rather serious disease of apples, but with us it seems to be confined to the peach, plum and cherry. It has also been reported on the pear, quince and apricot in addition to the above.

Symptoms.

On the Flowers.

Under favorable climatic conditions the disease may attack the flowers before or after the petals have fallen. At first a slight discoloration will appear on some part of the flower and soon this spreads so as to give the whole flower a brown and withered appearance. In Alabama during 1897 an epidemic of this disease of the peach flower appeared that practically destroyed the peach crop for that season. Foggy, rainy and very warm weather were the conditions then prevailing that made possible the germination of an unusual number of the spores, derived, as usual, from the old diseased "mummy" fruits adhering to the trees. The spores formed on the diseased flowers were then sources of infection for any fruit that was later developed.

On the Twigs.

On the peach and plum, particularly the peach, the mycelium of the fungus may grow down into the twigs from the flowers or fruits that are infested. This condition of affairs is often referred to as the "twig-blight" of the peach. (See also canker of plum on page 131.) If only one or two peaches are found on a twig the twig is apt to become infected at only one point and thus be girdled by the fungus, resulting in the death of the uninfested terminal portion of the twig. If several infested fruits occur on the twig it may become infested throughout its entire length.

On the Fruit.

Small brown spots appear—these rapidly enlarge and whitish tufts of spore-bearing hyphae may appear. The peach may fall to the ground or simply shrivel up and remain attached to the tree. (See Plate III.)

In the case of the plum the fruit may be infected for some time before any external evidence appears. As the plum begins to ripen, however, the ash grey tufts of spore-bearing threads appear. This difficulty of distinguishing between infested and healthy plums leads in many cases to serious losses in shipping these fruits.

Peaches also often suffer en route to market from this rot—particularly if the refrigeration is not properly attended to.

Treatment.

The brown rot can be effectually controlled by two lines of treatment: (1) spraying with Bordeaux mixture as explained below and (2) removal and destruction of all affected fruit from both the tree and the ground.

The trees should be sprayed with the Bordeaux mixture as follows:

1. Just before the buds open.
2. Just after the blossoms fall.
3. Ten days to two weeks later.
4. Keep the fruit covered with the Bordeaux mixture until ripening begins and then employ either the ammoniacal copper carbonat or a solution of dibasic copper acetat made by dissolving six ounces of the salt in fifty gallons of water. These two mixtures will not injure the fruit.

Too much stress cannot be placed upon the absolute necessity of removing from the tree all the diseased fruits since these are sources of infection and their presence upon the tree may lead to most severe attacks of the twig disease produced by this same fungus. The fruits that are allowed to fall to the ground after rotting may serve as the home of the perfect stage of the fungus and act as sources of infection during the next spring. Mummy fruits (Fig. 8 on Plate III.) should not be allowed to remain on the tree.

Aetiology.

The brown rot is caused by the fungus now known as *Sclerotinia fructigena*—the conidial or imperfect form of the fungus, however, known as *Monilia fructigena,* being the direct cause of the disease. The perfect form of the fungus has been found on old fallen peaches in Maryland and Georgia. Its discovery emphasizes the necessity of removing and destroying all fallen and mummy fruits.

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CROWN GALL.

History and Distribution.

Crown gall is a contagious disease affecting a considerable number of the smaller and larger fruit trees and plants. The disease has been reported upon the following plants: peach, almond, apricot, prune, plum, pear, apple, English walnut, raspberry, blackberry, cherry, poplar and chestnut. It is, however, not at all certain that the galls on all the above plants, though very similar in general appearance, are caused by one and the same organism.

Symptoms.

The gall generally behaves as an annual growth—those that begin in the spring mature the same fall. But in this climate the galls that start in late summer or fall continue their growth through the winter season. It is strictly a nursery disease—seedlings 1 to 6 months old being most likely to become infected. The first gall in such cases generally appears on one side of the main root a few inches below the surface or near the "crown" of the seedling. On larger trees the galls genrally appear on the lateral roots though the crown is also commonly attacked in the case of large trees. (Plate V.)

The wart at first is a light colored clear or translucent mass of succulent tissue frequently attached to the plant by means of a slender stalk or neck. The galls grow very rapidly and the outer surface soon takes on a warty appearance and a reddish brown color. The parts of a gall that become dark colored have lost their power of growth—the discoloration being due perhaps to the action of various fungi attacking the gall. From the surface of such a discorored gall many new smaller outgrowths may appear.

Toward the end of the season the gall becomes badly decayed and may readily be broken away from the plant leaving an ugly deep wound. During the following spring a new lot of gall growth may take place around the margin of the old scar. And if the gall be removed new growth may begin even in the center of the wound thus formed. (Fig. 14 on Plate V.) This process may continue until the resulting wound is so deep that the tree falls of its own weight.

If a section of rapidly growing gall be examined there will frequently be found through it numerous darker colored irregular spots that are centers of more rapid growth. These centers frequently become beautifully twisted nodules of woody tissue—after the gall matures and begins to decay many of thes curious nodules may readily be removed from the outer portion of the gall.

Spread of the Disease.

The disease has been widely scattered over the country by shipments of stock from infested nurseries.

Locally it is known that a single diseased tree may in a few years suffice to infect most of the trees in the orchard. The spores of the parasite are small and may be carried by the air and it is likely that the disease may be communicated from old decayed galls.

The careless wounding of the crown of a tree or the break in the bark produced by escaping "suckers" both make a pathway for the parasite to gain entrance into the tree.

Care should in all cases be taken to see that all removed galls and uprooted diseased trees be burned on the spot and not hauled through the orchard at all.

Aetiology.

Toumey in Arizona gave special attention to the crown gall on the almond and described as the cause of this disease a new species of slime mould which he called *Dendrophagus globosus.* As has been said it has never been demonstrated that this organism is the cause of the widely distributed crown gall on the various plants that were mentioned above. Toumey was able to communicate the almond disease to the peach and apricot, but failed to do so to the apple. Selby believes that the gall may be communicated from the raspberry to the peach, but Halsted came to the opposite conclusion. Much work remains to be done on this very important disease.

Treatment.

The best advice that can be given fruit growers relative to the crown gall is this—never plant trees from a nursery known to be infested with the disease and never plant trees showing the disease. If a diseased tree is planted it is practically certain that the tree will never amount to anything. And what is even more important one is thereby very likely to introduce the disease into the soil of the orchard. If a bundle of nursery stock has a single crown gall on any of the trees the whole lot of trees should be destroyed.

It is possible that some good may be done by inspecting the orchards annually and removing all galls that have formed at the crown of the trees. After carefully cutting away the gall the wound surface should be covered with a paste made of lime and blue vitriol. But it must be remembered that, though the galls at the crown do the most damage, the smaller galls on the roots, which cannot be removed after planting, will reduce the vitality of the tree. It is therefore certaint hat no amount of after treatment of any sort will make a diseased tree give as large a yield as a healthy one.

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LEAF CURL.

History and Distribution.

The leaf curl of the peach is found practically wherever the peach is cultivated and is one of the most serious of all peach enemies. The total losses from curl in the whole United States have been estimated by Pierce to be as high as $3,000,000.00 in a single year.

Symptoms.

As soon as the young leaf buds begin to open the leaves show the characteristic roughened surface and deeper green color. This "curling" of the leaves progresses rapidly as the leaves grow (Fig. 9 on Plate IV). A part only or all of the leaf blade may become affected. A mature leaf, affected with curl, may have a reddish color, but generally the diseased leaves become simply discolored.

The fungus also grows inside the terminal portion of the young twigs and causes these to become swollen and to take on a lighter, paler color. These swollen terminal portions of the twigs constitute the only home of the perennial portion of the fungus. The spring infection seems to take place largely from spores formed from the mycelium present in these swollen twigs. The leaves soon become covered with a greyish mealy coating—composed of the fruiting bodies of the fungus. The spores are produced in small sacs arranged parallel to each other and at right angles to the surface of the leaf. These asci are produced on the ends of hyphae that grow out through the epidermis of the leaf. Defoliation occurs soon after spore-formation.

Gummosis of affected twigs is frequently to be seen as a result of the action of this fungus.

The tree attempts to make up for the loss of leaf surface by forcing some of its dormant buds to grow—these buds may grow to give a healthy twig—but at the base will be left the swollen fungus-infested portion—constituting a dangerous source of infection for another spring.

Relationship to the Weather.

The epidemic character of leaf curl has been frequently noticed and attempts made to connect the sporadic character of the disease with some climatic factor. No very definite statements can be made further than the suggestion that the phenomenon referred to can perhaps best be explained as due to the influence of certain climatic factors upon the spores either at the time (a) they are being scattered or (b) during germination and infection of the tree.

Treatment.

Leaf curl may be prevented by

(1.) Spraying with Bordeaux just previous to the opening of the buds in the spring.

(2). Spraying again with weaker Bordeaux as soon as the petals of flowers have fallen; this is to prevent late infection from the ground or neighboring trees.

(3.) Spraying again with weak Bordeaux when the first leaves are full grown or when the spores of the fungus are developing. This is to prevnt summer infection and cover places where spores may lodge to pass over the winter.

Where winter spraying against San Jose Scale with the lime-sulfur-salt wash is conducted this treatment may suffice of itself to hold the curl in check.

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ROSETTE.

History and Distribution.

The rosette is known from a few stations in the West, but is principally known from Georgia and a part of South Carolina. It is found in peaches and almonds and perhaps also in plums. It seems not to have attracted much attention in Georgia until about ten years ago, but is now known to be present in many counties in budded and seedling orchards and also in seedlings growing in out of the way places.

Symptoms.

The rosette is in some respects closely related to the yellows. It may attack only parts of the tree at first, but may appear suddenly in the spring attacking nearly the whole tree at once. In such cases all the leaf buds grow out into compact tufts of leaves or rosettes, whence the name. Fig. 10 on Plate IV shows some of these characteristic rosettes. If a tree is attacked all over it will die the following autumn, but if only one or more branches are first attacked then only the diseased branches will die after a period of about six months. The leaves in these rosettes are generally of a peculiar yellowish color. The lower leaves in the rosette are frequently much larger than the normal leaves and have inrolled margins and are stiffer than the usual leaves of the peach. These outer larger leaves turn yellow and fall early in the season while the inner leaves are still green. If a tree is attacked in all parts it bears no fruit, but otherwise the fruit born will generally be apt to shrivel up while still green and fall off or it may ripen naturally.

The disease may be spread through budding or root grafting as has been demonstrated by many experiments. However, it is known that mere contact of diseased with healthy tissue is not sufficient to introduce the disease, but there must be a real union of the two tissues.

Aetiology.

Like the yellows the exact cause of rosette is yet unknown.

Treatment.

All trees which show the rosette in the spring should be at once dug up and burned. If any of the diseased leaves have fallen these should be gathered also and burned as they may serve as sources of infection.

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YELLOWS.

History and Distribution.

This distinctly American disease is known to affect, in addition to the peach, the almond, nectarine, apricot and plum. It seems to be widely distributed in the United States.

Symptoms.

"Prematurely ripe, red-spotted fruits, and premature unfolding of the leaf buds into slender, pale shoots, or into branched, broom-like growths, are the most characteristic symptoms of yellows." The reddish spots in the fruit extend from the skin to the stone and their presence is one of the best tests for the disease.

During the first season that the disease is present in any given tree it may confine its attacks to one or a few only of the branches, but in later years other symptoms may appear and these are principally the premature opening of the winter buds. This is most plainly seen in the fall after the tree has lost all its leaves. The shoots may at this time be produced from these prematurely opened buds and are then very conspicuous. Very feeble shoots may also appear on the larger branches of the tree and these also are rather conspicuous on account of their broom like appearance. In the later stages of the disease or when the disease has been present in a tree for several years the yellowing of the leaves may become apparent and this condition has given rise to the common name, but this is not the most conspicuous symptom and has led many to confuse the disease with leaf curl and other diseases.

Aetiology.

The exact cause of the disease is not yet known, though it is generally looked upon as a so-called "physiological disease." As to its spread and its infectious nature we are certain. It may be present in a dormant condition in buds employed in the nursery for budding and the disease is often introduced into a new region in just this manner.

The disease is also known to be spread from living and dead trees affected with the disease to healthy trees in the same orchard.

Soil and climatic conditions certainly cannot be charged with the cause of a disease which possesses such an infectious or contagious nature and there is no good evidence to show that the disease is caused by bacteria or other vegetable organisms.

Treatment.

The only line of treatment that promises to control the disease is to dig and burn the roots and entire tree as soon as it shows certain symptoms of this disease. Spraying is of no value and special fertilization of the soil seems to be of no value in its control. "Pits" or seeds from diseased trees should never be employed in a nursery or elsewhere.

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PEAR.

BLIGHT.

History and Distribution.

Pear blight, called also twig blight, and fire blight, is a contagious bacterial disease of pear, apple, quince and other pomaceous fruit trees. It is of very wide distribution and may be found practically throughout the United States east of the Mississippi river. It has been ascribed to the most various causes, but the complete demonstration of its bacterial nature was made by Dr. Burrill, of Illinois, in 1879.

SYMPTOMS.

This disease attacks the flowers, young fruits and the young twigs and shoots, frequently working its way down through the bark to the larger limbs or even to the trunk itself. The disease has its most prominent symptom in the blackish discoloration of the leaves on the attacked twigs, but the bacteria do not as a rule find their way into the leaves except into the petiole and the larger veins. This discoloration of the leaves occurs in a week or more after the death of the branch on which they are found. (See Fig. 15 on Plate VI.)

There is much variation in the manner the attacked plant behaves or rather in the way the disease works. In some cases the affected twig is simply girdled and in that case the damage is not so great as when the whole twig or branch is killed. The very sudden death and rapid discoloration of the leaves has led many to suppose that the disease spreads in the tree more rapidly than it actually does. As a matter of fact the disease does not spread more than 2 to 10 inches per day in the twigs.

In the spring the blight first makes its appearance in the blossoms causing there the so-called "blossom blight." The most rapid distribution of the disease in the orchard takes place while the tree is in bloom. It is now known that the principle agency in this work is the various bees that visit these flowers for the nectar there found. In this nectar the bacteria causing the blight find a most suitable situation for rapid development. Bees going from flowers whose nectar contain even a few of these bacteria to healthy flowers on the same or other trees are very apt to carry some of the germs and thus rapidly spread the infection.

The disease also gains entrance to the plant through the tips of young shoots or twigs. This form of blight is often referred to as twig blight. In the case of nursery stock not in flower the disease is more often carried about in this manner.

Aetiology.

Pear blight is now known to be due to *Bacillus amylovorus,* one of the bacteria. This discovery was made in 1879 by Dr. T. J. Burrill. By means of the usual inoculation experiments this has been demonstrated beyond a shadow of doubt. There can never be any blight in the absence of this species of bacteria, no matter how very favorable soil and climatic conditions may be.

It was once supposed that the germ might live over winter in the ground, but that is now known to be false. As a rule the blight ceases at the close of the growing season, but in some cases, particularly where new infection has taken place late in the season, the germs may live over winter in the twigs and slowly push out into the healthy bark during the winter. The blighted twigs hold their moisture longer than healthy twigs and this is naturally very favorable to the germ and besides it is known that the germ may be exposed to a freezing temperature without injury.

In the spring the rapid accumulation of sap in the twigs sets up a flow of gum from the twigs in many cases and if the germs are alive in any of the twigs they are naturally carried out by this gum flow. Bees and other insects are attracted to this gum and by this means the germs are carried to flowers at which point they rapidly multiply in the nectar and enter the twig.

Influence of Environment Upon the Disease.

The pear blight makes best headway during warm moist weather and is more or less retarded by cold, dry and sunny weather. The germ is very sensitive to dryness and in the old, dead and dry twigs the germs will all be found to be dead.

Treatment.

Disease resistant sorts—

Such sorts as the Keiffer and Duchess resist the blight more than the Bartlett and some others and in general the apple is much less injured by the disease than are the pear and quince. There seems to be no need of attempting to breed special resistant sorts when we consider the positive remedial measures mention below.

Cultivation and soil fertility—

In general we may state that a well cultivated, highly fertilized and rapidly growing tree is most apt to be attacked by the blight. The use of too much barnyard manure is particularly dangerous if the soil is already rich in nitrogenous matter. In some cases it may be well to avoid too excessive cultivation. In general any measure that will tend to check the too rapid growth of the tree will tend at the same time to protect the tree against the blight. Heavy pruning in the winter time, since it promotes rapid formation of much new wood in the spring, may also be avoided at times with good results.

Treatment—

The absolute destruction of every blight germ should be aimed at and may be secured by the pruning away and destruction of each and every blighted twig as soon as detected. These may be removed during the growing season, but it is best to do this very thoroughly at the close of the growing season, but before the leaves have fallen. The blighted leaves will then serve as a guide. Most careful inspection of the trees must be made during the winter and again early in the spring before new growth starts to make sure that no cases of living blight are allowed to remain in the orchard. This is important since these cases of blight that are allowed to live over winter are the only starting points for new infection in the following spring.

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LEAF BLIGHT.

History and Distribution.

This disease has long been known to horticulturists as the "leaf blight" or "scald" of pear and as the "cracking" of the fruit. It occurs practically wherever the pear is cultivated. It was mentioned in this country early in the sixties.

Symptoms.

The prominent symptoms are the premature discoloration of the leaves and their falling off together with the frequent cracking of the fruit. This leaf fall may be sudden or more gradual, extending in the latter case throughout the growing season. Often the leaf fall is accompanied with a second blossoming—both together making a rather severe drain upon the food supplies of the tree.

Small reddish spots are first seen upon the leaves; these spots as they increase in size take upon themselves a more definite circular shape. At maturity the spots are provided with a white to reddish brown center and a darker raised border. The spots may unite with each other and thus the whole leaf may become affected. The spots may come to be seated upon a reddish brown discolored leaf or the leaf may turn yellow. In any case the leaves fall from the tree.

In many cases there is also a so-called "cracking of the pear" produced by the same fungus. Small reddish spots appear upon the fruit and these spots may rapidly increase in number and finally coalesce with one another to give the fruit a very much blotched appearance that will greatly reduce its market value. At the same time the growth of the spots may be accompanied by a cracking of the fruit and of course this cracking may make an entrance for the spores of the rot fungi that may cause much damage. The same fungus often attacks the young twig of the pear. The spots upon the green bark of these twigs are somewhat elongated, sunken and of a black color.

In each of the spots referred to above on either the leaves, fruits or twigs one may see one or more blackish spots just beneath the surface. These spots are the spore producing bodies of the fungus.

The petioles and leaf scales are also frequently attacked.

Aetiology.

This disease is produced by the fungus *Entomosporium maculatum*.

Treatment.

Fallen leaves should be gathered together and burned.

The disease may be controlled by spraying with Bordeaux mixture, as follows:

(1.) When leaves are half grown.

(2.) Three subsequent sprayings at intefvals of two weeks.

The sprayings after the second should be made with ammoniacal copper carbonat to avoid the "russetting" injury to the fruit often produced by the Bordeaux mixture.

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SCAB.

History and Distribution.

The scab of pear is, like the similar disease of apple, very widespread and well known. It is known from practically every region where pears are grown.

Symptoms.

The symptoms are practically the same as for the apple scab. (See page 97.)

Aetiology.

This disease is due to the fungus called *Fusicladium pirinum.*

Treatment.

The diseased leaves should be plowed under or else gathered together and burned during the fall.

Two sprayings with Bordeaux mixture of the 1-10 formula should be made while the pear leaves are opening. Considerable good in controlling pear scab will result from a spraying with the lime-sulphur-salt mixture as late in the winter as possible.

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PLUM

CANKER.

History and Distribution.

This disease is one of the most serious plum diseases we have to contend with in this State. Its distribution is somewhat uncertain.

Symptoms.

The real canker may be preceded by a gummosis. (See Gummosis under Cherry on page 106.) And this gummosis may be due to one of several causes. But when through gummosis or any other cause wounds of plum trees remain for a long time unhealed a canker may form on the twig.

It is probable that aside from wounding the most frequent source of the trouble is to be found in the attacks of the brown rot fungus. (*Sclerotinia fructigena.*) This fungus, as has been explained, works in the tissues of the twigs, particularly the fruiting spures, and finally may kill such parts. Then gummosis sets in to be followed soon by the canker. The canker may also follow severe attacks of plum pockets.

The Japan plums, being very subject to brown rot, and having soft coarse grained wood, are very apt to succumb to this canker.

Treatment.

The only treatment to be recommended consists in a thorough spraying to prevent the brown rot and plum pockets; and then the removal and burning of the cankered limbs.

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PLUM POCKETS.

History and Distribution.

This disease on account of its very characteristic and striking symptoms has long been known to horticulturists and others. It is very widely distributed throughout the United States and has frequently been forwarded to me from various parts of this State.

Symptoms.

The vegetative portion or mycelium lives over winter in the younger twigs and grows out into the developing ovaries in the spring. All or most all of the parts of the ovary are affected and the action of the fungus is to greatly stimulate the tissues of the ovary so that a very rapid growth takes place. The result is a much swollen, somewhat irregular and spongy body of light yellowish or white color (Fig. 17 on Plate VII.) No stone is developed in this "plum-pocket" but the center is hollow or frequently traversed by loose threads of torn tissue.

The leaf buds and young twigs may also become modified by the action of this fungus to form very irregular spongy swollen objects. In this case the resulting hypertrophy varies with the stage at which the fungus begins its work. If the leaves are not far developed when attacked their normal form may never be attained, but the hypertrophy may affect only a portion of the leaf if its attack is made upon the leaf when partly grown.

Aetiology.

This disease is produced by the fungus *Exoascus pruni*—a species somewhat closely related to the one causing the leaf curl of the peach.

Treatment.

No special spraying treatment can be recommended, though the use of Bordeaux mixture would no doubt reduce the chance of infection. Diseased fruits, buds, leaves and twigs should be removed and burned.

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FUNGICIDES.

Spraying is now looked upon by progressive and successful fruit growers as a necessary operation to be per-formed if a full crop of fruit of a good quality is desired. In the case of a large and increasing number of diseases spraying has been demonstrated on a large scale to be of immense value. The financial gain from intelligent spraying depends solely upon the number of trees and the diseases prevalent in your orchards.

Spraying is plant insurance and, like life insurance, should be attended to before the disease has gained a foothold in the orchard. All trees should be sprayed every year whether the diseases usually present make their appearance or not.

A large number of formulas have been proposed by various investigators for special purposes. We give below directions in some detail for the preparation of the fungicides now most widely employed in connection with diseases mentioned in this Bulletin.

Bordeaux Mixture.

Bordeaux mixture consists of two essential ingredients, freshly slaked lime and copper sulfat, dissolved in water. The fungicidal action is entirely dependent upon the copper sulfat. The lime is added for the following reasons:

(1.) To prevent injury to the foliage.

(2.) To render the mixture more adhesive.

(3.) To render the mixture more readily seen after being applied.

Standard Formula for "1-10" Bordeaux.

We give here the formula of the common "1-10" Bordeaux mixture—so-called because it contains 1 pound of copper sulfat to 10 gallons of water:

Copper sulfat—5 pounds.

Quick lime (not slaked)—3 1-2 to 5 pounds.

Water—50 gallons.

A. Dissolve the 5 pounds of copper sulfat in hot or cold water in a wooden vessel. Dilute the solution thus secured to 25 gallons.

B. Slake the lime carefully and thoroughly. Dilute this milk of lime to 25 gallons.

C. Pour the two solutions thus obtained through strainers, at the same time, into the spray barrel. The mixture in the spray barrel should be stirred while the two solutions are being poured together.

D. Never attempt to mix the two solutions until they have been diluted as suggested above.

Special Directions.

A. The copper sulfat may best be dissolved in cold water by suspending it in a coarse sack near the top of the water.

B. In slaking the lime add at first a small amount of water, preferably hot water, and then, as slaking begins, continue to add small amounts of cold water as needed. Never add much water at a time and never allow the lime to become dry.

C. For the more tender foliage of peaches and plums employ the "1-25" Bordeaux mixture, i. e., one containing 2 pounds of copper sulfat to 50 gallons of water.

D. In all cases use at least 2 pounds of lime to 3 pounds of copper sulfat.

E. A small amount of yellow prussiate of potash or potassium ferrocyanid dissolved in about ten times its bulk of water is often used as the so-called "ferrocyanid" test to determine whether or no the Bordeaux is properly made. A few drops of this solution are added to the Bordeaux. If a brown discoloration at once appears not enough lime has been used. Continue to add lime solution and stir until no discoloration appears upon adding a few drops of the ferrocyanid solution.

F. *The most important precaution is to unite the cold dilute solutions of lime and copper sulfat quickly and then to stir the mixture thoroughly.* (See Fig. 22 on Plate IX.)

Ammoniacal Solution of Copper Carbonat.

This mixture, designed for use when the Bordeaux might by adhering to the fruit injure its market value, is made according to the following formula:

Copper Carbonat—6 ounces.
Ammonia—3 pints.
Water—50 gallons.

The copper carbonat is to be dissolved in the ammonia, just as much ammonia being used as is required to dissolve the copper carbonat. This solution is then thoroughly stirred into the water.

Lime-Sulfur-Salt Wash.

This wash, long used along the Pacific coast to control the San Jose Scale, has recently sprung into favor for the same purpose in the East. We mention it here since its use seems to reduce various plant diseases, particularly apple scab and peach leaf curl. It is in a sense therefore both an insesticide and a fungicide. We give but one of the several formulas suggested:

Stone or lump lime—15 lbs.
"Flowers of sulfur"—15 lbs.
Salt—15 lbs.
Water—50 gallons.

"Place the lime in a kettle, or in a vat if steam is used, and slake it with hot water so that it forms an even white paste. Now add enough water to reduce the lime paste to a thin whitewash. The sulphur and salt are then added and should be thoroughly stirred in. If the mixture is not already boiling, bring it to this point and allow it to boil for one hour."

Stir the mixture frequently and at the end of the hour dilute the resulting mixture with hot water to make the required amount. Apply the wash, while hot, with any good nozzle to the trees.

This mixture is very caustic and must be applied to none but dormant trees and should not be allowed to come into contact with the hands or face.

SPRAYING MACHINERY.

The type of spraying outfit to be employed and its size depends upon the size of the orchard in which it is to be employed. We can only briefly consider the matter here and refer to the two essential parts of any spray outfit: (1) the nozzle and (2) the pump and its accessory parts.

No nozzle of the multitude of forms upon the market is superior to those constructed on the principle of the Vermorel nozzle. These nozzles will give fairly good results even when the pump gives a very low pressure, though best results are secured with pressures of 100 pounds or higher. The "mistry" nozzle (Fig. 24 on Plate IX) made by the Goulds Mfg. Co., is of the Vermorel type and throws a finer spray with low pressures than do the Vermorel nozzles.

A good spray pump should have all working parts exposed to the spraying mixtures made of brass or some sort of bronze. And in addition neither rubber nor leather valves should be used. Assuming these two characteristics to be present the spray outfit is to be selected to fit the local conditions, particularly the number of trees to be sprayed. Fig. 23 on Plate IX, shows a well known type of pump to be attached to a barrel.

For further information on the subject of spraying outfits, consult the references in the Bibliography following and the catalogues to be secured from the following firms,—well known as makers of spray outfits:

Deming Co., Salem, Ohio.

Field Force Pump Co., Elmira, N. Y.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. Bitter rot of apples showing both isolated and confluent diseased areas and the concentric circles formed by the fruiting bodies of the fungus causing the disease. (From Bull. 44, Bureau of Plant Industry, U. S. Dept. Agr.)

Fig. 2. Limb cankers produced by the fungus causing the bitter rot. (From Bull. 44, Bureau of Plant Industry, U. S. Dept. Agr.)

Plate II.

Fig. 3. Twig of the red cedar showing one of the galls called "cedar-apples." This gall is produced by one stage of the same fungus that causes the rust of apple leaves. (Original.)

Fig. 4. The lower surface of an apple leaf showing the peculiar elongated horn-like fruiting bodies of the fungus causing the apple leaf rust. (From Rept. U. S. Dept. Agr. for 1888.)

Fig. 5. Fly speck and sooty blotch of the apple. (From Bull. 79, Ohio Exp. Stat.)

Fig. 6. The upper pile of apples is from the sprayed tree, the lower pile from the unsprayed tree—both together show the advantage in spraying against the apple black rot. (From Bull. 59, Ky. Exp. Stat.)

PLATE III.

Fig. 7. Brown rot of peaches. (From Bull. 50, Ga. Exp. Stat.)

Fig. 8. "Mummy" peaches, killed by the brown rot diseases, adhering to the tree and thus constituting a very fruitful source of new infection. (From Bull. 50, Ga. Exp. Stat.)

PLATE IV.

Fig. 9. Leaf curl of peach. (From Bull. 20, Div. Veg. Phys. & Path. U. S. Dept. Agr.)

Fig. 10. Rosette of peach. (From Journ. Mycol. Vol. 6.)

PLATE V.

Fig. 11. Longitudinal section of a root affected with crown gall. (From Bull. 33, Arizona Exp. Stat.)

Fig. 12. Crown gall; the upper left hand figure shows gall on Lombardy poplar, the upper right hand figure on pear and the two lower figures on peach. (From Journ. Mycol. Vol. 7.)

Fig. 13. Crown gall on apple; this gall appeared at the point where the graft was inserted shown at "A" in the figure. (From Bull. 93, Ky. Exp. Stat.)

Fig. 14. Crown gall showing the growth of new gall tissue after the removal of the old gall. (From Bull. 33, Arizona Exp. Stat.)

PLATE VI.

Fig. 15. Pear blight. (Original.)

Fig. 16. Hairy root of peach. (From Rept. Geneva N. Y. Exp. Stat. for 1900.)

PLATE VII.

Fig. 17. Plum pockets. (From Rept. U. S. Dept. Agr. 1888.)

Fig. 18. Black knot on plum. (From Prof. Farlow's paper in Bull. Bussey Institution, 1876.)

Fig. 19. Apple canker. (From Bull. 163, N. Y. Geneva Exp. Stat.)

PLATE VIII.

Fig. 20. "Shot-hole" affect produced on Japan plum leaves by improper spraying. (From Bull. 164, N. Y. Cornell Exp. Stat.)

Fig. 21. Cherry leaf-spot disease. (From Report N. Y. Geneva Exp. Stat., 1896.)

PLATE IX.

Fig. 22. Jars showing, after one hour's standing, the amount of settling of the precipitate in Bordeaux mixture made in the following ways. The lower light colored part in each figure is the precipitate:

A. Dilute lime poured into dilute sulfat slowly.
B. Dilute sulfat poured into dilute lime slowly.
C. Made as in E, but using hot lime milk.
D. Made as in E, but less thoroughly stirred.
E. Properly made from dilute solutions, quickly united and thoroughly stirred.
F. Made as in E, but with concentrated solutions.
G. Properly made mixture, one day old.
H. Old Bordeaux mixture, two weeks old.
I. "Bordeaux Powder" mixed with water.

Fig. 23. One example of the barrel-type of spraying apparatus. (From Bull. 243, N. Y. Geneva Exp. Stat.)

Fig. 24. "Mistry" spray nozzle. (Cut loaned by the Goulds Mfg. Co., Seneca Falls, N. Y.)

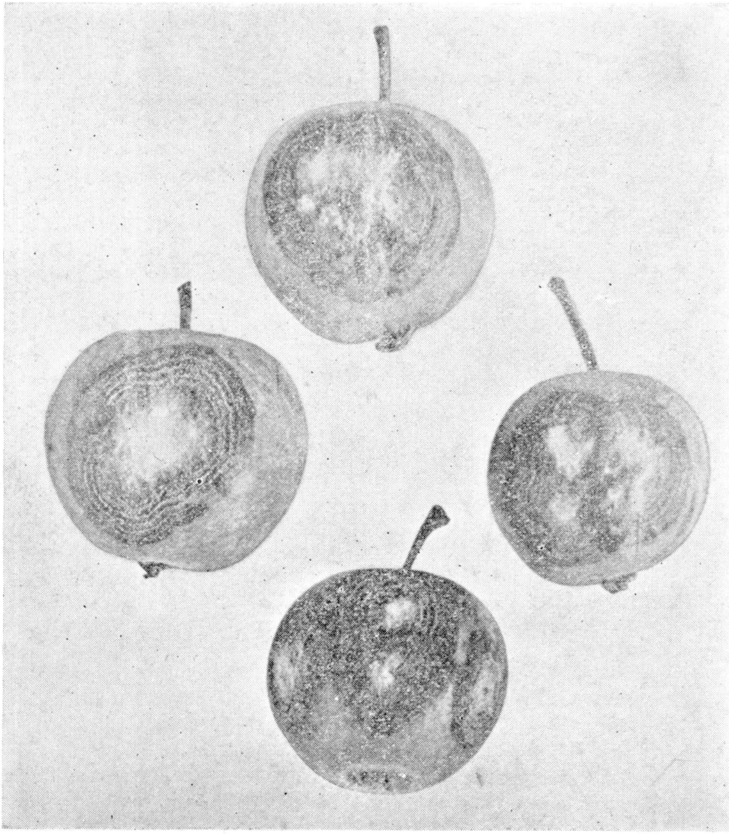


Fig. 1.

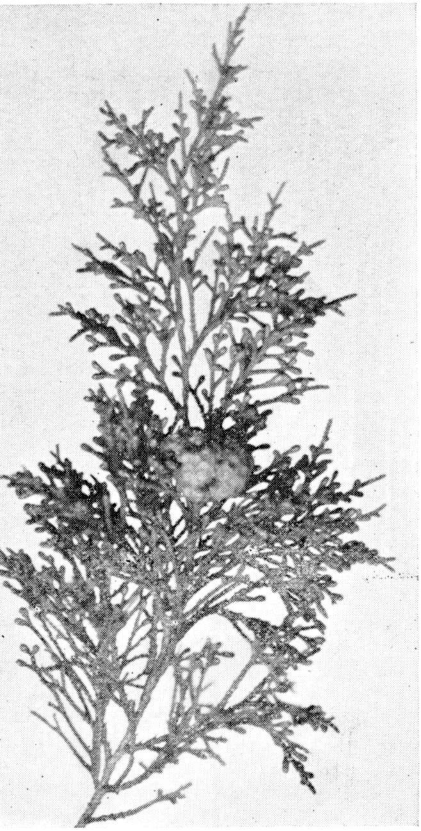


Fig 3.

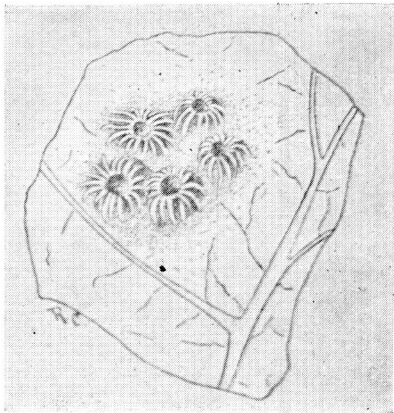


Fig. 4.

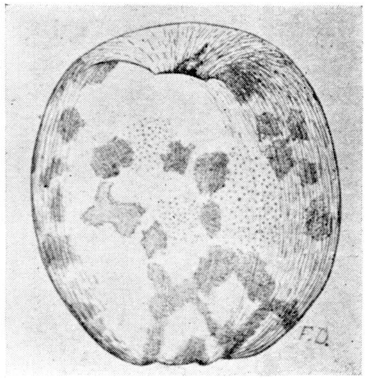


Fig 5.

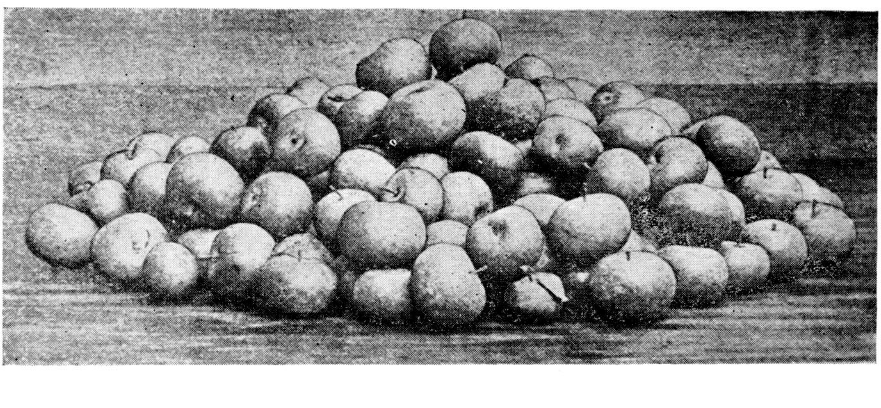


Fig. 7.

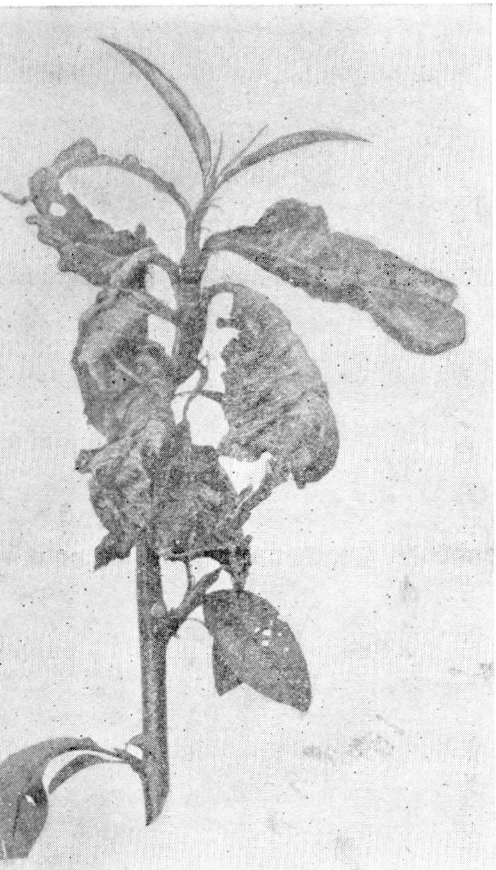
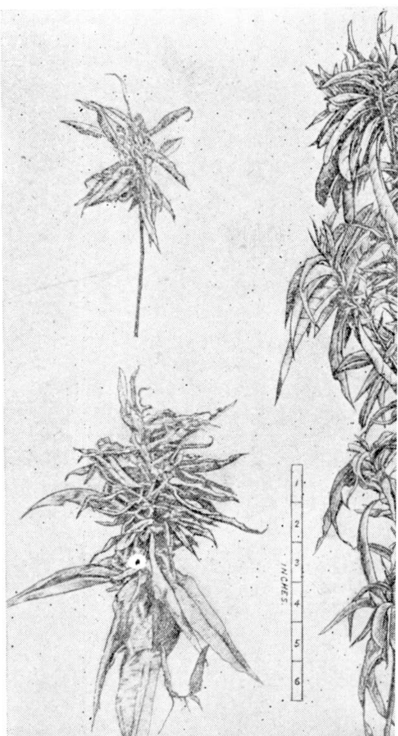


Fig. 9.



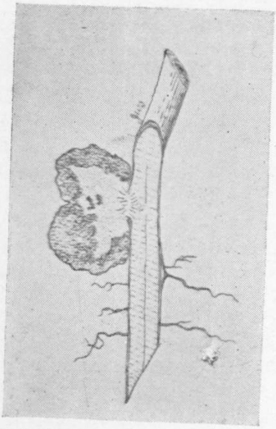


Fig 11.

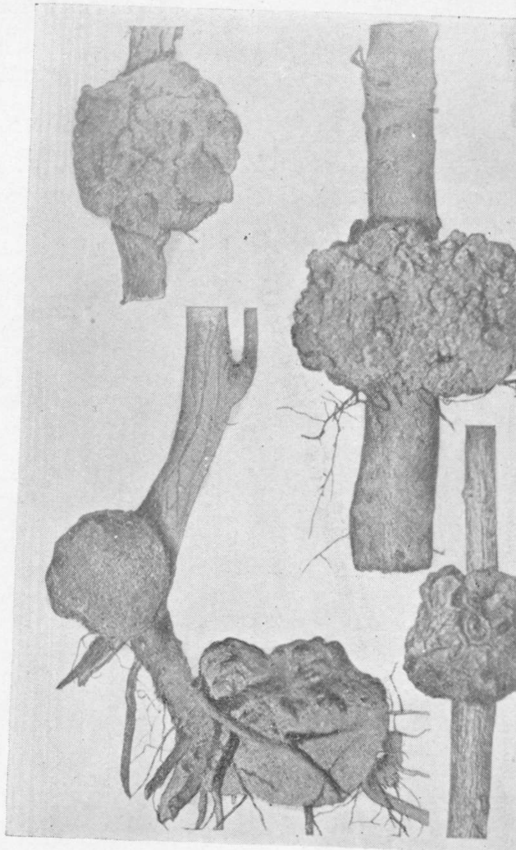
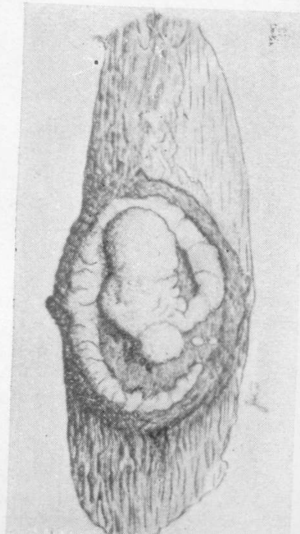


Fig 12.



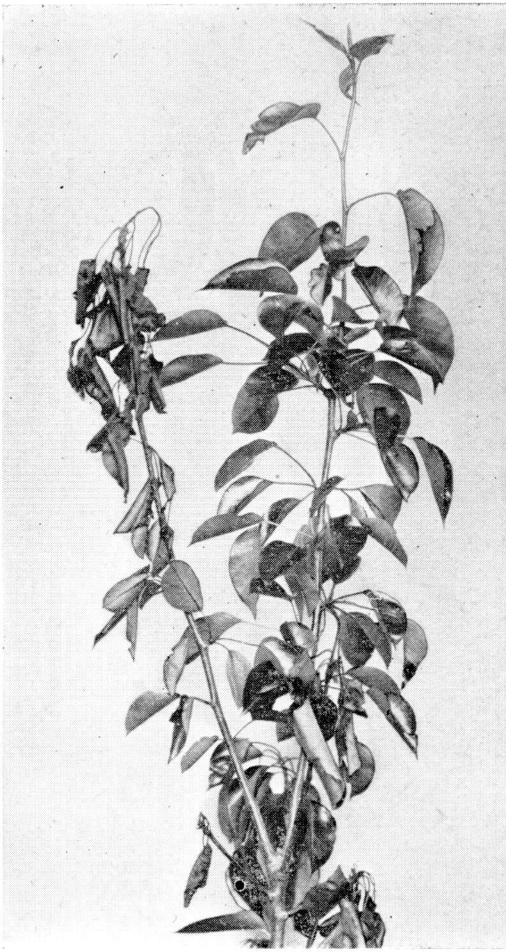


Fig. 15.

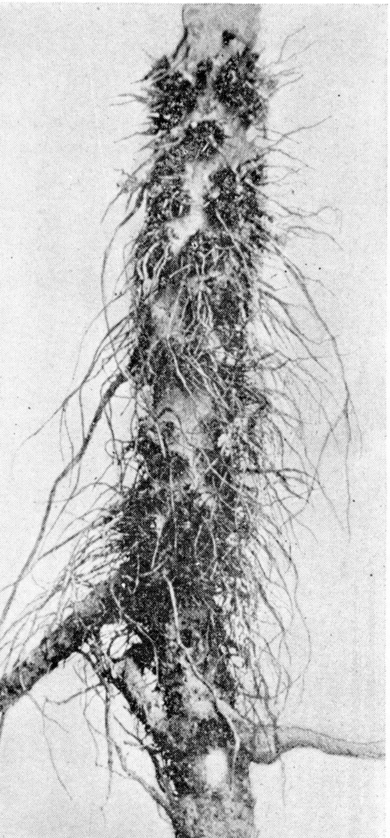


Fig. 17.

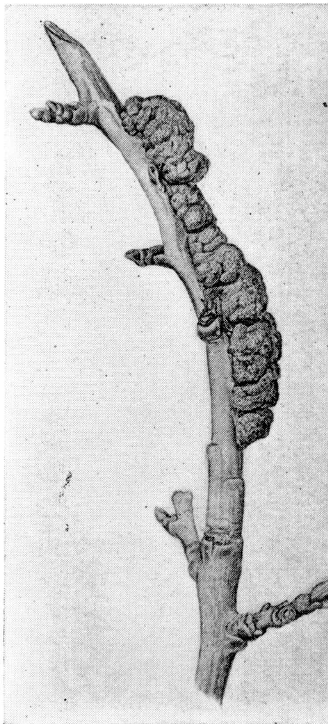


Fig. 18.

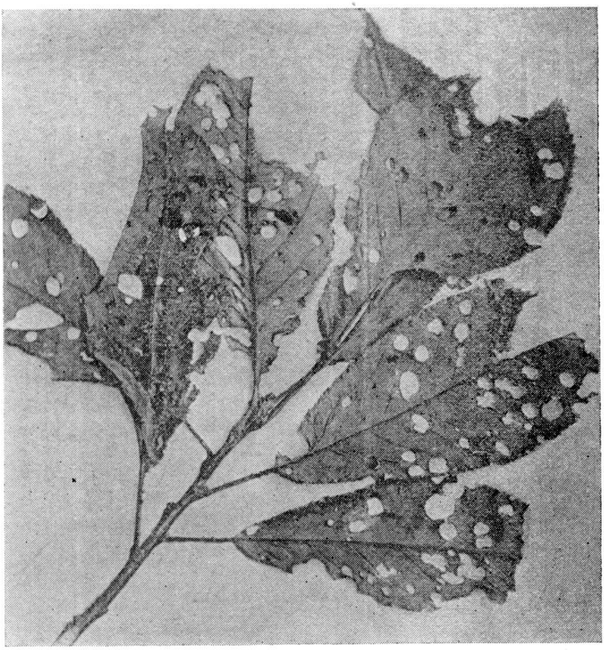
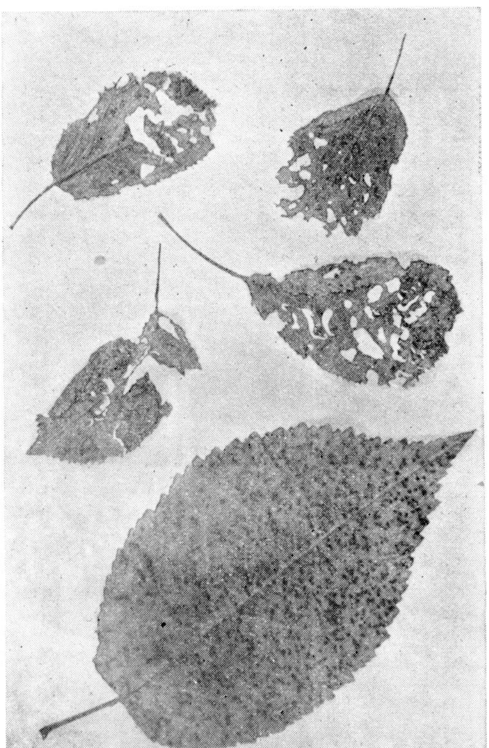


Fig. 20.



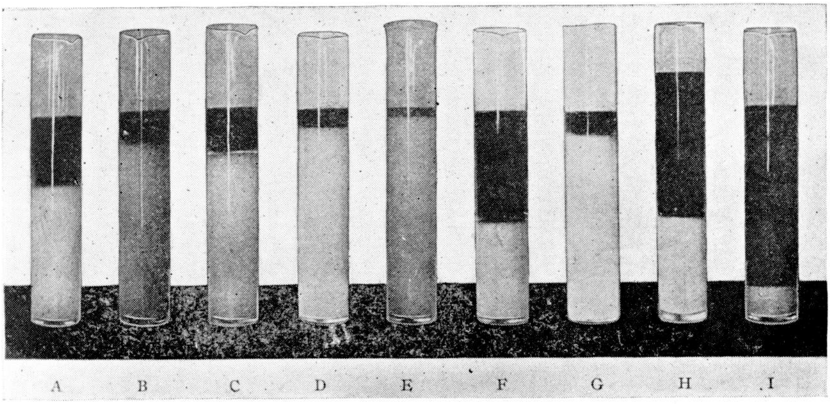


Fig. 22.

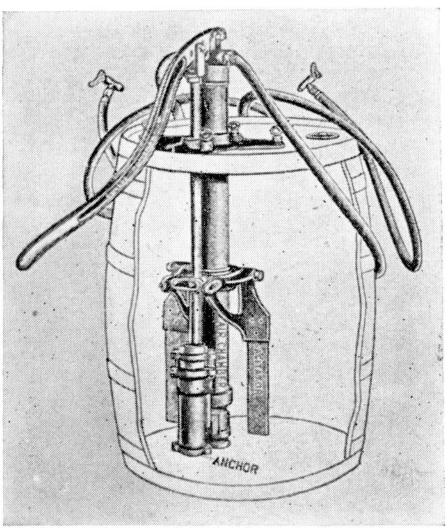


Fig. 23.

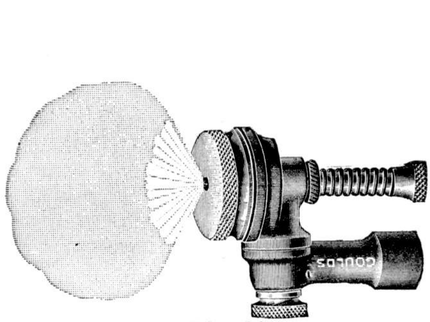


Fig. 24.

BULLETIN NO. 133. DECEMBER, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

The Manufacture of Cane Syrup.

BY

B. B. ROSS

Chemist.

Opelika, Ala.:
The Post Publishing Company.
1905.

THE MANUFACTURE OF CANE SYRUP.

By B. B. Ross.

The Chemical Department of the Experiment Station has, within the past few years, issued two bulletins of the regular series, and at least one press bulletin, upon the subject of syrup making, but owing to the extent to which this industry has progressed in this State and on account of the numerous inquiries which have reached this office with regard to methods of clarification and of manufacture of syrups, it is deemed advisable to issue the present bulletin, which is designed to furnish fuller and more detailed information upon his subject than has been supplied by previous publications of this department.

The official reports of the twelfth census of the United States revealed the fact that sugar cane was grown and cane syrup manufactured in forty-four out of the sixty-six counties of the State and while these statistics indicate a wider distribution of this crop throughout the State than has been generally supposed, the area of profitable and satisfactory cultivation of sugar cane would have to be restricted to a considerably smaller number of counties, although it can be produced with greater or less success throughout the whole of Southern and Middle Alabama. In many of these counties patches of no larger area than from one-half to one acre are to be found in cultivation, while in the Southernmost tier of counties of the state some tracts of from ten to fifty acres are being devoted to cane growing for syrup production.

As regards the date of the introduction of sugar cane culture in Alabama, no definite or authentic information can be secured and there is even some difference of opinion as to how and where this important saccharine plant reached this continent. Dr. Stubbs, formerly Director of the Louisiana Sugar Experiment Station, who has investigated quite carefully and critically the history of the sugar cane, is inclined to the opinion that Cochin China or Bengal was its original habitat, the cane plant being introduced successively into Arabia, Nubia, Ethiopia and Egypt, while, after the crusades, it found its way to Syria, Cyprus and Sicily. Some four centuries ago it was introduced into Madeira and the Canary Islands, and, until the beginning of the Nineteenth century, practically the whole of the sugar consumption of Europe was obtained from these islands.

Soon after the discovery of San Domingo, sugar cane culture was inaugurated in that island, and later, sugar cane was carried from there to South and Central America, to Mexico, to other islands of the West Indies, and finally in 1751 to Louisiana. Although attempts were made at that early period to grow cane and produce sugar in the vicinity of New Orleans, it appears that the first efforts were entirely unsuccessful, and it was not until about 1794 that Etienne de Bore, operating at a plantation and sugar house almost on the site of Audubon Park in that city, succeeded in demonstrating the practicability of the production of cane sugar upon a commercial scale. This was virtually the beginning of the cane sugar industry in Lousiana, and the successful termination of the experiments of de Bore marked an important epoch in the development of the industrial and agricultural activity of that rich commonwealth.

Soon after the introduction of the sugar cane plant into Louisiana, it is claimed that cane culture was commenced upon a small scale on the East Florida coast and later along the Georgia coast south of Savannah, sugar-making upon a not inconsiderable scale for that period being carried on in the latter state during the early part of the last century. As to whether sugar cane was brought from Louisiana to this state or carried west to Alabama from the Georgia coast, is a question whose solution I have been unable to accomplish, and it is even possible that it might have been introduced direct from some of the West Indian islands.

Suffice it to say, sugar cane culture has been carried on in Southern and Middle Alabama upon a small scale at least almost from the date of the admission of the state into the Union, and while this cane has been grown chiefly for use in the production of syrup, nevertheless, in years gone by, crude and low grade sugar was produced in small quantities upon many plantations by processes still more crude.

As is well known to those residing in Middle and Southern Alabama, nearly all of the villages and towns of those sections of the state are supplied with home made cane syrup during the fall and winter months, and there has been a steady increase in the production of domestic syrup for a number of years past, although during the remainder of the year the local product does not meet the requirements of the local consumption.

The cane syrup production of this State in the last census year, according to the figures given in the twelfth census reports, was much larger than many of our own people would imagine, aggregating a total of 2,672,438 gallons of syrup upon 32,871 acres, although no allowance was made for the acreage of cane reserved for planting. The value assigned this product was $1,003,922, and though no information is given with regard to the marketing of this syrup there is no little doubt but that domestic consumption absorbed practically the whole output at that time.

The writer has called attention in a number of papers to the fact that at certain seasons of the year even in our local markets, it is well nigh impossible to secure pure cane syrups and the demand is largely supplied by syrup from outside markets.

These imported syrups are often adulterated with corn glucose, or else are the product of reboiling syrups and molasses which have undergone partial fermentation, while in still other cases it has been found that the syrups consist in part of low grade or dark colored molasses or syrups which have been bleached or brightened by treatment with such chemical agents as bi-sulphite of soda and pulverized zinc.

It is gratifying to note, however, that within the past two or three years there has been a marked increase in the production and consumption of the domestic article in this State, and already some little attention is being given to securing outside markets for a portion of the yearly output of cane syrup. There has also been a noteworthy increase in the number of syrup producers, and some of these newest accessions to the ranks of producers are among the most progressive in the employment of rational and improved methods of cultivation and fertilization, as well as in the utilization of advanced and intelligent methods of manufacture.

In some of the border counties of South Alabama where a few years since cane patches of only from one to five acres were to be found, there can now be seen tracts of from twenty-five to fifty acres in cane, some of which vies in luxuriance and rankness of growth with the cane grown on the rich alluvial lands of Louisiana, while the sugar content is as a rule well in excess of that of the average Louisiana product.

In a previous bulletin the writer stated that as a result of observations and investigations made by him during a residence of several years in the sugar regions of Louisiana the conclusion was reached that the lighter and more easily drained uplands in the lower Mississippi valley yielded from season to season a cane much richer in sugar and total solid matters than the rich alluvial lands of the valley, although a much heavier tonnage was produced on the latter.

The results of experiments and investigations extending throughout a still longer period in this state have shown that the cane grown on the light loamy and sandy lands in the Southern part of this state exhibits a like superiority over the product of the heavy bottom lands of Louisiana, while a good tonnage can be readily secured where a judicious system of fertilization is resorted to.

Much of the South Alabama cane will show a cane sugar content of 15 per cent. and upwards, while samples containing more than 18 per cent. sucrose have been analyzed in the laboratory at Auburn. The co-efficient of purity of the juices is also almost uniformly high, and with a high content of total solids the yield of syrup per ton of cane is correspondingly large.

The following analysis of three samples of cane selected at random while on a visit to Baldwin county may serve to illustrate the excellence of much of the cane grown in that section of the State.

	Sample No. 1	Sample No. 2	Sample No. 3
Total solids	19.3	19.2	19.0
Sucrose	17.0	15.1	16.9
Reducing sugars	1.31	1.92	1.15
Solids not sugars	.99	2.18	.95
Co-efficient of purity	88.1	78.7	88.9

When the fact is noted that much of the Louisiana cane does not show a total solid content in the juice of more than 14 per cent. and a cane sugar content frequently not exceeding 12 per cent., the good quality of such canes as the above is rendered more apparent, and as the syrup producing capacity of a cane is practically in direct proportion to the amount of total solids in the juice, the superiority of these canes for syrup making is at once evident.

Notwithstanding the fact that cane of such high sugar content can be produced upon many of the soils of Middle and Southern Alabama, it must be admitted that prior to the last three or four years the syrup industry had made but little progress from year to year and the production of this commodity commercially had not attained very large proportions.

Among the causes and conditions that have so far contributed to the slow progress and growth of the syrup industry may be mentioned; the employment of crude and unprogressive methods in the manufacture of the syrup from the cane; the production of syrup of poor keeping quality and lacking in uniformity of composition, character and flavor, and, finally, the failure to build up a market for the product, by reason of the uncertainty of its quality and of its variable composition.

In most cases throughout the cane growing region of Alabama, small bottoms are selected for the growing of cane, and, too often, comparatively little attention is paid to fertilization. The crop is grown for several successive years upon the same plot and when the land commences to fall off in productiveness the cane patch is transferred to another bottom which, in turn, becomes the seat of cane growing operations for a number of years, to be later abandoned like its predecessor, when the limit of its producing capacity has been reached.

Fortunately, some of the more intelligent and progressive cane growers in the southern portion of Alabama have demonstrated that the flat, slightly elevated, sandy uplands, with a clay sub-soil can, with proper cultivation and fertilization, be made to produce crops of large tonnage, accompanied by a high sugar content. In that section the best results have been secured by the growing of preparatory green crops, such as cow peas, or velvet beans, which supply the soil with a good proportion of humus forming material and nitrogen, together with no inconsiderable amounts of phosphoric acid and potash brought up from the lower soil. These fertilizing materials furnish nutrition to the cane crop which is to follow, while the humus which has been added to the soil makes the latter more retentive of moisture and better enables it to withstand the droughts which may come sooner or later during the cane growing season. This preliminary treatment of the soil to be devoted to cane culture is followed up by heavy applications of a mixed fertilizer furnishing a moderate supply of phosphoric acid and relatively large proportions of nitrogen and potash.

A number of years ago the writer conducted a series of investigations with regard to the composition of the cane plant at different stages of growth, and also made complete analyses of the fully matured plant, including both tops, or blades, and stalks. As a result of these experiments it was ascertained that a crop of twenty tons per acre required for its production 68 pounds of nitrogen, 44 pounds of potash and 30 pounds of phosphoric acid. As the juice from the cane contains only a very small amount of these constituents, it would seem that nearly the whole amount of these materials could be restored to the soil by turning under the bagasse from the cane mill, as well as the leaves stripped from the cane, but in practice the disintegration and the incorporation of the tough and fibrous bagasse in the soil is found to be an extremely difficult problem and in Louisiana this material is used as fuel under the sugar house boilers, while the cane leaves are burned in the field with a view to checking or preventing the ravages of the cane borer.

A glance at the proportions in which these elements occur in the cane will show at once that the cane plant has a strong predilection for nitrogen, and will enable one better to understand the good results secured from the growing of cane upon lands containing abundant natural supplies of this valuable element, or upon which liberal applications of nitrogenous manures have been made.

If the employment of progressive and rational methods is necessary in the cultivation and fertilization of the crop, the use of intelligence and skill in the manufacture of the syrup is doubly essential. Indeed, it is quite surprising that the industry in some portions of this and of the adjacent States has been conducted with any profit, whatever, in view of the crude and uneconomic methods which have obtained to a greater or less extent in the manufacture of this commodity.

In the first place the extraction of the juice from the cane is often effected most imperfectly, and even where a mill is normally capable of extracting 65 of the 90 per cent. of the juice contained in the cane, its maximum efficiency is seldom realized for the reason that the rolls are not screwed up tightly for fear that the feeding of the mill will be rendered more difficult. On this account, many mills only give an extraction of from 55 to 60 per cent., leaving from 30 to 35 per cent. in the half crushed cane, and, even where the maximum extractive capacity of the average three roller horse mill is attained, there is still a very heavy loss sustained by reason of the unexpressed juice left in the bagasse.

As an illustration of the advantage of the employment of a modern mill of high extractive power, it might be stated that Mr. E. Smith, of Fairhope, Ala., one of the most successful syrup producers in the State, was able to secure as high an extraction as nearly 75 per cent. of juice by the use of a five roller mill purchased by him from George L. Squiers & CO., Buffalo, New York. This mill consisted of two crusher rollers together with a three roller mill of the usual type, and by its employment the yield of juice from the cane was increased more than one fourth. A mill of similar construction is in operation at the plant of the Southern States Lumber Co., at Magnolia Hill plantation, in Baldwin county.

The question of the satisfactory extraction of the juice having been solved, the next problem which presents itself is the proper clarification and evaporation of the juice, and it is in this part of the process that our present or commonly followed methods of procedure have proved most unsatisfactory and unscientific.

The removal of mechanical impurities is often effected by passing the juice through an old burlap bag, while the clarification and evaporation are conducted in a single wooden-frame evaporater, the bottom of which is covered with sheet copper or galvanized iron, while transverse partitions, supplied with gates or openings, are designed to regulate the flow of juice or of partially cooked syrup from one end of the evaporater to the other.

As a rule, no clarifying agents are employed, and the juice running in at one end of the evaporator is hastily brought to a boil, hurriedly skimmed, and, before full opportunity has been had for the formation or removal of the blanket of impurities, the liquid is pushed rapidly along from compartment to compartment, the impurities in solution and those still left in suspension being rapidly cooked down with the syrup, giving a product dark in color, lacking in delicacy of flavor, and more readily susceptible to fermentation by reason of the presence of an undue proportion of albuminoids and other organic impurities.

As the finished product is commonly allowed to flow out in a slow, continuous stream, with no means of determining its density except by the application of the "rule of thumb," the syrup is greatly lacking in uniformity of density and quality. If, on the one hand, the syrup boiler fails to cook the syrup to a proper density, fermentation is all the more likely to ensue, while if the desirable density is exceeded the product is sure to crystalize, or "sugar," sooner or later.

In addition to all of these defects and disadvantages of the ordinary evaporator, the regulation of the heat is quite a difficult matter. A slow fire will not permit the evaporation to keep pace with the mill, while a too rapid fire may scorch the syrup or cause loss by boiling over, the usual remedy being to rake out some of the fire, or else lift the evaporator off of the furnace, while operations are always resumed after some delay with the possibility or probability of the recurrence of the same trouble after a short interval.

In order to secure the best results in clarification and evaporation, the heat should be easily and quickly controlled, so that evaporation can be accelerated or retarded at will, or, if necessary, suspended instantaneously. The employment of steam for heating purposes is the only sure means of attaining these ends, and while it may not be practicable to utilize the steam evaporator where only a crop of 200 or 300 gallons of syrup is produced, or where the only use of the boiler employed is in the working up of a small crop of cane, still, steam evaporation can be employed advantageously upon a comparatively small crop upon farms where a boiler and engine can be used to good purpose in other departments of the farm economy. With somewhat larger crops the employment of steam evaporation will be highly desirable without regard to any other possible use of the boiler and engine, as the superiority and uniformity in the quality of the product secured fully justifies the increased initial cost of the steam plant.

As regards the clarification of the juice, a number of different methods of procedure have been adopted in various portions of the cane producing belt of the Southern States and there is naturally some difference of opinion as to the relative merits of the several processes employed.

Where a syrup of higher grade and purity, as well as of a brighter color, is desired, sulphuring and liming of the juice is resorted to, and a much more thorough removal of impurities is affected by this process. With a juice slightly acid in its normal condition the acid reaction is largely increased as a result of the sulphuring process, and a portion of this acidity is overcome by the use of a high grade lime, slaked to a thin paste. Especial care must be taken to avoid the employment of an excess of lime, and the juice should be left distinctly acid to litmus test paper, as inversion, the "bete noir" of the sugar maker, should have no terror to the syrup producer, who should delight in the presence of a large proportion of non-crystalizable sugar in his syrup.

If an excess of lime has been inadvertently added, this excess can be easily removed by the use of a small amount of high grade "acid phosphate" of lime, such as is sold under the trade name of "Clariphos." This latter agent is also employed as a clarifying agent instead of sulphur fumes, and bi-sulphite of lime is also employed to no little extent as a substitute for the sulphur and lime process of clarification.

With the simplest form of sulphuring apparatus ordinarily used in small syrup plants, the juice fresh from the mill is allowed to run slowly through a sulphuring box containing a number of inclined shelves, and, as the juice trickles slowly down from shelf to shelf, it meets with an ascending current of sulphur fumes, which are produced by burning brimstone or roll sulphur in a roughly constructed brick furnace. In this way the juice is at once rendered lighter in color and when heated in the evaporator, after careful liming, the separation of albuminous matters and other impurities is affected more readily and rapidly.

To show the adaptability of even crudely constructed steam evaporators to syrup making on a small scale, experiments have been conducted at the Alabama experiment station at intervals for a number of years with the employment of two small evaporators especially devised for experimental purposes, the smaller of the two being improvised from an ordinary open-fire evaporator already on hand.

The sides of the evaporators were of wood, as usual, and the bottoms were constructed of sheet copper, but no partitions were employed as in the ordinary evaporators. A series of pipes, connected at the end by return bends were placed in the bottom of each evaporator, almost the whole surface of the bottom being thus covered, with the exception of a space about four or five inches in width, which was reserved for the collection of the scums from the boiling juice. This unoccupied space should be on the side of the evaporator opposite to the point at which the steam is admitted, and this side should be slightly lower than the other in order to facilitate the removal of the scums. The piping employed was galvanized iron, from three-fourths to one inch inside diameter, and valves were provided for the proper regulation of the steam used in the evaporation, while another set of valves enabled the operator to prevent the too rapid escape of waste steam from the coil.

The juice, after sulphuring, is run into the small evaporator or clarifier, milk of lime is added, and the contents of the evaporator brought gradually to a temperature slightly under the boiling point. The scums and impurities come to the surface quite rapidly, the greater portion of them collecting over the space not occupied by the pipes, where they can be easily removed.

The clarifier is somewhat more elevated than the evaporator, and when the juice has been well skimmed it is at once run into the large evaporator, and the steam is immediately turned on. Fresh quantities of the juice are now run into the clarifier, boiled, skimmed and then run into the evaporator, the evaporation of the juice being conducted all the while. Any scums which form in the evaporator can be removed in the usual way, and when the syrup has reached the proper density the steam is shut off and the evaporator is emptied through the usual outlet.

By the substitution of copper coils for the galvanized iron pipe, a very much greater evaporative effect can be secured from the same heating surface and from the same steam pressure—an advantage which will in most cases, outweigh the increased first cost of the evaporating apparatus.

Many of our cane planters and small syrup producers still persist in drawing off the syrup at random, and without reference to its density, notwithstanding the fact that the Beaume hydrometer or saccharometer can be employed to good advantage in determining the point at which the syrup becomes sufficiently dense to be drawn off, and when the spindle immersed in the hot liquid reads 33 to 34 degrees the liquid can then be run out of the evaporator. Farmers in Alabama who have used the Beaume spindle report good results from its employment, and state that by means of its use no difficulty is experienced in boiling the syrup to a uniform density.

While the flavor of a syrup is a prime consideration in the production of marketable article, the relative clearness and color of the product is an important factor in determining the price it will bring upon the market, and this fact should not be lost sight of in the clarification and defecation of the juice and syrup, though it also must be borne in mind that the employment of undue proportions of clarifying agents is liable to affect the flavor or taste to an objectionable extent.

Whether the syrup is to be marketed in barrels, cans or bottles, the receptacles in which the product is put up should be well cleaned and thoroughly scalded out or steamed and every precaution taken to exclude ferments from contact with the contents of the vessels.

As is well known, a large part if the cane syrup found on the markets after the first warm weather of the spring sets in is that which has been put up in sealed cans or bottles, and almost invariably in the former. Moreover, a syrup put up hot in a clean vessel, and securely sealed while still hot, may be preserved almost indefinitely without danger of fermentation or of crystilization of sugar.

Samples of syrup in sealed jars or bottles have been preserved at the laboratory of the Alabama Polytechnic Institute for from four to five years without any indication whatever of fermentation or separation of sugar being observed, and analyses of the syrups before and after the completion of the period of the tests, showed no appreciable variations in the composition of the article.

With the exercise of proper care in the clarification and preservation of the genuine cane syrup, the imported, or at least the adulterated article, should soon be excluded from the market, and the consumer can then be assured of the purity and good quality of the goods which he purchases.

Moreover, when it is once known that syrup of good quality and high purity and possessing the fresh taste of the original article, can be obtained in any month in the year, it will be quite easy to build up a market for such goods and the home demand will necessitate an increase in the supply of the home manufactured product, while outside markets will readily take care of the surplus production of an article whose reputation for purity and excellence of quality has become well established.

EXPERIMENTS IN SYRUP MAKING.

In addition to experiments described in previous bulletins (Nos. 66 and 103,) a large amount of experimental work in methods of syrup making has been done both at the Station and at various syrup plants in the Southern part of the State, facilities for this work having been afforded at Mr. E. Smith's place, near Fairhope, and at the syrup plant of the Southern Industrial Association near Gateswood, Ala., while visits were paid to a number of other plants during the syrup making season.

EXTRACTION OF JUICE.

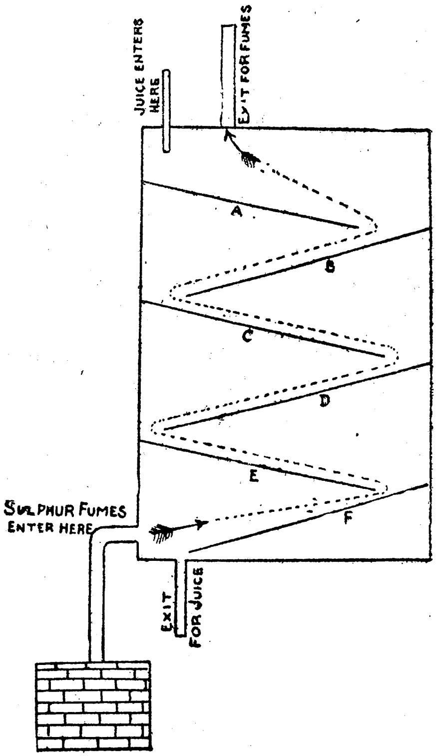
A number of extraction tests were made at various steam and horse mills, and it was found that in most cases the proportion of juice extracted by the two roller and three roller mills ranged from 55 to 60 per cent. The highest extraction noted was that secured upon the five roller mill of Mr. E. Smith, to which previous reference was made, and upon some trial runs approximately 75 per cent. extraction of juice was obtained. When the fact is noted that the employment of one of the poorer grades of mills would involve a loss equivalent to five tons of cane per acre upon a crop of twenty tons per acre, the importance of securing a good yield of juice should be readily recognized.

DEFECATION OR CLARIFICATION OF JUICE.

Allusion has been previously made to the common employment of burlap strainers for filtering the juice as it comes from the mill, but a strainer of fine sheet metal gauze can be used to much better advantage and can be easily kept clean. This gauze is, of course, chiefly of value in removing particles of trash, small fragments of bagasse, etc.

At some syrup plants in the southern part of the State it was noted that the juice from the mill was conducted through filters of Spanish moss, but so far as the observation of the writer has extended, the utility of this material is solely dependent upon the removal by it of mechanically suspended impurities which are found in the juice.

In bulletin No. 66, a form of sulphuring apparatus which has been much employed in Louisiana was described in detail and illustrated by a cut, this apparatus being constructed substantially as described on a preceeding page in this bulletin. For the information of the readers of the present bulletin this cut is reproduced herewith.



This sulphuring box has been used to good advantage at the Experiment Station and upon some nearby farms, but as some syrup producers have experienced trouble in constructing this particular form of apparatus, it was deemed desirable to devise a somewhat simpler appliance for use in sulphuring juices, and it was soon found that a satisfactory apparatus could be improvised from a large syrup barrel of 50 or 60 gallons capacity.

Several of the upper hoops of the barrel were removed and the head was carefully taken out, in order that a couple of false bottoms might be inserted in the barrel at about one-third and two-thirds of its height, these false bottoms being held in position by small cleats nailed to the sides of the barrel. A half inch pipe was inserted in the bottom of the barrel to provide for the outflow of juice, while a two inch pipe passing through the side of the barrel about three inches above the bottom was used to convey the sulphur fumes from the small sulphur furnace. A pipe of like dimensions fastened through the top of the barrel was employed as an exit for the fumes, while numerous perforations in the top provided for the inflow of the juice.

Straw was loosely packed between the bottom, the false bottoms and the top of the barrel, before replacing the top, this material being used to cause the juice to break up into a number of fine streams in order that it might expose a larger surface and absorb the sulphur fumes more readily. It was found that instead of perforated false bottoms a framework of small strips could be used to good advantage as a support for the straw.

The sulphur furnace to be employed in connection with the above described sulphuring apparatus can be contstructed of a few brick or else a small box of sheet iron can be used. A cone of thick sheet asbestos, with the apex of the cone inserted in the end of the pipe designed to convey the fumes can also be used as a furnace in case a large volume of fumes is not required. Brimstone or roll sulphur is the form of sulphur employed and is burned in a small iron dish or in the inverted top of a tin can, comparatively free access of air being permitted.

It is desirable that the barrel be well filled with fumes before the juice is allowed to run through it and it will be noted that the escaping juice is much brighter in color, while it has been found that in many cases a sufficient absorption of sulphurous acid is affected to admit of the sulphured juice being mixed with an equal volume of the raw juice.

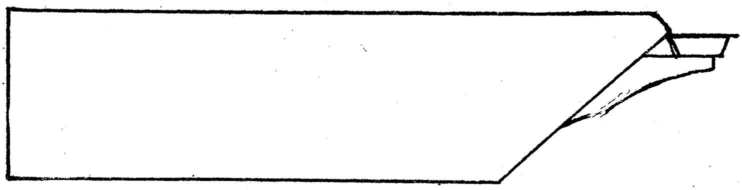
This department has also found that it is possible to employ liquified sulphurous acid in the sulphuring of juice, this product being obtained by condensing sulphur fumes under pressure in steel cylinders. A valve is attached to the cylinder and upon opening it shightly a flow of gas takes place, it being possible to conduct this gas through a tube to the bottom of a tall juice vat and as the gas bubbles up through the liquid it will sulphur it quite thoroughly. When purchased in small quantities the liquid sulphurous acid is somewhat expensive for use as a clarifying agent, but if a considerable demand for it were created in a given section, it could no doubt be secured at much lower figures.

If a settling tank is at hand the sulphured juice can be transferred directly thereto and within an hour or two it will be found that a considerable proportion of the impurities of the juice have separated from the main body of the liquid, rendering its subsequent clarification more easy.

The juice is next transferred to the clarifier or small evaporator previously described, and heated up slowly to the boiling point, milk of lime (in the form of a whitewash, free from lumps,) being added until the juice is left only slightly acid as indicated by litmus test paper. The juice is then brought to a brisk boil, so that the blanket or coating of scums rises and shows a number of cracks and seams on its surface, after which the heat is partly cut off and the scums are removed.

A deep form of clarifier is more effective than a shallow one and as before suggested it is desirable that a space unoccupied by the coil of steam pipe be left either at the side or end of the clarifiers and evaporators. It will also be found advantageous to have one end of the clarifier inclined at an angle of about 40 or 45 degrees to the horizontal, the scum trough being attached to the inclined end of the evaporator.

The following cut shows the side elevation of such a clarifier and also the position of the scum trough.



Side Elevation of Clarifier.

In a clarifier of this character the scums can be pushed along easily by a broad wooden skimmer from one end of the vat to the other, being easily brushed over the inclined end of the clarifier into the scum trough.

Although the use of lime as a clarifying agent is recommended in connection with the employment of sulphur, it is quite possible to secure good results from the use of sulphur, even where lime is omitted, though the sulphur fumes in the absence of lime would give the juice quite a perceptibly acid re-action. Instead of the employment of sulphur fumes for brightening or bleaching the juice, bi-sulphite of lime may be used in the proportion of one quart to 50 gallons of juice, although it does not usually yield quite so bright a syrup as does the juice treated with sulphur fumes. This chemical can be purchased from I. L. Lyons & Co., New Orleans, La., and is prepared by the action of sulphurous acid or sulphur fumes upon milk of lime.

In conjunction with sulphur, or in the entire absence of sulphur, acid phosphate of lime may be used as a clarifying agent and in many cases with most excellent results.

The preparation of acid phosphate used by this department was sold under the trade name of "Clariphos," and was purchased from J. Watts Kearny & Sons., New Orleans. This is simply a strong solution of acid phosphate of lime, which is free from any objectionable impurities and has been prepared especially for use as a clarifying agent in sugar factories.

Prior to the application of this agent the juice must be treated with lime until the original acidity of the juice has been neutralized and the manufacturers of this preparation even recommended that lime be added in slight excess, or until red litmus test paper changes to a slight blue. At this point the clariphos is added in the proportion of one-half gallon to 1000 gallons of juice it being diluted somewhat with water before adding it. Experiments made by the writer indicate that for syrup making it may be used advantageously in as large a proportion as one gallon of clariphos to 1000 gallons of juice.

After addition of this agent, the juice is boiled gently for a moment or two, the heat is turned off and the juice allowed to settle in the clarifier, or else it is run off in a settling tank. The lime which was added previous to the clariphos combines with the free acid of the latter, forming a bulky precipitate which settles rapidly, carrying down with it a large amount of organic impurities and suspended matter and leaving a clear, bright juice, which can easily be drawn off from the sediment. In this connection, it must be noted that the juice should be thoroughly skimmed or brushed after the addition of the lime and before the addition of the "Clariphos," and especial care should be taken to see that the milk of lime is free from lumps or granular particles.

Where agents other than clariphos are employed in clarification and in case considerable suspended matter is still present in the clarified juice, bag filters may be used to some advantage in the removal of much of this suspended matter.

The form of bag filter best adapted to this purpose is a long slender bag of closely woven texture which is supported by an outer bag of coarse netting, the two being suspended from the top of a tall wooden box or chamber which can be closed tightly, so that the interior of the compartment may be well heated by a jet of steam. The juice is allowed to enter the filter through an opening in the top of the chamber, and is drawn off from the bottom into a settling tank or into an evaporator.

By admitting steam to the filtering chamber, the filter and the juice being filtered are both kept hot and the filtration, in consequence, can be effected more rapidly.

This department is under obligations to Mr. West Livandais, New Orleans, La., for filter bags kindly donated for use in experiments conducted during the past season.

In case the syrup plant is supplied with a sufficient number of deep clarifiers, the juice may be advantageously evaporated down to semi-syrup in them before being transferred to the final evaporator or an intermediate evaporator may be employed between the clarifiers and the finishing pans. Where this plan is adopted, the semi-syrup is generally allowed to attain a density of from 20 to 25 degrees Beaume, hot, before being transferred to the last evaporator of the series.

Experiments were made during the past season in connection with the employment of sand filters for the removal of suspended matters from the semi-syrup, and where sand of pure quality was employed, some fairly good results were secured.

It was found necessary to wash even the best sand for some little time in order to remove clay and finely divided matter, whose presence rendered the wash water turbid, and when the sand finally permitted the water to pass through clear, it was found that the syrup would also pass through the sand filter comparatively clear and practically free from suspended matter. The sand filter was arranged by employing a tray or shallow box, the bottom of which was constructed of coarse wire gauze, covered by a coarse cloth, upon which a layer of sand of one and a half to two inches thick was placed.

Unless very pure sand, requiring very little washing be used, the employment of sand filters may be found troublesome, however, and the sand will, of course, have to be renewed frequently. Filters of this kind, nevertheless, would serve quite a good purpose in case some special lot of semi-syrup contained an excessive amount of suspended matter, which previous treatment in the defecators had failed to remove.

The concentration of the syrup in the final evaporators is continued until the Beaume hydrometer registers about 34 degrees in the hot syrup, and where there is only a thin layer of syrup left in the evaporator, it may be advisable to shut off steam when the instrument registers 33 and one half degrees, as the hot syrup in contact with the hot pipes which may still contain a little steam, will probably evaporate a little further before it can be drawn off.

For the removal of finely divided suspended particles from the hot syrup, the employment of cotton batting which was suggested and tried last season by Mr. A. F. Cory, at the syrup plant of the Southern Industrial Association, Gateswood, Ala., appears to be quite advantageous and good results were secured both by Mr. Cory and also by the writer in some experiments conducted at Auburn. The kind of cotton batting employed in the syrup filters was the same as that used by the turpentine distillers, one surface of the goods being glazed, while the other surface was rough. The batting was placed upon coarse wire gauze in a shallow box or tray and the syrup was allowed to flow on the filter in such a way as to obviate the possibility of washing a hole through the cotton filter, the liquid being diffused over the whole surface of the material.

Previous allusion has been made to the importance of thoroughly scalding out and steaming the containers in which the syrup is to be put up, and too much care and caution cannot be given to the matter of excluding ferments or bacteria from the packages if an article capable of long preservation is desired.

As regards the arrangement of the settling tanks, vats, clarifiers, evaporators, etc., in the syrup factory, the writer would say that the plan adopted by the Southern States Lumber Co. at their plant at Magnolia Hill plantation in

Baldwin county is a most excellent and convenient one. The juice from the mill is pumped to settling or storage tanks placed on the highest floor in the building, the juice from these tanks being allowed to flow by gravity to the clarifiers or defecators, of which there was one for each storage tank on the next lower floor. The juice or semi-syrup from the defecators was also conducted by gravity to settling tanks on the next lower level, and from there to the large evaporator or finishing pan on a still lower level.

The packing of the syrup was carried out on the ground floor of the plant, the natural slope of the ground having favored the arrangement of the interior of the establishment in the maner described—an arrangement which greatly facilitated the operations of the factory.

SMALL CENTRAL SYRUP PLANTS.

Several years since the writer advocated the idea of the operation of small central syrup-making plants in connection with steam gins which are found occurring in such close proximity to each other throughout much of the cane growing territory in this State and practical demonstrations of the feasibility of the plan were made during the past two seasons. Since many of these neighborhood gins suspend operations before any destructive freezes occur, the motive and steam power of these establishments can be utilized to good advantage in making syrup.

During the present season an experiment along this line was made at the place of Mr. J. C. Moore, near Auburn, only a few hours being required to install the clarifiers and evaporators and to make the necessary connections with the boiler, while all the apparatus worked satisfactorily from the beginning of the experiments and quite a good article of syrup was produced.

As before stated, wherever a boiler of sufficient capacity is in use for ginning, milling or other purposes, it is quite a simple matter to instal a syrup making outfit, and where new steam gins are established in cane growing regions, sufficient steam power can be provided to meet the combined requirements of a syrup plant and steam ginnery.

By the adoption of such a plan, small central syrup factories could easily be put in operation throughout a large portion of Southern and Middle Alabama, and the introduction of improved methods of manufacture would quickly follow upon the inauguration of such a system.

BULLETIN NO. 134. DECEMBER, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

Corn Culture.

By

J. F. DUGGAR,

Director and Agriculturist.

Opelika, Ala.
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1905.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

CORN CULTURE

BY J. F. DUGGAR.

SUMMARY.

During the past ten years 52 varieties of corn have been tested at Auburn, Alabama. Among these the most productive varieties were Mosby, Cocke, Henry Grady and Sanders.

Varieties of the prolific type, "two-eared varieties," afforded larger average yields than did the type in which the number of ears was smaller but the size larger.

Early varieties were relatively unproductive.

Repeated tests of seed corn grown in different latitudes indicated that with certain varieties seed from Virginia and Tennessee proved superior to that from Delaware, Illinois, Alabama and Georgia. It is impossible to determine whether this result was due chiefly to climate or to more careful selection of the seed corn obtained from Virginia and Tennessee. It is generally advisable that seed corn for Alabama be obtained either from this latitude or from some other region south of the Ohio and Potomac rivers.

Many early varieties from northern grown seed afforded a large proportion of unsound corn.

In six tests seed corn from the bottom ear afforded a slightly larger yield than from the top ear and in two tests seed from the top ear gave the larger yield.

Subsoiling did not increase the yield of corn sufficiently to be profitable.

The yield was not materially influenced by the depth of the first cultivation.

Planting corn in water furrows did not increase the yield.

The yield of grain was slightly decreased by pulling fodder, by topping and by cutting and shocking the plant. The average yield of dry fodder or blades was 515 pounds, of

cured tops 473 pounds and of cured stover 1,799 pounds per acre.

The increase in the yield of corn due to the use of velvet bean stubble as a fertilizer was 4.3 bushels per acre. Where the entire growth of velvet beans was plowed under the increase in the first corn crop was 12.3 bushels and the increase in the second corn crop was 4.4 bushels. The increase in the two corn crops was 16.7 bushels greater where the entire growth of velvet beans was plowed under than where only the roots and stubble were plowed under.

The yield of corn was 8.9 bushels per acre greater when cow pea vines were plowed under than when only the stubble was used as fertilizer. The increase from plowing under beggar weed, which grew after the corn was laid by, averaged 5.4 bushels per acre.

When velvet bean vines or cow pea vines were plowed under the addition of acid phosphate profitably increased the yield of corn.

Applying a part of the fertilizer before planting and a part at the second cultivation did not increase the yield as compared with using all of it before planting.

Nitrate of soda afforded a larger increase than did cotton seed meal, cotton seed or barnyard manure.

It is recommended that a fertilizer for corn contain a relatively large proportion of nitrogen.

TESTS OF VARIETIES OF CORN IN 1901, 1904 AND 1905.

For ten years in succession tests of varieties of corn have been made on the Experiment Station farm at Auburn under the present management.

Bulletins Number 76, 88 and 111 of this Station, now out of print, give the results of variety tests at Auburn from 1896 to 1900 inclusive. In 1902 an unprecedented drought, from April to August, ruined our variety test, and in 1903 rogues vitiated the results. The results obtained in 1901, 1904 and 1905 are presented in this bulletin.

All of our tests were made on upland soil characteristic of this region, and naturally poor. Only commercial fertilizers were employed, except in 1905, when in addition to commercial fertilizers, barnyard manure, chiefly from cattle, was used at the estimated rate of ten tons per acre.

Planting was done at the usual time or a few days later and the distance between rows was usually 4 feet 8 inches, and between plants about three feet. The distance between plants was the same for all varieties.

Every precaution was taken to secure and maintain a stand, but when this was impaired by bud worms, no correction of yields was attempted.

Yield of varieties of corn in 1901.

Variety	Per ct. of stand	Yield per acre	Rank in yield
	Per ct.	Bus.	
Mosby	93	**35.2**	1
Shaw	94	**31.9**	2
Cocke	100	**31.8**	3
Arnold's Cross Bred	100	30.1	4
Tennessee White	91	29.9	5
Tennessee Yellow	100	28.8	6
Red Cob, Tennessee	93	27.7	7
Experiment Station Yellow	98	27.1	8
Blount	95	21.6	9
Jones Pearl	99	19.6	10
Hickory King	100	18.9	11

Yield of varieties of corn in 1904.

Variety	Per ct. of stand	Yield per acre	Rank in yield
	Per ct.	Bus.	
Sanders	88	**35.5**	1
Mosby	100	**35.5**	2
Cocke	91	**33 5**	3
Henry Grady	93	32.3	4
Cocke (Ga.)	96	29.6	5
McMackin's Gourd Seed	95	29.6	6
Experiment Station Yellow	100	26.8	7
Boone County White (Tenn.)	87	25 8	8
Boone County White (Ind.)	92	24.2	9
Boone County Special	88	23.5	10
Reid's Yellow Dent	92	22.1	11
Riley's Favorite	91	19.6	12
No. 77 U. S. Dept. Agr	91	19.4	13
Silver Mine (Iowa)	81	19.1	14
Leaming Yellow	94	18.2	15
Snow Flake	81	12.9	16

Yield of varieties of corn in 1905.

Variety	Per ct. of stand	Yield per acre	Rank in yield
	Per ct.	Bus.	
Henry Grady	97	**40.6**	1
Sanders	99	**39.4**	2
Mosby	99	**38.9**	3
Marlboro	97	34.9	4
Local White Cob	91	34.3	5
McMackin's Gourd Seed	95	33.1	6
No. 77 U. S. Dept. Agr	99	32 6	7
Cocke (Tenn.)	92	30.9	8
Experiment Station Yellow	96	30.7	9
Albemarle	81	30 3	10
Shaw	81	29.7	11
Boone County Special	94	29.4	12
Red Cob (Tenn.)	84	28.9	13
Cocke (Ala. Exp't Sta.)	92	28.6	14
Hickory King	96	28	15
Boone County White (Tenn.)	88	26.3	16
Reid's Yellow Dent	85	25.7	17
Boone County White (Ind.)	87	24.6	18
Boone County White (Ill.)	76	22	19
Silver Mine (Iowa)	93	22	20
Leaming Yellow	94	18.9	21
Riley's Favorite	80	17.1	22

Relative yield of varieties of corn at Auburn, taking the yield of Experiment Station Yellow as 100.

	1896	1897	1898	1899	1900	1901	1904	1905	Average
Tested 8 years									
Mosby	91	138	109	92	115	130	132	130	117
Exp't Sta. Yellow	100	100	100	100	100	100	100	100	100
Tested 7 years									
Hickory King	122	72	73	73	80	70		91	83
Tested 6 years									
Cocke		129	87		108	117	118	97	109
Shaw		99	117	81	95	118		97	101
Blount	132	103	72	83	98	80			95
Tested 5 years									
St. Charles	148	90	104	81	96				105
Tested 4 years									
Red Cob (Tenn.)				82	99	102		96	95
Jones Pearl	99	97		93		72			90
Champion White Pearl	126	79		74	70				87
Tested 3 years									
Sanders					104		132	128	121
Farmer's Pride		101	94		96				97
Early Mastodon	134	60			91				95
Iowa Silver Mine		48					71	72	64
Leaming Yellow					57		55	61	58
Tested 2 years									
Henry Grady							121	132	127
Arnold					113	112			112
McMakin's Gourd Seed							110	108	109
Renfro	86	128							107
Higgins	72	134							103
Boone County Special							88	96	92
No. 77 U. S. Dept. Agr							73	106	90
Boone County White							93	79	86
Golden Beauty			89		83				86
Evans				86	81				84
Reid's Yellow Dent							82	84	83
Riley's Favorite							73	56	65
Tested 1 year									
Golden Giant	125								125
Cade Prolific		124							124
Yellow Dent	117								117
Marlboro								114	114
Baden			113						113
Local White Cob								112	112
Bradbury					112				112
Tennessee White						110			110
Peabody	108								108
Tennessee Yellow						106			106
Albemarle								99	99
Cary Klondike					97				97
Strawberry		97							97
Giant Broad Grain					94				94
Chester County Mammoth	93								93
Golden Dent				92					92
Poor Man					89				89
Welborn's Conscience		87							87
Cuban Giant			79						79
Sheep Tooth White					75				75
Creole					74				74
Snow Flake							4		48

Mosby is one of the most productive of the prolific varieties. Comparing its record with that of other prolific varieties we find that in each of six years Mosby yielded more than Cocke; in comparison with Blount, Mosby led in five out of six tests.

Comparing Mosby with some of the most productive nonprolific varieties, we find that it stood ahead of Sanders in 2 out of 3 tests, and equaled Sanders in the third test; once Mosby stood above Henry Grady and once slightly below. Compared with Shaw, Mosby was the more productive in 5 out of 6 tests.

Compared with all varieties tested, Mosby occupied *first* place in 2 tests, *second* place in 2 tests, *third* place in 2 tests, *fourth* place in 1 test and *twelfth* place in 1896, when weather conditions injured all late varieties.

Cocke, though averaging less than Mosby, proved to be one of the most productive varieties when all of our tests, made during the last ten years are considered.

In six tests its relative position was *second* in 2 tests, *fourth* in 2 tests, and *seventh* and *tenth* in the other two years.

Henry Grady has been tested only two years, but has taken high rank, namely *first* in 1905 and *third* in 1904.

Sanders has been tested only two years, but in both has taken high rank. It was *first* in 1904 (equaling Mosby), and *third* in 1905.

Other promising varieties as regards yield, but which have not been often tested here, are: Bradberry, Marlboro, Arnold, Local White Cob, Tennessee White and McMackin's Gourd Seed.

For illustrations of ears of certain varieties, see Appendix.

RELATION OF NUMBER OF EARS PER PLANT TO YIELD OF GRAIN PER ACRE.

The following table gives the number of ears and nubbins of each variety per plant. It will be noted that even most of the prolific varieties average less than two ears and nubbins per plant and that several varieties average less than one grain-bearing shoot per plant.

The number of grain-bearing shoots varies greatly for the same variety in different seasons, but, nevertheless, this number is largely a variety characteristic.

Number of ears and nubbins per plant.

Variety	1900		1901		1904		1905		
	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Average
Albemarle	....	....	....	....	....	....	2.02	1	2.02
Arnold	.91	22	.94	10	....	....	....	....	.93
Blount	1.86	1	1.00	9	....	....	....	....	1.43
Boone County White	....	....	....	....	1.11	5	....	....	1.11
Bradbury	1.40	4	....	....	....	....	....	....	1.40
Cary Klondike	1.00	16	....	....	....	....	....	....	1.00
Champion White Pearl	.99	17	....	....	....	....	....	....	.99
Cocke	1.55	2	1.85	1	1.49	2	1.60	6	1.65
Creole	1.39	5	....	....	....	....	....	....	1.39
Early Mastodon	1.04	10	....	....	....	....	....	....	1.04
Evans	.92	21	....	....	....	....	....	....	.92
Experiment Sta. Yellow	1.17	7	1.36	3	....	....	1.44	7	1.32
Farmers' Pride	.99	17	....	....	....	....	....	....	.99
Giant Broad Grain	1.03	12	....	....	....	....	....	....	1.03
Golden Beauty	1.03	12	....	....	....	....	....	....	1.03
Henry Grady	....	....	....	....	1.15	4	1.37	9	1.25
Hickory King	1.31	6	.91	11	....	....	1.38	8	1.20
Jones' Pearl	....	....	1.18	5	....	....	....	....	1.18
Leaming	.99	17	....	....	.77	11	....	....	.88
Local White Cob	....	....	....	....	....	....	1.10	14	1.10
Marlboro	....	....	....	....	....	....	1.86	2	1.86
McMackin's Gourd Seed	....	....	....	....	1.11	5	1.21	12	1.16
Mosby	1.02	14	1.60	2	1.36	3	1.74	3	1.43
No. 77 U. S. Dept. Agri.	....	....	....	....	.85	9	1.24	11	1.05
Poor Man	1.15	8	....	....	....	....	....	....	1.15
Red Cob, Tenn.	1.01	15	1.04	8	....	....	1.15	13	1.07
Reid's Yellow Dent	....	....	....	....	1.05	7	1.68	5	1.37
Riley's Favorite	....	....	....	....	.98	8	1.08	15	1.03
Sanders	1.45	3	....	....	1.61	1	1.74	3	1.60
Shaw	.96	20	1.12	7	....	....	1.27	10	1.12
Sheep Tooth, White	1.04	10	....	....	....	....	....	....	1.04
Silver Mine, Iowa	....	....	....	....	.85	9	.99	16	.92
St. Charles	1.12	9	....	....	....	....	....	....	1.12
Tennessee White	....	....	1.22	4	....	....	....	....	1.22
Tennessee Yellow	....	....	1.16	6	....	....	....	....	1.16

Dividing the varieties tested according to number of ears and nubbins per plant, we have the following classification:

Prolific varieties.

Sanders	Albemarle
Blount	Marlboro
Mosby	Cocke

Medium prolific varieties.

Hickory King	Creole
Jones' Pearl	Reid's Yellow Dent
McMackin's Gourd Seed	Experiment Sta. Yellow
Tennessee Yellow	Henry Grady
Poor Man	Tennessee White
Bradbury	

Non-prolific varieties.

Golden Beauty	Shaw
Riley's Favorite	St. Charles
Cary Klondike	Boone County White
Farmers' Pride	Local White Cob
Champion White Pearl	Tennessee Red Cob
Arnold	No. 77, U. S. Dept. Agr.
Silver Mine, Iowa	Early Mastodon
Evans	Sheep Tooth White
Leaming Yellow	Giant Broad Grain

The above classification has been made as a means of securing an answer to the question, "What type of corn has been most productive in recent tests at the Alabama Experiment Station?" An examination of the yields gives the following table of averages:

Average yields of types of corn in bushels per acre.

	Prolific.	Medium.	Non-prolific.
	Bus.	*Bus.*	*Bus.*
1900—Average yield	37.4	27.8	31.6
1901—Average yield	29.5	24.7	29.9
1904—Average yield	34.2	26.6	20.2
1905—Average yield	34.0	31.6	26.5
4 years, average of averages	33.8	27.7	27.0

In three out of four years the prolific varieties gave decidedly the highest average yield. It must be stated, however, that the averages for the medium and non-prolific varieties are low largely because these lists embrace so many early non-productive northern varieties.

In the following table all early or otherwise unproductive varieties have been eliminated and a comparison made between the average yields of the best prolific, the best medium and the best non-prolific varieties.

Average yields of best varieties of three types.

YEAR	PROLIFIC VARS.		MEDIUM VARS.		NON-PROLIFIC VARS	
	Bus.		Bus.		Bus.	
1900	39.	Mosby Cocke	37.	Bradbury Expt. St. Yel.	35.9	Shaw Red Cob Arnold
1901	33.5	Mosby Cocke	28.6	Expt. St. Yel. Tenn. White Tenn. Yel.	29.9	Shaw Red Cob Arnold
1904	34.2	Mosby Cocke Sanders	29.6	Expt. St. Yel. Henry Grady McMackin		
1905	36.9	Mosby Cocke Sanders Albemarle Marlboro	34.5	Expt. St. Yel. Henry Grady McMackin	31.6	Local Wh. Cob Red Cob
Av.	35.9		32.4		32.4	

The above figures show that the best prolific varieties each year averaged higher than the best varieties bearing a smaller number of ears.

SIZE OF EAR IN DIFFERENT VARIETIES.

Number of ears and nubbins required to shell 56 pounds of grain.

Variety	1900		1901		1904		1905		
	Number	Ra k	Number	Rank	Number	Rank	Number	Rank	Average
Albemarle	....	....	....	....	....	....	168	....	168
Arnold	78	1	115	1	....	....	....	....	97
Blount	151	22	161	7	....	....	....	....	156
Boone County White	....	....	....	....	141	5	....	....	141
Bradbury	122	11	....	....	....	....	....	....	122
Cary Klondike	99	4	....	....	....	....	....	....	99
Champion White Pearl	139	18	....	....	....	....	....	....	139
Cocke	133	14	209	10	167	10	154	12	166
Creole	172	23	....	....	....	....	....	....	172
Early Mastodon	109	6	....	....	....	....	....	....	109
Evans	111	8	....	....	....	....	....	....	111
Experiment Sta. Yellow	120	10	161	7	....	....	130	7	137
Farmers' Pride	99	4	....	....	....	....	....	....	99
Giant Broad Grain	113	9	....	....	....	....	....	....	113
Golden Beauty	123	12	....	....	....	....	....	....	123
Henry Grady	....	....	....	....	126	1	101	2	114
Hickory King	149	21	184	9	....	....	148	11	160
Jones' Pearl	....	....	220	11	....	....	....	....	220
Leaming	147	20	....	....	135	3	....	....	141
Local White Cob	....	....	....	....	....	....	90	1	90
Marlboro	....	....	....	....	....	....	161	14	161
McMackin's Gourd Seed	....	....	....	....	134	2	106	4	120
Mosby	143	19	156	6	151	7	137	10	147
No. 77 U. S. Dept. Agri.	....	....	....	....	159	8	117	6	138
Poor Man	126	13	....	....	....	....	....	....	126
Red Cob, Tenn.	93	3	137	4	....	....	102	3	111
Reid's Yellow Dent	....	....	....	....	165	9	172	15	169
Riley's Favorite	....	....	....	....	171	11	157	13	164
Sanders	136	17	....	....	145	6	135	9	140
Shaw	97	2	121	2	....	....	108	5	109
Sheep Tooth, White	135	15	....	....	....	....	....	....	135
Silver Mine, Iowa	....	....	....	....	136	4	131	8	134
St. Charles	109	6	....	....	....	....	....	....	109
Tennessee White	....	....	136	3	....	....	....	....	136
Tennessee Yellow	....	....	149	5	....	....	....	....	149

By means of this table we are able to make three groups of varieties according to the average size of ears and nubbins, that is according to the number of ears and nubbins required to shell one bushel of 56 pounds of grain.

A much better showing would, of course, be made for each variety if we should give a table showing the number of well grown ears required to shell a bushel. The figures in the above table are not intended to show the average weight of typical, well grown ears, but to indicate how many ears and nubbins a farmer must handle to obtain one bushel of grain. This, of course, varies widely with the season, as well as with the variety.

Large-eared varieties.

Arnold	Local White Cob
Cary Klondike	McMackin's Gourd Seed
Early Mastodon	Red Cob
Evans	Renfro
Farmers' Pride	Shaw
Giant Broad Grain	St. Charles
Henry Grady	Strawberry
Higgins	

Medium-eared varieties.

Bradberry	Poor Man's
Experiment Station Yellow	Sheep Tooth White
Golden Beauty	Silver Mine
Jones Pearl Prolific	Tennessee White
No. 77 U. S. Dept. Agr.	Welborn's Conscience

Small-eared varieties.

Champion White Pearl	Hickory King
Sanders	Marlboro
Leaming	Riley's Favorite
Boone County White	Cocke's Prolific
Mosby	Albemarle
Tennessee Yellow	Reid's Yellow Dent
Blount	Creole

EARLY AND LATE VARIETIES.

Grouping the varieties according to earliness when grown in the South, we have the following groups:

Early varieties.

Blount	Leaming
Boone County White	No. 77 U. S. Dept. Agr.
Champion White Pearl	Reid's Yellow Dent
Early Mastodon	Riley's Favorite
Golden Beauty	Silver Mine
Golden Dent	Snowflake
Hickory King	Saint Charles

Late varieties.

Albemarle	Marlboro
Arnold	McMackin's Gourd Seed
Bradbury	Mexican June
Cade's Prolific	Mosby
Cocke's Prolific	Poor Man's
Creole	Red Cob
Experiment Sta. Yellow	Renfro
Evans	Sanders
Farmers Pride	Shaw
Henry Grady	Strawberry
Higgins	Tennessee White
Jones Pearl Prolific	Tennessee Yellow
Local White Cob	Welborn's Conscience

Of course still further sub-division of each class is possible. For example, we might place St. Charles in a medium early group, and probably include Blount in the same. Subdividing the second group, we should have as medium to late, Albemarle, Marlboro, Evans; and as very late, Creole, Poor Man's and Mexican June.

The yields of the late and medium late varieties are very much greater than the yields of the early varieties.

The large-eared group consists of late varieties, except Early Mastodon and St. Charles.

The medium-eared group includes both early and late varieties, the late prodominating.

The small-eared group is made up chiefly of the early northern varieties and the prolific or many-eared kinds; it thus includes both the most unproductive and the most productive varieties.

SEED CORN FROM DIFFERENT LATITUDES.

This series of experiments has been under way for nine years under the present management. The plots for this experiment have always been located on upland soil, naturally poor, on the Station farm at Auburn.

The northern or western seed corn used in all of these eight years has come from the same grower, J. C. Suffern, Voorhees Post Office, in the central part of Illinois, in latitude 39 degrees and 50 minutes, or about one degree north of St. Louis. This northen seed corn has been compared with, (1) seed corn of the same varieties grown in Georgia and Alabama and, (2) with seed corn from Virginia, Delaware and Knoxville, Tennessee.

Tests of this character are beset with difficulties and results are not easy to interpret, for the reason that other factors besides climate enter into the problem. The soil in which each strain has recently grown, the carefulness of different growers in maintaining the purity and excellence of their strains of corn, and other factors complicate the results. Nevertheless, the average of a number of experiments extending over nine years and made with four different varieties should afford reliable indications.

For detailed tabulated results the reader is referred to the Appendix to this bulletin.

In sixteen separate tests, in which seed from Alabama or Georgia was compared with the same variety from Illinois, the yields were in eight cases in favor of seed corn from

Alabama and Georgia and in eight cases in favor of seed corn from Illinois. The average difference in yield was only thirty five one-hundredths of a bushel per acre, in favor of northern seed. Thus the seed from the two sources proved to be of practically equal value so far as regards the average of results with Hickory King, Blount and St. Charles. These varieties may be ranked as early or medium early varieties as compared with southern varieties. Our variety tests show that they are relatively unproductive here, like all other early varieties of corn. It seems that while northern seed corn has afforded as large yields as southern in the case of early varieties, it is advisable for the southern farmer to give the preference to southern seed corn, for the reason that he cannot, in the North, obtain seed of the varieties that are most productive in the South, the season there being too short for our best southern varieties.

Comparing seed corn from Illinois and Delaware we find that each led in one test, the difference in their average yields being very slight.

In each of three tests seed grown in Virginia proved decidedly more productive than seed of the same varieties, (Hickory King and Blount), grown in Illinois. The average difference in favor of Virginia seed was 8.5 bushels per acre.

In three out of four tests, using the varieties Hickory King, Blount and Cocke the yields decidedly favored the Virginia seed, as compared with seed from Alabama and Georgia, the average difference for the four tests being 4.9 bushels per acre in favor of the seed corn from Virginia.

Using the same three varieties just mentioned and comparing seed grown at Knoxville, Tennessee, with seed from Alabama and Georgia, we find that in each of four tests the advantage was with the Tennessee seed, the average difference being 2.3 bushels per acre.

Thus on the whole there was some advantage in using seed from Virginia and from the more elevated region of Tennessee, as compared with seed of Cocke, Hickory King and Blount grown in Georgia and Alabama.

Are these differences due to climate, or are they due to more careful selection and greater purity of the seed from certain regions? A positive answer cannot be given. The writer's own opinion is that the difference is chiefly due to selection. If this be the correct view, it follows that the only thing needed to make Alabama seed corn the equal or superior to that from any other part of the country is to improve it by careful selection. Methods of thus improving corn will be dealt with in a later publication from this Station.

In view of results here recorded and of observations made elsewhere, the writer's conclusions relative to the source from which we, of the Gulf States, may advantageously draw our seed corn may be stated as follows:

Varieties of corn from north of the Ohio river usually give smaller yields in Alabama than corn grown further south.

Seed corn from the northern corn belt is sometimes useful in the Gulf States as a means of securing a field of early maturing corn, especially when the local corn crop of the preceding year has been poor. On such early ripening patches we need not expect as large yields as are obtained from corn maturing at the usual time.

Corn from the northern corn belt has often given, in Alabama, a very poor quality of grain, which has often been too poor for marketing or for making meal.

For planting in Alabama, seed corn of late and prolific varieties may safely be obtained from any locality south of the Ohio and Potomac rivers, and perhaps slightly above this line.

Seed corn from about the same latitude as that in which it is to be grown appears to be as good as that from further north, provided it is as well selected and maintained as pure as the imported strain. Local seed corn, when pure and well improved, has the advantage of permitting the grower to select it in the ear, the condition in which it is desirable that all seed corn, whether local or from a distance, should be received by the farmer.

Corn brought south from higher latitudes becomes later and later each year for several years after its introduction, the plant grows taller, and generally the proportion of trashy, weevil-eaten or otherwise unmarketable grain becomes less than during the first year of growth in the South.

TOP VERSUS BOTTOM EARS.

To ascertain whether there is any difference for seed purposes between the lower and the upper ear on plants bearing two ears, tests were made in 1903 and in 1905.

The results in 1903 with St. Charles White corn were as follows, in bushels per acre:

From upper ear....................25.0 bushels per acre.
From lower ear....................22.8 bushels per acre.

In 1905 five pairs of plots were used, planting seed corn from five different plants of the variety Experiment Station Yellow. Plots 1 and 2 were planted with upper and lower ears respectively from the same plant, plot 3 with corn from the same plant as plot 4, and so on for each pair of plots.

Yields in 1905 from planting upper and lower ears from the same plant.

Plot No.	Seed corn from.	Yield per acre from Top ears Bus.	Yield per acre from Bottom ears. Bus
1.	Top ear	26.3	——
2.	Bottom ear	——	27.7
3.	Top ear	30.0	——
4.	Bottom ear	——	29.4
5.	Top ear	32.9	——
6.	Bottom ear	——	33.1
7.	Top ear	28.5	——
8.	Bottom ear	——	29.4
9.	Top ear	27.1	——
10.	Bottom ear	——	28.6
	Average 5 plots top ears	28.9	——
	Average 5 plots bottom ears	——	29.6
	Increase from bottom ears over top ears		.7

Viewing the six tests made in the two years we note that the yield was greater with seed from bottom ears in four cases and with seed from the upper ears in two cases. In 1905 the average number of ears and nubbins combined and their average size or weight were almost identical from planting upper and lower ears. This evidence is not sufficient to justify the conclusion that the bottom ear is better than a well developed upper ear, or the reverse.

SUBSOILING.

A tract of level rather poor upland has, for ten years, been devoted to continuous experiments in subsoiling, using different crops each year. The surface soil is made up of flinty stones and of rather stiff reddish loam. The subsoil is a very compact yellowish sandy clay, which in winter is usually too wet for the subsoil plow to do effective work. A regular subsoil plow drawn by two mules is run in the furrow made by a one-horse turn plow, giving a total depth of from 10 to 12 inches of loosened soil. Subsoiling is not done every year, but every second or third year. The following table shows that when the land for corn was subsoiled only about six weeks before corn was planted, the yield was slightly less on the subsoiled plots than on those not subsoiled. When subsoiling was done two years before planting, this operation resulted in a slight increase in yield.

Immediate and third year effects of subsoiling.

Crop grown in	When subsoiled	Yield per acre Not subsoiled	Yield per acre Subsoiled	Loss from subsoiling	Gain from subsoiling
		Bus.	*Bus.*	*Bus.*	*Bus.*
1901	Never subsoiled	13.1	....	....	....
1901	Subsoiled Feb. 1901	....	11.2	1.9	....
1903	Never subsoiled	13.8	....	....	....
1903	Subsoiled Feb. 1901	....	14.5	....	.7
Average loss from subsoiling		....	....	.6	....

Subsoiling should not be condemned simply on this showing. The figures, together with slightly better results on the same land with some other crops, should emphasize the fact that subsoiling done within two months of the time of planting may have an injurious effect. It is believed that land of this character would be helped by using the subsoil plow during long dry periods in the fall when the subsoil is dry enough to crumble.

DEPTH OF EARLY CULTIVATION.

In 1900 on rather stiff reddish soil, with flinty stones, there was no injury from making the first cultivation deep with two scooter furrows per row, all subsequent cultivations being shallow.

In 1901 on gray sandy upland the yield was 23.6 bushels on the three plots cultivated shallow and 23.4 bushels on those given an early deep cultivation with two scooter furrows per row, the subsequent cultivation being shallow. Thus in both experiments there was no marked advantage in favor of making the first cultivation deep. However, it should be noted that in both tests the first cultivation or "running around" was given when the plants were only a few inches high. If cultivation had been delayed as late as sometimes occurs, the injury from early deep cultivation would doubtless have been appreciable. When land is in good condition there seems to be no need for deep early cultivation. Possibly when clay land has been plowed early and has become badly compacted there may be some justification of "running around" the young plants with a scooter. But in general the danger of injury to roots, of excessive drying of the soil if dry weather follows, and the slowness of this process, are against this primitive method of cultivation.

PLANTING CORN IN WATER FURROW VERSUS ON A LEVEL.

On light sandy lands farmers frequently plant corn below the general level, or in the water furrow. This method was compared with planting on the level flushed field, both in 1900 and in 1901.

In preparing to plant corn in the water furrow the land was thrown into beds with a one-horse turn plow, leaving unbroken until planting time a narrow balk where the corn was to be planted. When ready to plant, this balk was thrown out with a shovel plow and seed and fertilizer placed in this freshly-stirred soil. Likewise seed and complete commercial fertilizer were applied on the same day in the furrow on the plot that was planted on the level. In both cases the fertilizer was mixed with the soil before the seed were put into the ground.

The yields in bushels per acre were as follows:

	1900	1901
Planted on the level	22.2	16.5
Planted in water furrow	19.0	16.5

In 1900, in which April and June were wet months, there was a loss even on this porous soil, from planting in the water furrow. In 1901 when there was abundant rain from time of planting until June 15, but a drought from the middle of June to the middle of July, the yields by the two methods were identical.

METHODS OF HARVESTING CORN.

The ordinary method of harvesting corn in the Gulf States consists in stripping the blades while they are still green, a practice that is expensive in labor and in the decreased yield of grain that frequently results. In recent years in many southern localities a number of farmers have cut and shocked the plants when the shucks have colored, afterwards passing the plants through a shredder to remove and shuck the ears, and better to prepare the stalk for food and bedding. Rarely the tops are cut, bound into bundles, and cured.

An experiment covering this point was made in 1904, to secure data additional to that obtained in our earlier experiments in 1896, 1897 and 1900. The yields in 1904 were as follows:

Yield per acre of corn and forage from different methods of harvesting in 1904.

Method of harvesting	Corn per acre.	Forage per acre.
Only ears harvested	25.7 bus.	00 lbs.
Tops cut and ears harvested	26.1 bus.	360 lbs.
Entire stalk cut and ears afterwards harvested	25.4 bus.	1980 lbs.
Blades stripped and ears harvested	25.5 bus.	415 lbs.

In 1904 there were practically no differences in yield attributable to the method of harvesting.

The table below summarizes the yield of corn in four experiments made at Auburn, the results of the earlier years having been published in Bulletins Nos. 88 and 111 of this station.

Yield per acre of corn from different methods of harvesting.

Methods of harvesting	Corn per acre					
	1896	1897	1900	1904	Average 4 years	Average loss
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Only ears harvested	34.4	31.0	46.9	25.7	34.5	.....
Tops cut and ears harvested	30.2	29.2	44.3	26.1	32.5	2.0
Entire plant cut and shocked	29.2	29.5	44.3	25.4	32.1	2.4
Blades stripped and ears harv't'd	.....	.....	45.9	25.5	.....	.....

This table shows that the average loss of grain per acre where the tops only were saved for forage was 2 bushels, or where the plant was cut and shocked, 2.4 bushels per acre. Both losses were greater than in most of the experiments at other stations. As to the effects of pulling fodder, we have data for only two years. The average of all experiments at all stations show that generally stripping the blades reduces the yield by several bushels per acre, but that under some conditions (probably when the stripping is late) no material reduction in yield occurs.

The following table shows the amount of forage derived from "fodder pulling," from topping, and from shocking.

Yields of cured corn tops, stover and blades.

	Average yield of grain	Yield of forage per acre					
		1896	1897	1900	1904	Avg.	
	Bus.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
Only ears harvested	34.5	......	......	......	......	......	......
Tops cut and ears harvested	32.5	312	509	711	360	473	Tops
Entire stalk cut and ears afterwards harvested	32.1	2103	1355	1759	1980	1799	Stover
Blades stripped and ears harvested ..	......	......	......	615	415	515	Blades

It should be noted that the average amount of cured blades per acre was 515, of cured tops 473 and of cured stover (leaves and stalks) 1799 pounds. It is evident that we can expect less than a ton of stover per acre on southern uplands when the yield is thirty-five bushels or less per acre.

When only the ears are harvested, partial utilization may be made of the weather-worn blades, and of leaf sheaths and tips of stalks, by pulling the ears early and turning cattle into the field. Where labor is scarce, other winter forage abundant, and a shredder not at hand, this may prove to be the most practicable method.

Considering the cost and usual injurious effects of fodder pulling, this method of obtaining forage must be condemned.

This Station is accumulating data relative to the feeding value of shredded corn stover, which may throw further light on the advisability of shocking and shredding corn, the method that is usually regarded as the best.

Assuming—in the absence of a sufficient number of exact experiments in feeding tops and stalks,—that tops are worth 40 cents, stover 30 cents per 100, and corn blades 60 cents, we find that one acre gives a value of $1.80 in corn tops; or of $3.09 in corn blades or "fodder," and of $5.40 in stover.

Cutting and shocking can be done before cotton picking begins, a merit that will be generally recognized. Moreover, the cutting of the stalks leaves the land in better condition for plowing, and enables the farmer to begin the plowing for small grain at an earlier date than is practicable when the ears are allowed to cure slowly on the living plants. The removal of the stalks is somewhat more exhaustive to the land than is burying them with the plow, but this on most soils is probably counterbalanced by the greater convenience of preparing and cultivating land that is free from stalks.

LEGUMINOUS PLANTS AS FERTILIZERS FOR CORN.

Velvet bean stubble vs. vines as fertilizer for corn in 1901.

In 1900 velvet beans were planted after oats in 4 feet rows on certain plots of light sandy upland adjacent to the land on which for a long period our fertilizer experiments with cotton and corn were conducted. On certain other plots corn was grown in 1900.The velvet bean vines were cut for hay on a part of the area, yielding 3332 pounds of hay per acre.

In 1901 corn was grown on all plots, using on all acid phosphate at the rate of 100 pounds per acre. The object was to note the comparative values as fertilizer of (1) the entire velvet bean plants plowed under late in winter, (2) the stubble of velvet beans, plowed in at the same time, and (3) as a check, corn stalks of the preceding corn crop.

	Yield per acre *Bus.*	Increase per acre *Bus.*
Corn following corn	13.6	....
Corn following velvet bean stubble	17.9	4.3
Corn following velvet beans, entire growth plowed in	25.9	12.3

The increase attributable to the plowing in of the entire growth of velvet beans, grown as a catch crop after oats, was 12.3 bushels per acre, this increase being worth, at 70 cents per bushel, $8.61 per acre. Doubtless there was also a considerable residue of humus and nitrogen left in the soil to increase the crop of 1902.

The cost of growing the velvet beans consisted chiefly of expenditures for 200 pounds of acid phosphate per acre, for the seed, and for a small amount of cultivation. By using the entire crop of velvet beans as fertilizer the yield of the first crop of corn was nearly doubled.

The plot on which only the stubble of velvet beans was used for hay afforded an increase of 4.3 bushels per acre, and lacked 8 bushels of giving as large a crop as the plot on which the entire growth was plowed under. Hence in deciding which was the more profitable use of the velvet bean vines we have on one side 8 bushels of corn and the saving of labor from not harvesting the hay and on the other hand the value of more than one and a half tons of hay.

As recorded in Bulletin 111 of this Station, (the issue of which is now exhausted), in 1900 on a similar and adjacent soil, the increase in yield of corn after plowing in the entire vines of velvet beans of 1899, as compared with plowing in only the velvet bean stubble, was 11.9 bushels per acre. That year the yield of velvet bean hay was 2800 pounds.

On the same plots in 1901 on all of which corn was the preceding crop, the residual fertilizing effect of the 1899 crop of velvet beans was 4.4 bushels greater where the entire growth of vines had been plowed under than where only the stubble had been plowed under. Here we have in two years a total superiority of vines over stubble of 16.3 bushels of corn per acre, which may be weighed against 2800 pounds of velvet bean hay, less the cost of harvesting the hay.

Cowpea stubble versus cowpea vines as fertilizer for corn.

On a poor reddish loam upland soil cowpeas were sown in drills June 13, 1900, following oats, and fertilized with 150 pounds of acid phosphate per acre.

A part of the cowpea area was cut, yielding 1648 pounds of hay per acre. On another part of the area the peas were neither cut nor picked, but the entire growth turned under.

In 1901 corn was grown on both areas, and was fertilized with 100 pounds of high grade acid phosphate per acre. The yields of corn in bushels per acre were as follows:

After drilled cowpea stubble.................11.4 bushels
After drilled cowpeas, all plowed in..........20.3 bushels
Excess from entire growth of cowpeas as compared with cowpea stubble............ 8.9 bushels

Beggar weed as a fertilizer for corn.

On June 24, 1899, beggar weed seed were sown on certain plots on a poor hilltop, where the soil is a light gray sandy loam. The growth that year was only medium and the stand poor, but some of the plants matured and shed seed.

The entire growth of beggar weed was plowed under during the winter, as was also the stubble of drilled velvet beans on adjacent plots, and all plots planted in corn in 1900 and again in 1901. After cultivation of the corn ceased in 1900 beggar weeds sprang up , reseeded the land, and this volunteer crop was plowed under as a fertilizer for the corn crop of 1901.

As compared with the plot where velvet bean stubble was left in 1899, the increase on the plots where beggar weeds were plowed in immediately preceding each corn crop was 3.1 bushels in 1890 and 7.6 bushels in 1901, an average annual increase of 5.4 bushels per acre. Doubtless this increase, especially in 1900, would have been considerably greater could the comparison have been made with some plot on which no legume had recently been grown.

Acid phosphate as a fertilizer for corn grown after velvet beans.

In 1901 acid phosphate containing 14 per cent. available phosphoric acid was applied to corn on poor gray sandy upland. No other fertilizer was used, but on both plots the entire growth of velvet bean vines had been plowed under late in the winter. The yield without any phosphate was 21.5 bushels per acre; with 100 pounds of phosphate 25.9 bushels. This difference of 4.4 bushels of corn per acre represents the effect of 100 pounds of high grade acid phosphate when applied in the presence of abundance of vegetable matter.

Likewise in 1905 a test was made to determine whether, after plowing under a luxuriant growth of velvet bean vines, it would pay to apply commercial fertilizers in addition.

On level sandy land in good condition a very heavy growth of velvet bean vines was plowed under with a disc plow February 27, 1905. On the adjacent plots on either side there was plowed under at the same time and in the same way the stubble of drilled sorghum which had been cut for hay. Two of the velvet bean plots received no other fertilizer than the vines and two of them, besides the vines of velvet beans, were also fertilized with 40 pounds of muriate of potash and 240 pounds of acid phosphate per acre.

Average results for two plots in each test are given below:

Yield of corn per acre fertilized with velvet bean vines alone........................21.3 *bushels.*

Fertilized with velvet bean vines, potash and phosphate ....27.3 *bushels.*

Increase from potash and phosphate..........6.0 *bushels.*

In this experiment it was profitable to employ as fertilizer for corn, muriate of potash and phosphate, in addition to a mass of velvet bean vines. The gain from this mineral fertilizer, when used in the presence of an abundance of vegetable matter, was 6 bushels per acre.

A crop of velvet bean vines turned under gave practically the same yield of corn as did a very heavy application of the best grade of barnyard manure, applied on adjoining plots, at the estimated rate of about ten tons per acre.

FRACTIONAL APPLICATIONS OF FERTILIZER.

It is a favorite plan of some farmers to apply only a part of the fertilizer to cotton or corn before planting, and to apply the remainder after growth has well begun.

After the publication of Bulletin No. 111, in which it was shown that corn had not responded very freely to large applications of commercial fertilizers, the writer received several letters suggesting that the results with fertilizers would have been much better if a part of the fertilizer had been withheld until the plants were one or two feet high.

To test this matter again eight plots were employed in 1905, located on fairly good upland, where the soil is a reddish loam, containing many flint stones.

The fertilizer applied before planting was drilled in the planting furrows and mixed with the soil March 7, and planting was done March 29. The portion of fertilizer withheld was applied on certain plots May 15, in the siding furrows of the second cultivation.

Fractional application of fertilizer for corn in 1905.

Plot number.	FERTLIZER			Yield per acre	Increase over unfertilizer plots
	Amount per acre	Kind	Time applied		
	Lbs			*Bus.*	*Bus.*
1	200 200 40	Cotton seed meal .... Acid phosphate ...... Muriate of potash	All at planting	25.1	......
2	200 200 40	Cotton seed meal .... Acid phosphate ...... Muriate of potash	½ of fert. at planting .... ½ of fert. at 2nd cult.	24.0	......
3	00	No fertilizer	....	19.4	......
4	200 200 40	Cotton seed meal .... Acid phosphate .... Muriate of potash	All at planting	20.9	......
5	200 200 40	Cotton seed meal .... Acid phosphate ...... Muriate of potash	½ of fert. at planting .... ½ of fert. at 2nd cult.	22.6	......
6	00	No fertilizer	....	20.0	......
7	200 200 40	Cotton seed meal .... Acid phosphate .... Muriate of potash	½ of fert. at planting .... ½ of fert. at 2nd cult.	24.0	......
8	200 200 40	Cotton seed meal .... Acid phosphate .... Muriate of potash	All at planting	25.4	......
Av. 3,6	00	No fertilizer	....	19.7	......
Av. 1,4,8	200 200 40	Cotton seed meal .... Acid phosphate ...... Muriate of potash	.... All at planting	23.8	...... 4.1
Av. 2,5,7	200 200 40	Cotton seed meal .... Acid phosphate ...... Muriate of potash	½ of fert. at planting .... ½ of fert. at 2nd cult.	23.5	3.8

Wherever fertilizer was employed a complete fertilizer, at the rate of 240 pounds per acre, was used. The average results show a difference of three-tenths of one bushel per acre in favor of applying the entire amount before planting.

In favor of this method is also the greater convenience and saving of labor.

The corn receiving the entire amount of fertilizer before planting made a much better start than did the other plots, but the difference nearly disappeared late in the season.

The increase due to 240 pounds of a complete fertilizer was only 4.1 bushels when all was applied before planting, and only 3.8 bushels when applied in two doses.

COTTON SEED VERSUS COTTON SEED MEAL AS FERTERLIZER.

In 1901, 200 pounds of cotton seed meal was compared with 434 pounds of cotton seed, these amounts containing equal quantities of nitrogen. The cotton seed was scalded to prevent germination and all fertilizers were applied in the drill April 8. Acid phosphate at the rate of 160 pounds per acre was used on all plots.

Increase from 200 pounds cotton seed meal......2.8 bushels
Increase from 434 pounds cotton seed..........2.3 bushels

This shows a slight superiority the first year for cotton seed meal.

An experiment made in 1897 on similar soil, comparing 200 pounds of cotton seed meal with 434 pounds of cotton seed, all applied when corn was planted, April 7, also resulted in a slight advantage for cotton seed meal.

In 1904 and again in 1905 on the same plots a comparison was made between the following nitrogenous fertilizers:

Cotton seed meal, 200 pounds per acre; cotton seed, 434 pounds; manure (unleached) from feeding steers on cotton seed meal and sorghum hay, 4800 pounds; 100 pounds of nitrate of soda; and a mixture of nitrate of soda and cotton seed meal. To prevent germination the cotton seed were scalded in 1904 and ground in 1905.

Cotton seed meal versus cotton seed, nitrate of soda and stable manure.

Fertilizers per acre.		Yield per acre.			Increase per acre from nitrogenous fertilizers.		
Am't. per acre.	KIND	1904	1905	Av.	1904	1905	Av.
Lbs.		*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bu.*
200 240 48	Cotton seed meal ...... Acid phosphate .... Muriate of potash	22.9	18.9	20.9	1.8	2.2	2.0
434 240 48	Cotton seed .... Acid phosphate .... Muriate of potash	21.0	17.8	19.1	.8	.7	.8
240 48	Acid phosphate .... Muriate of potash	20.2	17.1	18.7	......	......	....
100 240 48	Nitrate of soda, 2nd cult. Acid phosphate .... Muriate of potash	27.3	21.1	24.2	7.1	4.0	5.6
100 50 48 240	Cotton seed meal ...... Nitrate of soda .... Muriate of potash ...... Acid phosphate	25.2	21.2	23.2	5.0	4.1	4.6
33 67 240 48	Nitrate of soda (at plantg Nitrate of soda, 2nd cult Acid phosphate .... Muriate of potash	29.3	24.4	26.8	9.1	7.3	8.2
4800	Manure from steers fed cotton seed meal and hulls or sorghum fodder	24.2	22.3	23.5	4.0	5.2	4.6

This soil did not respond very generously to any of the fertilizers in either year, although it had been rather exhaustively cropped with silage corn, wheat and sorghum, and had borne no leguminous plant for at least two years before the beginning of this experiment.

It is obvious that cotton seed meal was more effective than cotton seed; that a mixture of cotton seed meal and nitrate of soda was still more useful; and that nitrate of soda was more beneficial than any other fertilizer. One pound of nitrate of soda afforded a greater average increase than 48 pounds of manure made under shelter by feeding steers on cotton seed meal and coarse sorghum fodder. Unexpectedly there seems to have been but little cumulative or second-year effect from either cotton seed or manure. This experiment is being continued on the same plots, using wheat as the crop, and we may reasonably expect that as this experiment is continued we shall obtain some cumulative effect from the manure.

There was an advantage both years in applying one-third of the nitrate of soda with the other fertilizers before planting, instead of reserving all this for use at the second cultivation. Nitrate of soda is believed to be the only fertilizer which can be applied to corn with as much advantage after growth begins as before planting.

A number of fertilizer experiments have been made with corn. But these will not be published until some of these tests have been further repeated. In general they point to the conclusion that corn, growing on average upland soil in Alabama, usually requires a fertilizer rich in nitrogen, and that the application of very large amounts of commercial fertilizers for corn is not very profitable.

The following fertilizer formulas for corn are suggested:

(A) 100 lbs. acid phosphate,
50 lbs. nitrate of soda, (both just before planting).
50 lbs. nitrate of soda, at second cultivation.

(B) 100 lbs. acid phosphate
200 lbs. cotton seed meal, (both before planting).

Credit is due to the following for participation in the experiments detailed in this bulletin: T. U. Culver, formerly superintendent of the farm; C. M. Floyd, superintendent of the farm during 1904 and 1905; and L. N. Duncan, assistant in agriculture, who has prepared most of the tables in this bulletin.

APPENDIX

Seed corn from different latitudes.

Year	Variety	Seed from	Yield per acre: Seed from Ill.	Yield per acre: Seed from Gulf Region.	Yield per acre: Seed from Del. & Va.	Increase per acre from: Gulf Region over Ill. seed	Increase per acre from: Va. & Del. over Ill. seed	Increase per acre from: Gulf over Va., Del & Tenn seed.
						Bus.	*Bus.*	*Bus.*
1896	Hickory King	Alabama		16.5		—2.8		
do	do	Illinois	19.3					
do	do	Delaware			15.6		—3.7	
1896	Blount Prolif	Ga. (South)		13.1		—1,1		
	do	Illinois	14.2					
1897	Hickory King	Alabama		12.1		—2.2		
d›	do	Illinois	14.3					
897	Blount Prolif	Ga. (South)		18.9		— .2		
do	do	Illinois	19 1					
1898	Hickory King	Ga. (North)		11.4		1.0		
do	do	Illinois.	10.4					
1898	Blount Prolif.	Ga. (North)		11.0		.5		
do	do	Illinois	10.5					
1899	Blount Prolifi.	Georgia		17.1		1,9		
do	do	Illinois	15 2					
1899	St. Charles	Alabama		15.3		—.8		
do	do	Illinois	16.1					
1900	St. Charles	Ala.(1 year)		34.2		1.1		
do	do	Illinois	33.1					
1900	Blount Prolif.	Ga. (South)		32.2		1.9		
do	do	Illinois	34.1					
do	do	Virginia			36 8		2.7	—4.6
1900	Cocke Prolif	Ga. (South; J.)		32 6 } Av.36.5				
do	do	Ga. (South; A.)		38.4 }				
do	do	Ga. (North)		38.6 }				
do	do	Virginia			41.7			—5.2
1900	King Hickory	Virginia			29.8			
do	do	Delaware			30 4			

Seed corn from different latitudes. (Continued).

Year	VARIETY	Seed from	Yield per acre: Seed from Illinois	Yield per acre: Seed from Gulf Region	Yield per acre: Seed from Va., Del. and Tenn.	Increase per acre: Gulf Region over Illinois seed	Increase per acre: Gulf Region over Va., Del. and Tenn.	Increase per acre: Va., Del, and Tenn. over Ill. seed
1901	Blount	Georgia	....	22.6	....	....	....	....
do.	Blount	Illinois	27.3	....	....	-4.7	....	....
1901	St. Charles White	Alabama	....	18.9	....	....	....	....
do.	St. Charles White	Illinois	24.6	....	....	-5.7	....	....
1903	Hickory King	Georgia	....	20.7	....	.6	....	....
do.	Hickory King	Tenn.	....	....	24.3	....	-3.6	4.2
do.	Hickory King	Illinois	20.1	....	....	....	....	....
1903	St. Charles White	Illinois	23.5	....	....	....	....	....
do.	St. Charles White	Alabama	....	23.9	....	.4	....	....
1904	St. Charles White	Illinois	20.5	....	....	....	....	....
do.	St. Charles White	Alabama	....	27.7	....	7.2	....	....
1904	Cocke	North Ga	....	31.2	....	....	.8	....
do.	Cocke	Virginia	....	....	30.4	....	....	....
do.	Cocke	Tenn.	....	....	33.4	....	2.2	....
1904	Hickory King	Virginia	....	....	31.7	....	-10.7	11.8
do.	Hickory King	Illinois	19.9	....	....	....	....	....
do.	Hickory King	Delaware	....	....	22.7	....	-1.7	2.8
do.	Hickory King	North Ga.	....	21.0	....	1.1	....	....
do.	Hickory King	Tenn.	....	....	22.0	....	-1.0	2.1
1904	Blount	Virginia	....	....	25.2	....	....	....
do.	Blount	Illinois	14.3	....	....	....	....	10.9
1905	Cocke	Alabama	....	28.6	....	....	....	....
do.	Cocke	Tenn.	....	....	30.9	....	-2.3	....

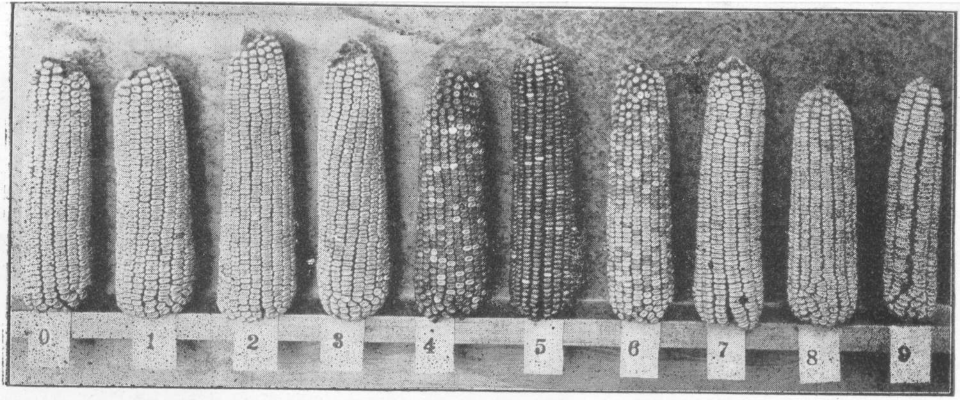


Fig. I. 0, 1 *and* 2, *Boone County White;* 3, *Boone County Special;* 4, *Leaming;* 5, *Experiment Station Yellow;* 6, *Reid Yellow Dent;* 7, *No.* 77 *U. S. Dept Agr.;* 8, *Iowa Silver Mine;* 9, *Hickory King.*

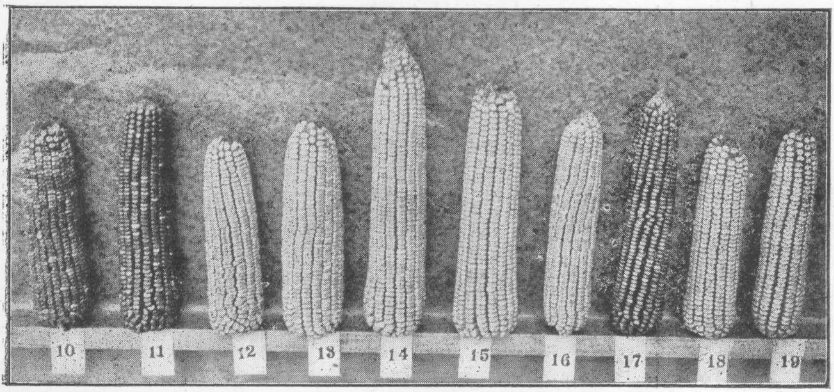


Fig. II. 10, *Riley Favorite;* 11, *Experiment Station Yellow;* 12, *Sanders;* 13, *McMakin's Gourd Seed;* 14, *Local White Cob;* 15, *Henry Grady;* 16, *Mosby;* 17, *Experiment Station Yellow;* 18, *Marlboro;* 19, *Cocke.*

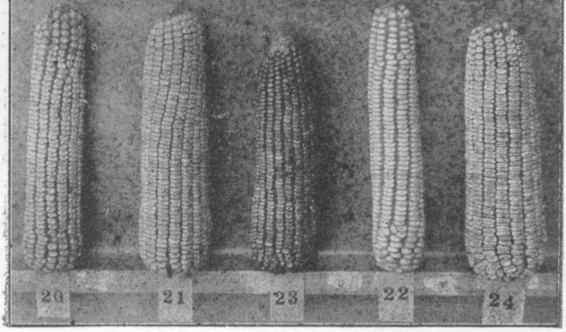


Fig. III. 20, *Cocke;* 21, *Shaw;* 22, *Albemarle;* 23, *Experiment Station Yel-*

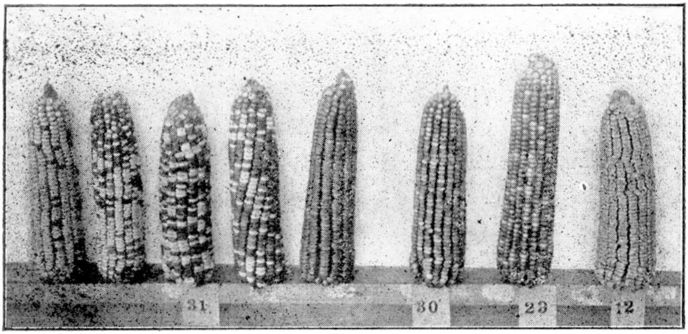
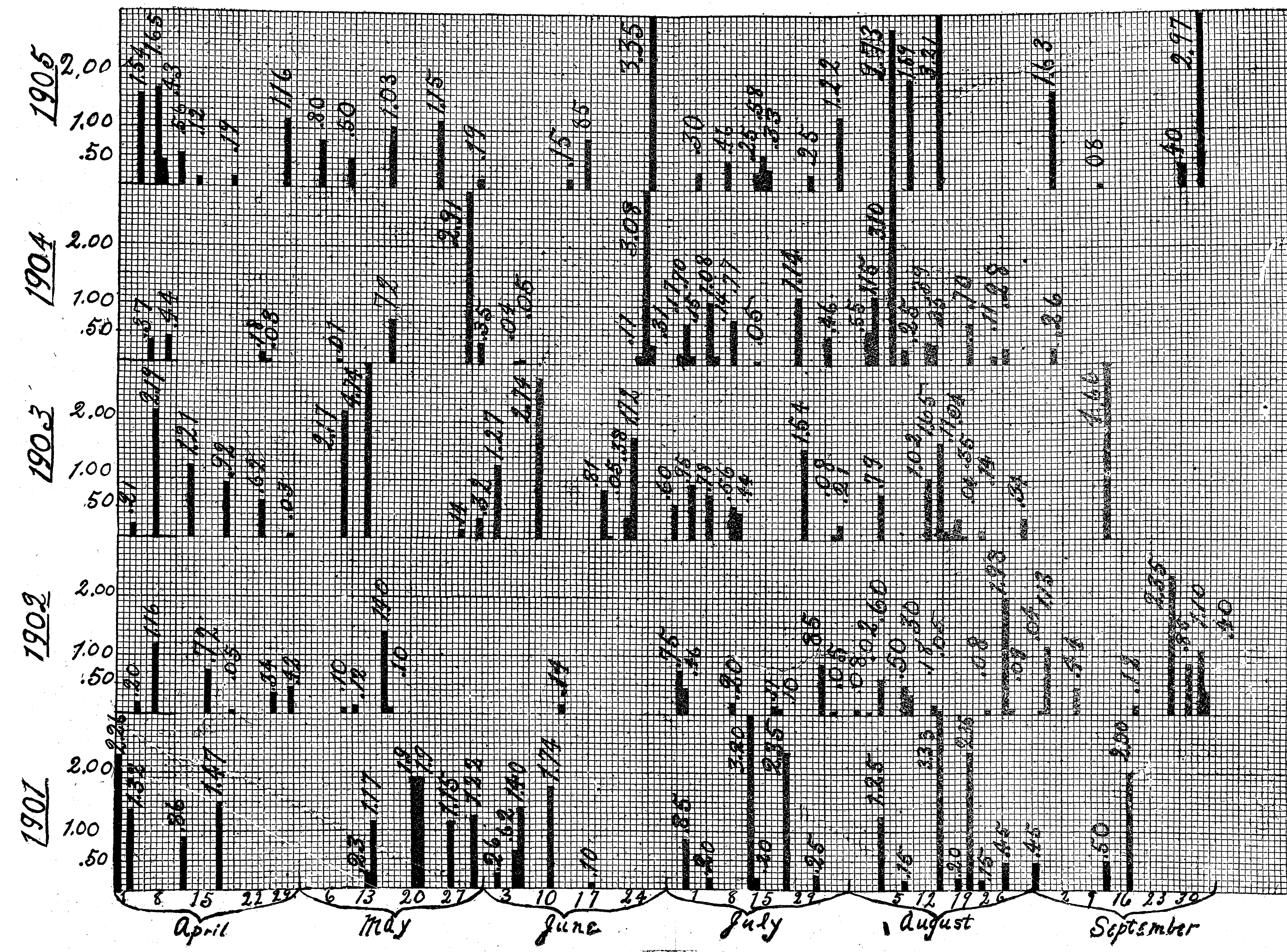


Fig. IV. 31, *Lead colored Mexican June and crosses;* 29 *and* 30, *Experiment Station Yellow, with cross on lead colored Mexican June;* 12, *Sanders, with few lead colored grains.*

Fig. V. White (or ordinary) Mexican June Corn.

Fig. VI. *Rainfall chart in inches for growing season, Auburn, Ala.*, 1901-1905.



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1908

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ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

Diseases of Sweet Potatoes in Alabama.

(A Preliminary Report.)

BY

E. MEAD WILCOX, Ph. D.,
Plant Physiologist and Pathologist.

Opelika, Ala.:
The Post Publishing Company,
1906.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

DISEASES OF SWEET POTATOES IN ALABAMA

E. MEAD WILCOX, PH. D.

INTRODUCTION.

The sweet-potato crop in Alabama is one of importance and one that, no doubt, will increase in value from year to year. At present Alabama stands fourth in order among the sweet-potato growing states. According to the census report for 1900, covering the year 1899, Alabama produced 3,457,386 bushels of sweet potatoes on 50,865 acres. Assuming the average value of the crop as $0.49 cents per bushel, as done in this report, the average value of this crop per acre during 1899 was $33.17. The following counties produced over 100,000 bushels: Dallas, Henry, Jefferson, Montgomery and Wilcox; and Montgomery county produced 163,832 bushels.

The value of the crop is much enhanced if it is possible to hold it until it can command the much higher prices that prevail during the winter and early spring. Methods of storage, therefore, deserve attention and it is our plan to make a thorough investigation of the subject in connection with some of the growers who now try to hold over a part or all of their crop. Some of the diseases which are mentioned in this bulletin are most serious obstacles to the storage of sweet-potatoes, and it is here largely, rather than during the growing season, that sweet-potato diseases cause the greatest losses. It has seemed wise in advance of the publication of our study of storage methods to publish here a summary of our present knowledge of sweet-potato diseases to include the work upon the subject done here and elsewhere.

It is hoped and urgently requested that all who grow sweet potatoes will assist us in this investigation by reporting all sweet potato diseases to this office promptly, accompanied by specimens of the diseased plants. In this manner

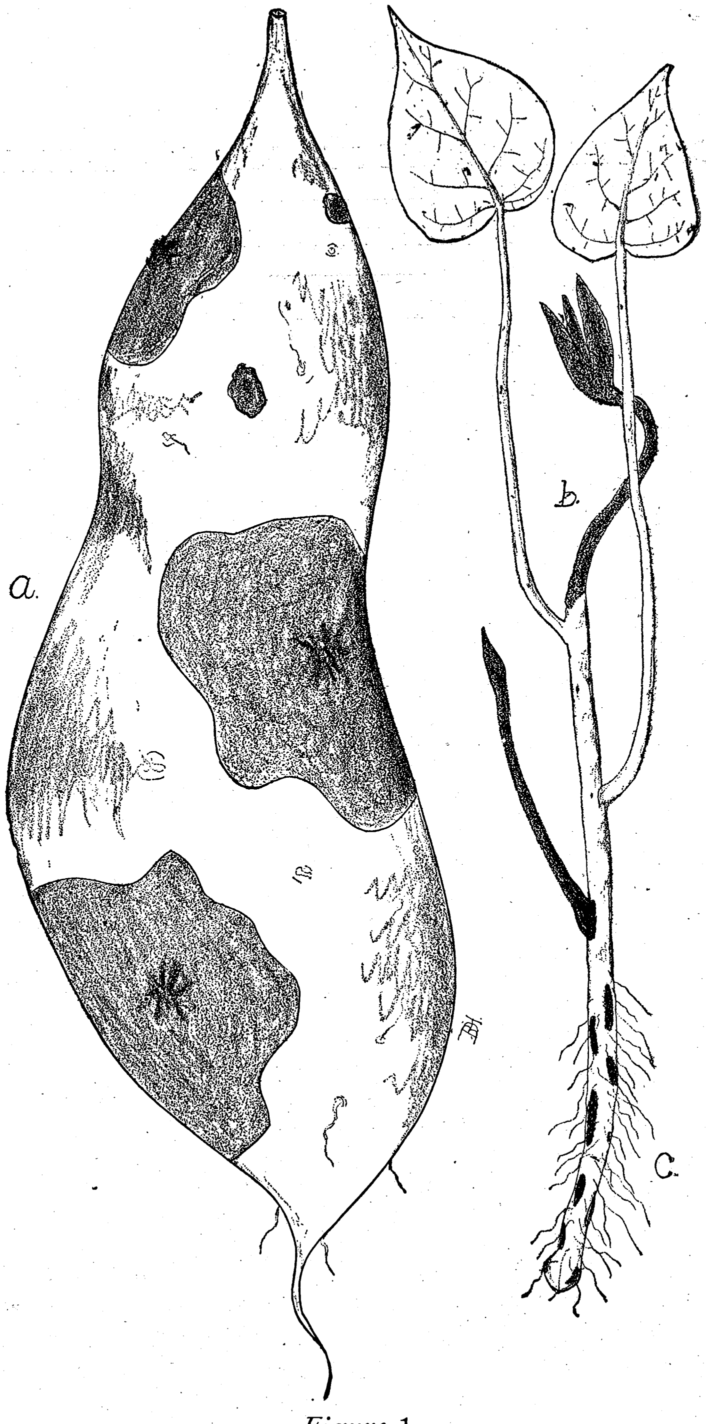

Figure 1.

we can become acquainted with the distribution and peculiarities of each of these and other diseases in this State. We shall be glad to learn also of the methods of storage now being employed in various parts of the State, and correspondence upon this matter is invited.

The present bulletin has been prepared largely from the notes submitted by W. M. Lewallen and H. F. McElderry as a thesis for the bachelor's degree June, 1906. To these gentlemen my thanks are due for the assistance rendered in this work and in the working out of the life histories of the various organisms, all of which will be published at a later date. Thanks are due Dr. B. D. Halsted of the New Jersey Experiment Station for the loan of the cuts.

BLACK ROT.

This disease may be recognized by the formation on the root of olive-brown or greenish spots. **See Fig. 1. A.** At first these diseased spots may be very small but as the dis ease progresses they become larger and extend deeper into the tissues of the potato until finally the entire root may turn black. Potatoes affected with this disease acquire a very characteristic bitter taste and are utterly unfit for eating. The troublesome feature about this disease is the fact that it may escape notice at the time of harvest but, if storage conditions are favorable to the growth of the fungus, much damage to the crop may result during storage. This, unlike the soft rot, is a dry rot.

This same disease attacks also the young sprouts, and in this case is at times called "black shank." See Fig. 1. B. Dark colored spots or lines are formed and these in extreme cases may completely girdle the stem. In that case the plant will be killed outright, but in any case it is apt to be very much injured and rendered of very little value.

It must be kept in mind that if diseased roots are used to secure the "sets" that these sets are very apt to have the disease on their stems. And more than this, the disease may be carried over for several years in the soil, the fungus causing the trouble being able to live for some time in this manner.

The disease is caused by the fungus known to scientists as *Ceratocystis fimbriata.*. This fungus produces three distinct sorts of spores and is therefore well provided with reproductive bodies. In addition to these methods of reproduction the fungus produces hard dark colored roundish bodies inside of the root known as sclerotia. See Fig. 2. These are simply compact masses of the vegetative filaments of the fungus, but each one of these masses is capable of developing the other stages and spores of the fungus. These black spots within a root in which the disease has made considerable progress are certain indications of the presence of the black rot.

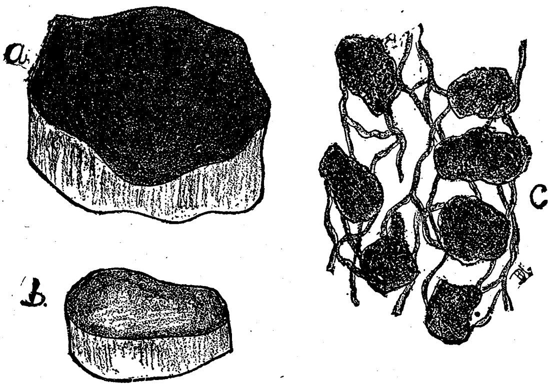

Figure 2.

The most important remedial measures to be suggested against this disease are the following:

1. Never employ diseased roots to secure sets.
2. Destroy by burning all diseased roots and sets and do not feed the diseased roots to animals if the resulting manure is to be placed upon the field where the potatoes are to be grown.
3. In general, commercial fertilizers are preferable in sweet potato culture on the above account and particularly in the beds employed for the growing of the sets.
4. As you select your sets it may be well to lift the root and discard sets coming from roots showing the rot.

5. Do not place diseased potatoes in storage as the loss may be very great.

6. The young sets if diseased may be sprayed with Bordeaux mixture.

7. If the disease has proven serious during the past year it would be well to mix a tablespoonful of sulphur with the soil about each set as it is planted.

8. Practice rotation of fields if one field becomes too badly infected with the fungus.

9. Collect and burn all diseased roots and stems!

Dry Rot.

This disease appears only on the underground portions of the plant. The whole upper end of the root becomes much wrinkled and covered with small pimples, and this condition rapidly progresses downwards until the whole of the root is diseased. The interior of the rot is converted into a dry powdery mass with very little change of color.

The dry rot is caused by the fungus known as *Phoma batatae.* The spores of this fungus are produced in small flask-shaped cavities just beneath the surface of the potato root—these cavities give to the diseased potato the pimply appearance referred to above.

The only remedy to be applied in this case consists in taking care to collect and burn all roots showing this disease, so that the numerous small spores formed in the cavities described may not become scattered over the entire field.

SCURF.

This disease attacks the root only and on it first makes its appearance as a small brownish speck. This enlarges and large areas of the root may become affected, assuming a dark color and rough character and at times shrivelling to a considerable extent. The disease does not affect the interior of the root but is confined to the surface.

This also is a fungus disease and is caused by the fungus called *Monilochaetes infuscans.* So far we have not met this disease in Alabama. The most practical method of treatment, where it is found, is simply to discard and burn all affected roots to avoid scattering the spores about the field.

SOFT ROT

This disease is rarely found at harvest time and never appears upon the stem or leaves of the plant. It is confined strictly to the roots and there even is largely a storage trouble. In Alabama it appears to be by far the most important of the diseases affecting the roots during storage. As a rule the fungus gains entrance to the root near the top at the point where it was separated from the stem at harvest time. As the disease extends throughout the root the latter becomes somewhat shrivelled. But the most characteristic indication of the presence of this disease is the fact that a diseased potato when broken open is found to consist of a black mass, the color being due to the spores which are formed in great quantities. If the skin of the potato is not broken no spores are formed and the fungus in that case simply grows throughout the interior of root. But in all cases the root soon acquires a very disagreeable and characteristic odor. The spores form only when the potato is broken or injured but the growth of the vegetative portion of the fungus destroys the value of the potato.

This trouble is due to the cosmopolitan fungus *Rhizopus nigricans.* The spores are born inside of globular sacs produced one at the end of threads that grow upright from the injured surface of the potato. These sacs are large enough to be seen readily with the unaided eye and if one is in doubt as to which fungus is causing trouble in any particular case it is only necessary to place a broken potato under a jelly glass and keep it moist for a few days. It will be found to be covered with a whitish coating composed of the interwoven vegetative threads of the fungus and with these many of the erect spore-bearing threads, the older of which have turned black due to the color of the contained spores.

The treatment to be applied against this rot may best be indicated by the following outline:

1. Since the fungus gains entrance to the roots through

injury of the root great care should be taken in digging and storing to injure as few roots as possible and to store none that are broken or badly bruised.

2. During the sweating period just after the roots are stored care should be taken to see that proper ventilation is provided and that the temperature be kept at about 70 degrees. The temperature, in case enough roots are stored to make the erection of a regular storage house profitable, may best be secured by means of a small stove.

3. Where the roots are stored in the usual dirt covered piles it is important not to let water get on them whenever they are opened to remove any potatoes. The fungus requires a certain amount of moisture for its most rapid development, and this is too often furnished by carelessness in opening these piles.

4. Do not store any potatoes affected with the soft rot; and remove and burn any that may be found in the storage bins during the winter.

SOIL ROT.

This unlike the preceding diseases is a strict field disease and no damage from it may be expected after harvest time. Its principal damage is done early in the season. It is characterized by the fact that the affected parts of the root cease to grow while the adjacent portions not only continue growing but remain perfectly healthy and edible. See Fig. 3. The first indication of the disease will be found generally about the base of one of the small rootlets and it seems that the fungus can gain entrance to the main root only through these young delicate rootlets.

This disease is caused by the fungus *Acrocystis batatas.* The spores in this case are so small that when they escape from the diseased portions of an affected potato they may be carried about in the field or to other fields in the air. In this manner fields become infested that have never grown a crop of potatoes.

Halsted has shown that kainit and sulphur sown broadcast in the field before planting will greatly reduce the amount of the soil rot even when the soil is known to be

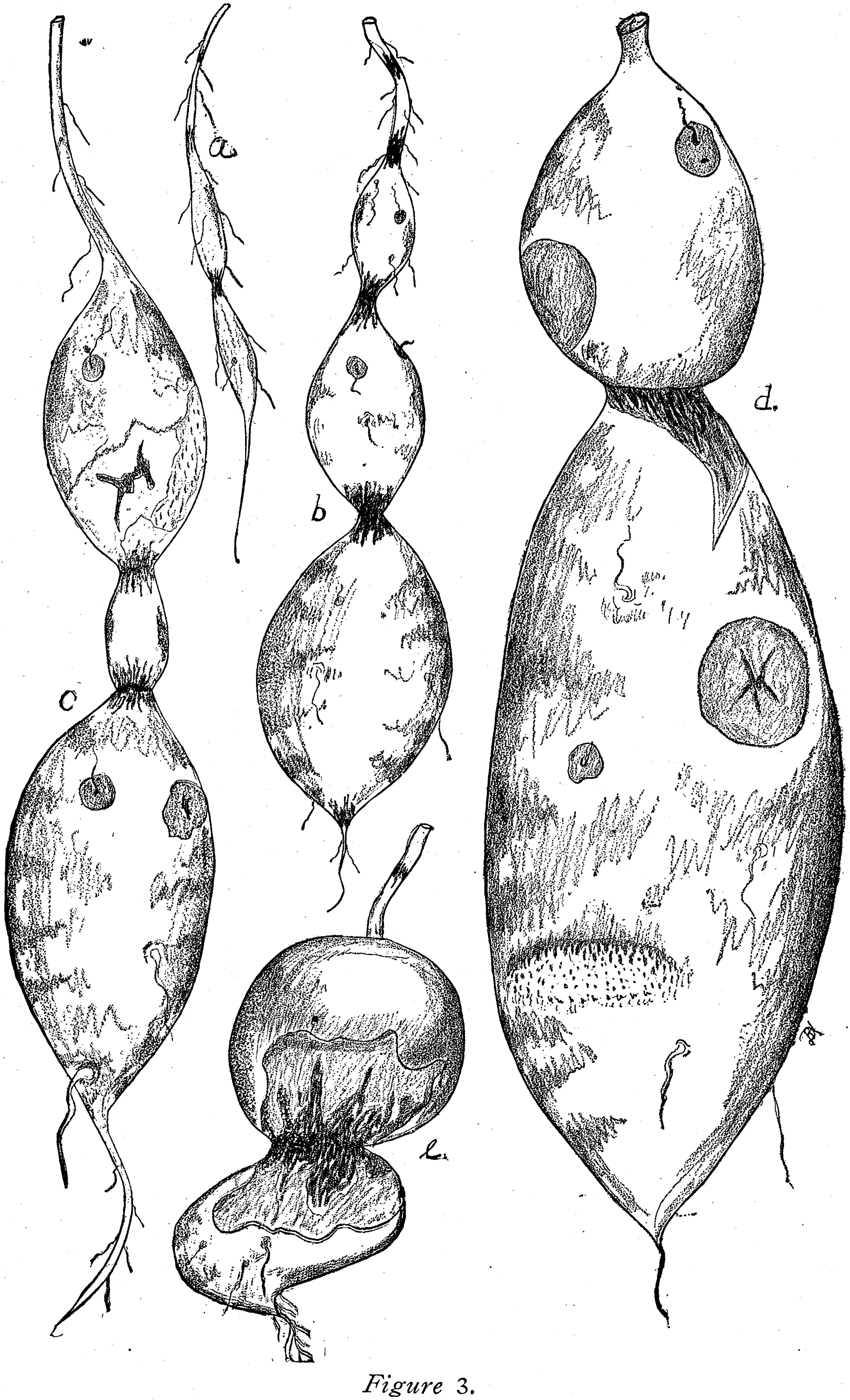

Figure 3.

badly infested with the spores of the fungus. He suggests three or four hundred pounds of each per acre. It is remarkable that this disease is most serius during dry seasons and this may be due to the fact that the plants are at such times unable to overcome the injury of the fungus and put out new roots.

STEM ROT.

This disease first appears in that portion of the stem at the surface of the ground and grows from there in both directions. See Fig. 4. And generally the entire vine dies

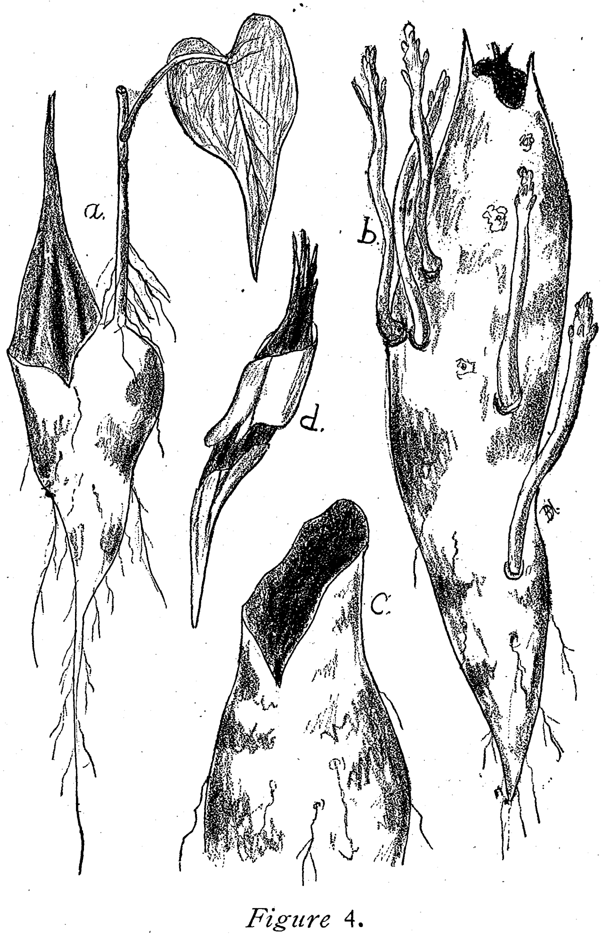

Figure 4.

as a result of this injury to the base of the stem. In the meantime the rot extends downward into the roots and the whole hill may be rendered of no value. This is also a field disease and does no damage during storage of the roots.

This disease is caused by the fungus *Nectria ipomoeae*. The spores of this fungus also retain their vitality for some time in the soil.

No method of treatment is known except that of long rotation periods between potato crops to starve the fungus out.

WHITE ROT.

This is one of the most serious troubles with us in Alabama, and during the past three years roots affected with this trouble could be found in any of the local markets. The fungus attacks the roots only and changes the tissues of the root into a granular whitish substance. No odor is generated and hence the trouble is generally overlooked but cultures of the fungus have often been made to establish the identity of the decay.

The fungus is a species similar to the mold that often appears upon decaying bread or other organic materials. The spores are produced in immense numbers and are greenish-blue in color. They live in the soil for some time and this determines the proper method of treatment to be followed.

Care should be taken not to plant sets coming from roots infected with this disease and none of the diseased roots should be placed in the storage bins. No other method of treatment is at present known.

BLACK ROT.

Burnette, F. H.

1894 Black Rot. (*Ceratocystis fimbriata*, E. & Hals.) Bull. La. Exp. Stat. ii-30: 1086-1089. fig. B-C.

Chester, F. D.

1891 The Black Rot of the Sweet Potato. *Ceratocystis fimbriata*. Rept. Del. Exp. Stat. 3-1890: 90-91.

1897 Experiment on the use of sulphur as a preventive of black rot of sweet potatoes. Bull. Del. Exp. Stat. 34: 21-22.

Duggar, J. F.

1895 Black Rot (*Ceratocystis fimbriata*) Farmers' Bulletin 26: 21-22. fig. 2.

Halsted, B. D.

1890 Some Fungous Diseases of the Sweet Potato. The Black Rot. Bull. N. J. Exp. Stat. 76: 7-14. fig. 3-10.

1891 Black Rot. Rept. N. J. Exp. Stat. 1890: 339.

1891 Field work of the season. Rept. N. J. Exp. Stat. 1890: 341-344.

1891 Field Experiments with Soil and Black Rots of Sweet Potatoes. Special Bull. N. J. Exp. Stat M: 1-19.

1892 Field Experiments with Soil and Black Rots of Sweet Potatoes. Rept. N. J. Exp. Stat. 1891: 260-266. fig. 15. This is a reprint of Special Bulletin M.

1895 Some of the More Injurious Fungi Upon Market-Garden Crops. Sweet Potato. Rept. N. J. Exp. Stat. 1894: 359.

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Chicken-Pox or Sore-Head in Poultry

BY

C. A. CARY

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CHICKEN-POX, SORE-HEAD OR CONTAGIOUS EPITHELIOMA IN POULTRY

By C. A. Cary.

INTRODUCTION.

This disease occurs in nearly every county in Alabama during the spring summer or fall of every year. It is more prevalent among young chickens, from broilers to maturity; yet younger and older chickens may have this disease. It is a common poultry disease and very probably more deaths occur from sore-head than from any other poultry disease in Alabama. Such a high mortality can be avoided with proper care and treatment.

The poultry industry in Alabama is not as extensive and as carefully and thoroughly worked as it should be. The extensive home markets in the mining and manufacturing regions of the South will take care of a much larger supply of chickens, ducks, turkeys and pigeons. The conditions in the South are ideal if the poultry business is conducted with that care and knowledge which are required in any place to bring success. With a small capital, plenty of regular work applied intelligently, it will bring as good returns as any line of the live-stock industry.

FORMS OF THIS DISEASE.

There are no positive differences between the various forms of diphtheria, roup and chicken pox or "sore-head" other than the locality in which the lesions occur; and possibly the per cent. of mortality in the different forms of the disease. Usually when the mouth, throat, air passages or alimentary canal in one or more places is peculiarly inflamed so that an organized or solid exudate is formed on the surface of the inflamed mcous membrane and that membrane bleeds rather freely when the diphtheritic exudate is torn away—such a diseased condition is called fowl (avian) *diphtheria.*

If the nasal passages and the cavities connected therewith have their mucous membrane inflamed producing a catarrhal (mucous) exudate, or solid, dried pus-like exudate in the nasal cavities, and sometimes pushing outward the tissues around the eyes—such a diseased condition is called "roup."

If the skin of the wattles, comb, ear lobes, eyelids or of the head and sometimes the conjunctiva (the mucous membrane lining, the eye-lids and reflected over the front part of the eye-ball) becomes inflamed in such a way as to produce crusts or scabs or an exudate of dried pus, broken down epithelical cells, etc—such a condition is called chicken-pox or "sore-head" or *epithelioma contagiosum.*

CAUSES.

The causes of these diseases, or this disease, have been attributed to coccidia (one-celled protozoa) to various bacteria and to ultra-microscopical organisms.

Neumann (11) gives the following:

"*Coccidia* or *Psorospermiae oviformes* constitute, in the class of sporozoa, an order in which the majority of the species belonging to it live as parasites in the interior of epithelial cells of the liver, intestine, skin, etc. At the commencement of their development these coccidia form small protoplasmic regularly rounded masses, which are usually nucleated. Gradually each of these masses increases in volume and becomes surrounded by a transparent membrane—the *cyst* or *shell*—and rupturing the cell into which it had penetrated, it falls into the biliary ducts, the intestine, the epidermic layers, etc. Thus liberated, the encysted coccidium passes through a phase of segmentation—its protoplasm becoming condensed, then dividing into several spheres or spores, Each spore in its turn subdivides into a number of corpuscles—*falciform corpuscles*—which, meeting with favorable conditions each becomes a new amœboid individual that invades an epithelial or epidermic cell, grows there and recommences the cycle of its progenitor."

Ostertag (9) says:

"Coccidia are parasites of epithelia. They are small, spherical or oval structures which destroy the epithelial cells by their rapid growth and then divide into a number of parts. These penetrate into the intact epithelia of the infested organ (*merozoites*) or become changed into microgametes and macrogametes (male and female sexual cells). By the copulation of these forms sporoblasts are produced and, finally, permanent forms with shells (*sporozoïtes*) arise. The latter cause infestation of new hosts." The sporoblasts (a) are elongated, oval and surrounded by a double capsule, at first the protoplasm entirely fills the capsule as a coarsely granular mass, but soon becomes contracted into a sphere from which four sporozoits arise. In the rabbits' liver infested with coccidia, round, white, abscess-like foci are formed.

Friedberger and Frohner (13) give the following:

Coccidia "are at first naked inhabitants of epithelial cells. By penetrating into the cells of the mucous membrane and by filling up these cells (in many cases completely, so that the enclosed coccidia assume the appearance of large nuclei), they produce grave disturbance of nutrition and this tends to induce necrosis of the parts attacked." "Gregarinous croupy diphtheritis is distinguished by the ease with which the disease extends from the mouth to the skin of the head. It can be readily transmited artificially, and is generally not difficult to cure, especially when it is confined to the mucous membrane of the mouth, pharynx, upper part of larynx and skin."

"The clinical phenomena of avian gregarinous (coccidian) diphtheritis agrees in all particulars with those of bacterial diphtheritis when these respective complaints affect the mucous membrane of the head. Here, also, the symptoms are essentially those of croupy diphtheritis of the mucous membrane of the mouth, pharnyx, air passages of the head, larynx, conjunctiva, etc., with secondary intestinal affections. Gregarines may also give rise to primary and independent enteritis (Zurn)."

"In gregarinous diphtheritis, the skin is much more frequently implicated than in diphtheritis caused by bacteria. The cutaneous affection consists of hypertrophied nodules on the skin, which are known as gerarinous epitheliomata (*epithelioma gregarinosum* of Bollinger, and are identical *with molluscum contagiosum* of man.). Their favorite seats are those parts of the head that are not covered with feathers; root of the beak, neighborhoood of the nostrils, angles of the mouth, lobes of the ear, parts adjacent to the auditory meatus, wattles, surface of the face, edges of the eyelids, intermaxillary space, and especially the comb. They sometimes spread over the feathered parts of the head, throat and neck, and may occur on the outer surface of the thighs, abdomen, under the wings and in the vicinity of the cloaca. At first these epitheliomata appear in the skin, as flat uodules, which soon become prominent, and which vary in size from a poppy seed to a millet seed. Later on, they usually attain the size of a hemp seed. They are of a reddish-grey or yelllowish-grey color, often show distinctly in their earlier stages of development a peculiar greasy, nacreous lustre; and are rather firm to the touch. Their surface soon becomes covered with a dirty-grey, yellow-brown or red-brown crust. They are discrete and disseminated in considerable numbers on the erectile tissues, etc. They vary in size according to their age; and frequently lie rather close to one another, so that the affected parts looks as if coarsely granulated; or they are crowded together in such a manner as to give the appearance of large warts with divisions through them, or mulberry-like hypertrophies. Even single nodules, to say nothing of groups, may attain the size of a lentil, pea, cherry-stone, broad bean or larger object. The older they become the rougher, and more covered with knobs will be their incrusted surface."

"If the edges of the eye-lids be affected by these tumors, the lids will become nodular, swollen and closed. The conjunctiva in this case also suffers; it projects outward; becomes catarrhally inflamed; assumes a yellowish color at the seat of eruption; and its surface becomse covered with crusts. Purulent conjunctivitis may appear and the inflammation may spread to the sclerotic and cornea, with keratitis and panophthalmia as the result. If, as sometimse happens with pigeons, the eruption of nodules extends over the whole of the skin of the eye-lids and its neighborhood, the entire eye will become covered with mulberry-like proliferations of various sizes.

COCCIDIA IN ANIMALS.

Coccidia (*C. oviforme* and *perforans*) have been reported as occuring in the following places in animals.

1. Leuckart (7) and many others have found coccidia in the bile ducts of rabbits there attacking the epithelium of the ducts, and in many cases causing the death ofthe rabbits.

2. Johne (8) and Ostertag (9) report coccidia in the liver of swine.

3. Birch-Hirschfeld (10) states that coccidia have been found "in the respiratory passages of rabbits, dogs, cats, calves, sheep, and birds, producing circumscribed or diffuse inflammation of the mucosa and submucosa, even superficial ulceration, which in many instances appears as infectious and results in numerous fatalities. He calls especial attention to the diphtheritic inflammation in the mucosa of fowl; its extension to the intestinal mucosa and the mesentaric lymph glands.

4. Ostertag (9) says *C, perforans* is found in the intestinal epithelia of rabbits producing a desquamative catarrh

of the entire intestinal tract and in consequence profuse diarrhœa.

5. Ostertag (9) also reports that in some of the Swiss cantons there is a disease called "dysenteria hæmorrhagica coccidiosa." The coccidia are found in the longitudinal folds of the mucous membrane of the colon and were oval or spherical and contained nuclei three times as large as those of epitheial cells. One observer says these are *C. oviforme.*

6. Ostertag (9) also reports *Coccidium tenellum* as an opizootic, croupous, diphtheritic enteritis in poultry and during the progresss of the disease or infestation the coccidia invade the mesenteric lymph glands producing disintegration foci.

7. Friedberger and Frohner (13) state that coccidia are very widely distributed as parasites in the animal kingdom and are found in birds, rabbits, rats, dogs, fish, snails, and earthworms. The diphtheritic products contain cast-off epithelial cells which contain in their interior a rounded body which fills up half or more of the cell-space and looks like a greatly enlarged nucleus. These bodies are highly refractive and have a greasy, glassy lustre, and swollen homogenous appearance. These spherical formations are also found free and in varying numbers in the croupy diphtheritic excretions of skin nodules in cocccidian diphtheria of chickens.

8. Moussu and Marotel (15) report coccidia in the intestines of sheep prducing hyperæmia and necrotic lesions in the mucosa.

9. Eckardt (16) found *Coccidium tennulum* in great numbers in the intestines of chickens, producing diarrhœa, great emaciation and intensely blue comb and wattles.

10. According to Nocard and Leclainche, (14) Rivolta, in 1869 found coccidia in the false membranes of diphtheria.

11. Thoma (18) says *C. perforans* has been reported as occurring in man, dogs, cats, rabbits and mice.

Coccidia (*Coccidium oviforme*) has been reported as occurring in the following diseases or conditions in man:

1. In the intestinal canal in two instances (2).
2. In *contagious epithelioma* (*molluscum contagiosum*) (1) a skin disease in man.
3. According to Leuckart (3) numerous cases of coccidia in the liver of man have been reported by Virchow, Dressler, Sattler, Peris, etc.
4. Padwyssozki (4) reports a case of extensive infestation of the liver of a man.
5. Peters (5) reports "ingekapselta gregarinen"—coccidia—in the diphtheritic membrane of six cases of diphtheria in man.
6. Leuckart (3) reports the records of Lindemann who found coccidia in the human kidney and also in one instance on the hair of the head of a young girl, where it was supposed to cause considerable irritation.
7. L. Pfeifer (6) reports coccidia in small-pox lymph.

The life history of coccidia has not been completely worked out. Johne, in Birch-Hirschfeld's book, (10) gives the characters and life history of *coccidium oviforme* as studied in rabbits, He says it is 0.03 to 0.037 Mm. long and 0.015 to 0.02 Mm. broad. The mature form consists at first, of the finely granular protoplasm which occupies the entire space in the cell (a fig. 5). In this stage the shell or wall of the cell may be quite thin but later it becomes thicker and apparently double contoured. In the next stage the protoplasm becomes contracted into a spherical granular mass (b fig. 5). In about four weeks (?) the proplasm is divided into 4 round granular spore-like bodies (c fig. 5) which later become the C-shaped bodies as observed in d. e. and f. in fig. 5. When these are taken into the stomach of a rabbit, the old capsule is dissolved and the spores or embryonic masses are set free and have amoebe-like movements and characters; in this condition they pass from the intestine into the bile ducts where they penetrate the epithelial cells and develop into the stage (a) in fig. 5. In doing this they destroy the epithelial cells.

The following bacteria have been found in diphtheria, roup and sore-head in fowls:

Loeffler (26) in 1884 found a bacterium in diphtheria of pigeons and claimed that he produced the disease by inoculation with pure cultures of the germ.

Loir and Ducloux (27), Haushalter (28) and Quaranta (29) have found a bacillus or motile germ in the diphtheritic exudate of fowls.

Moore (25) in 1895 isolated from chicken diphtheria a bacterium belonging to the haemorrhagic septicaemia group. In later years he failed to find this germ in other outbreaks. Moore states that the real cause of diphtheria, roup and chicken-pox has not been discovered.

Cornil and Megin (30) in 1885 found a germ similar to Loeffler's bacterium in lesions of the mucous membrane and of the skin of fowls.

Von Krajewski (31) discovered the bacterium of Loeffler in the lesions of poultry and transmitted the disease to pigeons and young chickens by inoculation on the mucous membrane.

Babes e Puscarin (32) found the Loeffler germ in the diphtheria of pigeons and described its mode of action in the tissues.

Eberlein (33) in 1894 found a bacillus in the diphtheria of the partridge.

Harrison and Streit (21) discovered in the blood under the diphtheritic exudate of roup or diphtheria in chickens and pigeons a short motile germ (*Bacillus cacosmus*); and after passing the pure culture through pigeons to intensify its virulency, produced the disease in healthy chickens by inoculation. They also isolated the green pus germ (*Pseudomonas pyocyanae*) from the lesions in chickens and produced the disease by inoculation. Moreover they found bodies in and among the epithelial cells of the exudates and tissues; these bodies may represent stages in coccidial life. They also found yeast cells in the diphtheritic exudates.

Gallez (34) isolated from the lesions in nasal mucuous membrane of chickens having contagious coryza (roup) a germ that he claimed was identical with the Klebs-Loeffler germ of human diphtheria.

Ferre (35) reports that he found the human diphtheria germ in the lesions of chicken diphtheria and he also found the germ on the mucous membranes of healthy chickens.

Gratia and Lienaux (36) isolated from diphtheritic pigeons a germ that closely resembles the human diphtheria microbe.

Harrison (23) made a number of tests with human diphtheria antitoxine and for the human diphtheria germ in chickens and pigeons and could not produce diphtheria in chickens by inoculating them with the human diphtheria germ. He also failed to find the germ of human diphtheria by examining over two hundred chickens affected with roup or diphtheria. He concludes that there is no relation between human and fowl diphtheria.

Guerin (37) makes a positive statement that there is no relation between human and avian diphtheria.

Moore, in his Pathology of Infectious Diseases of Animals gives the following records:

"The non-identity of these diseases (human and avian diphtheria) has been clearly pointed out by Menard (43). Although these maladies are shown by several observations to be unlike in their etiology and character of the lesions, the transmission of fowl diphtheria to the human species, and vice versa, is affirmed by several writers."

"Gerhardt (38) reports four cases of diptheria in Wesselhausen, Baden, among six workmen who had charge of several thousand fowls, many of which died of diphtheria. There were no other cases of diphtheria in the neighborhood and the evidence was quit conclusive that the disease was contracted from the affected fowls."

"Debrie (39) repórts briefly the transmission of human diphtheria to fowls. He is inclined to believe that human diphtheria is transmissible to fowls and fowl diphtheria to man. Cole (42) reports a case of supposed transmission of the disease from a fowl to a child."

"The diphtheritic disease of fowls reported by Loir and Ducloux (27) in Tunis, in 1894, spread to the people of that place, resulting in an epidemic of serious proportions. Menard (41) refers to the fact that men employed to feed young squabs contracted diphtheria by blowing the masticated food into the mouth and crop of squabs suffering with that disease. Schrevens (40) reports several cases of diphtheria in children in which he traces the sources of infection to certain poultry."

"Guerin (37) has pointed out with emphasis that there is no relation between diphtheria in man and in fowls."

Moore further states that until the relation between human and fowl diphtheria is positively determined it is wise to handle diseased fowls with care and especially keep all susceptible children away from diphtheritic chickens and pigeons.

M. Juliusberg (Deut. Med. Wochenschr, 30 (1904), No. 43, pp. 1576-1577), study of contagious epithelioma of pigeons and chickens is reviewed by Wilcox in the Experiment Station Record, for April, 1905, as follows:

"As a result of the study of the cause and symptoms of these diseases as well as the virus, it is found that the virus of pigeon-pox may be filtered in the same manner as the virus of chicken pox.

The incubation period of both pigeon and chicken pox after inoculation with filtered virus is about twice as long as after direct inoculation with the substance of the tumors (nodules or crusts). It was found that the repeated passage of the virus of pigeon-pox through animals attenuated it to such an extent that it finally became non-virulent. The adddition of erythrosin in 1 per cent. solution destroyed the virus. None of the pure cultures of yeasts, cocci, or bacilli obtained from contagious epithelioma were found to be pathogenic for pigeons or chickens.

BACTERIA OBTAINED FROM SORE-HEAD CASES.

(a) Dec. 2 1903. Obtained following germ from crust of naturally infected chicken:

Long, round end bacillus, usually in filaments forms spores: 1.6 to 2.8 long and 0.5 micro-millimeters wide; slightly motile, flagella peritrichic; takes Gram's stain. Blood serum growth crumpled becoming mealy and greyish white.

Agar plate—growth on surface irregular, streaming and to naked eye appears like ground glass. Agar stroke is rugose, becoming mealy and grey-white. Gelatine liquified and pellicle on surface. Bouillon—at first a crumpled film; then mealy, flaky pellicle; flaky precipitate. Litmus milk coagulated and peptonized slowly. Gas is produced in lactose bouillon.

Potato growth is at first watery, and later becomes white crumpled and mealy.

This germ is closely related to bacillus subtilis. Inoculated a field lark with negative results.

(b). Dec. 6, 1903, obtained following germ from eye exudate of sore-head chicken:

Bacillus 1.5 to 2 times as long as broad. In old cultures it appears beaded. It is motile. Does not liquify gelatine; in gelatine stab the growth is filamentious; colony on surface has wavy edges and is finely granular. Colony on agar surface white, finely granular, edges even or slightly lobed; colony two-zoned. Hydrogen and carbon dioxide gas in glucose bouillon. No gas in sacchrose bouillon. Inoculated field lark by smearing scarified conjunctiva. Negative results. Inoculated chicken by smearing scarified conjunctiva—negative results.

(c). Germ from sore-head chicken, taken from blood under crust on comb. Oval or short rod with round ends; 1 to 1.6m long by 0.4 broad; and agar white round raised colony: does not take Gram's stain; motile with peritrichie flagella; forms irregular light grey growth on surface of litmus gelatine; does not liquify gelatine; on neutral agar light gray growth. On potato the growth is gray in 24 hours and later becomes brown. It decolorizes litmus milk and coagulates it. Produces gas in acid, lactose agar and increases the acid color.

Tested by smearing sacrified surface on chicken and by injection under skin. Negative results.

(d) Germ obtained from sore-head crust; coccus occurring in masses, sometimes single and sometimes short chains; growth on gelatine surface a wax-like yellow and very slight growth in depth. Gelatine not liquified; germ nonmotile; takes Gram's stain; a lustrous yellow growth on blood serum. No gas in glucose, sacchrose or lactose bouillon. This germ was not tested by inoculation.

(e) Germ derived from crust of sore-head chicken. Large germ round ends; not motile; does not take Gram's stain; very slow growth in depth of gelatine at room temperature; in agar stab growth largely along depth of stab; slight brownish growth on blood serum; alkaline bouillon slight turbidity; acid bouillon heavy turbidity and precipitate at bottom of tube. This germ produces fermentation in glucose sacchrose and lactose bouillon. It may be a coli group germ or the *Bacterium aerogenes* of Escherich.

Inoculation of one chicken failed to give positive results.

(f) Obtained from crust of sore-head chicken, a coccus with following characters: It appears in two's, chains of six or eight and in masses; is motile and has one flagellum; it takes Gram's stain; yellow line growth from stroke on blood serum; milk not coagulated, yellow growth collects at bottom; in bouillon yellow or white cloudy growth at bottom; colonies on agar surface produce diffuse cloudiness; does not liquify gelatine; on potato the growth is slow and yellow. Inoculated pigeons (b) and (c) with negative results This germ corresponds closely to Chester's description of *Planococous citreus*.

(g) Yeast.

(h) A streptococcus—negative results from inoculation.

(i) A germ that stained like a young culture of human diphtheria bacilli. Unable to transmit it by inoculation.

(j) *Pseudomonas pyocyanae.* Found quite common in all forms of sore-head, roup and avian diphtheria.

(k) Molds of various kinds are often found in sore-head crusts.

INOCULATION TESTS.

Inoculation tests with Pseudomonas pyocyanae, other germs, and exudate from natural cases of sore-head.

1. Brown chick, 3 months old. December 1, scraped rose comb and left wattle ; then rubbed into raw places green pus germ (pure culture from sore-head case).

December 8—Very slight indications of the inoculation taking hold.

December 15—Distinct thickening of skin on comb.

December 25—Well developed sore-head growth on comb.

2. Gray chick, 3 months old. Injected December 15 aqueous suspension of some green pus germ into left wattle and into comb.

December 25—Fairly good case of sore-head on comb.

3. Hen, 1 to 2 years old. Injected 1cc of acid bouillon culture of green pus germ under skin of head and into wattle. No appreciable effects.

4. January 17, 1903. Brown chick, 5 months old. Inoculated by scarifying comb and injecting under skin with a big coccus obtained from Adam's sore-head rooster. Result negative.

January 17, 1903. Injected under skin in 4 places and into comb of young chick a short thick bacterium from

Adam's cock. Chick died January 20. Liver, kidneys, intestines, lungs, all contained the germ (septicaemia). This germ was a short bacterium that coagulates milk; does not liquify gelatine and forms white growth on surface and a villous growth along the gelatine stab; white, even cloudy, growth on surface of agar; white, watery, glistening growth on potato; white even surface growth on Loeffler's blood serum. In neutral bouillon, it gave a thin film on the surface and slight turbidity; a granular growth formed finally at the bottom of the tube.

5. Oct. 3. Scarified inner surface of eye-lid of hen and smeared over this *streptococci* obtained from sore-head case. Negative results.

6. Feb. 2, 1903. Black chick 5 months old inoculated with a coccus and a mould obtained from sore-head case. Injected the coccus and mold under skin below the eye and into the base of the comb; chick died February 6 of septicaemia without showing any signs of sore-head.

7. Dec. 1. Inoculated *cockerel, 16 months old,* in right wattle with 1-4 cc of big bacillus (bouillon culture). No results from this. At same time rubbed in pseudomonas pyocyanae on sacrified comb.

Dec. 4. The comb above the scarified place showed red and swollen papillœ and skin at base of papillæ was yellowish green.

Dec. 10. One tooth of the single comb slightly involved.

Dec. 15. Digit or tooth on comb still involved and other teeth or digits of comb appear slightly involved.

Dec. 30. Scab came off and comb recovered.

Jan. 12. Scarified side of comb and rubbed in material from fresh natural case of sore-head—no results beyond the effects of scarification.

8. Post-mortem on chicken (4 mos. old) died of sore-head; it had small white diphtheritic patches in mouth, pharynx, oesophagus and larynx. Had been sick 10 days. Body light and very poor. Indications of diarrhoea by

soft feces covering feathers below the anus. Crust on comb, wattles, skin of head and on eye-lids, and in corners of mouth. Yellowish exudate in conjunctival sac larger than eye-ball, cornea partly destroyed and whole eye inflamed. Plate cultures from the eye exudate gave a large bacillus apparently *bacillus subtilis; micrococcus albus* and a germ that liquifies loefflers blood serum and stain like the human diphtheria germ showing the beading. But this germ from cultures did not produce any form of the disease by smearing over scarified surfaces of skin, comb, eye-lid and mouth.

Archibald R. Ward (20) makes the following records:

Inoculated 17 cockerels with solid or semi-solid exudates applied to broken skin of head. Only one developed sore-head. Four out of the 17 developed nasal discharges resembling roup. The same case that showed sore-head developed diphtheritic lesions (not stated where). One case developed nasal (roup) discharge by exposure to another chicken in same cage. This would seem to indicate that roup, sore-head and diphtheria in some cases were associated in the same chicken or that the causes of these so-called diseases were sometimes found in one chicken. Ward has proven that faulty ventilation or exposure to draughts in California does not cause roup or sore-head.

INOCULATIONS OF PIGEONS WITH GERMS AND MATERIAL FROM SORE-HEAD IN CHICKENS.

(a) Inoculated pigeon with bacillus from blood obtained of a sore-head chicken. Blood taken from directly under sore-head crust. Hanging dop showed almost pure culture of short oval, motile germ. Blood was injected and injected under skin of head with Planococcus citreus and smeared. This had no effect on pigeon.

(b) Pigeon smeared on scarified inner surface of eye-lid and injected under skin of head with planococccus citreus obtained from sore-head case and cultivated in alkaline chicken bouillon. No results.

(c) Pigeon—Used the same germ as in (2) in the eye, the nose and under skin. No results.

(d) Oct. 18, 1905. Inoculated a pigeon with aqueous suspension of material from eye of sore-head chick. Injected material under skin of breast and smeared it over eye-lid. This material contained numerous green pus germs and a few micrococci.

October 31 this pigeon died. At point of inoculation was an abscess surrounded by characteristic green coloration of the green pus germ. Liver hyperæmic, also lungs and kidneys. Cocci in blood.

Oct. 31. Inoculated under skin another pigeon with blood from heart of above pigeon. Results negative.

TESTS WITH MOSQUITOES AS CARRIERS OF THE VIRUS.

(a) One Cockerel—Rhode Island Red.

Previously had one attack of nasal roup.

Two pigeons—grown.

Three grown hens.

Two chicks half grown.

One hen that had sore-head the year.

One young common cockerel.

All were exposed for three months from May 1 to August 1, 1905, to mosquitoes, (culex and stegomyia varieties). Rain barrels were kept close to the coops where numerous mosquitoes could be grown and easily get at the chickens. Not one case of sore-head. All kept in shed and the weather was quite damp and air very moist most of the time.

(b) Oct. 24, 1903, confined two hens and one rooster in a coop which was placed over a barrel of water from which mosquitoes were constantly hatching. Nov. 3 one hen had developed sore-head. All three of these chickens had a naturally acquired case of sore-head the previous winter.

At the same time (Oct. 24) four chicks (one-half grown) were confined in another coop in same room, and on November 3, two (2) chicks developed sore-head.

These chickens and the barrel of water were all confined in a room, where green pus germs were plentiful and the germ was present in the water in which the mosquitoes were developed and also found in the sore-head lesions. The mosquitoes were not tested for the green pus germ.

(c). At my home in Auburn, a hen with six chicks kept her chicks at night under a dense growth of honeysuckle vines. Three out of the six chicks developed sore-head. This was in November and mosquitoes were quite numerous about the honeysuckle vine. Another hen had four chicks in a coop 100 feet away from this vine and they did not contract sore-head. The chicks of the two hens mingled more or less in the day time.

A lady in Texas has recently reported to me that she has found that roaches are the carriers or the cause of sore-head in chickens; that when she exterminated the roaches the sore head cases disappeared. This is by no means conclusive, but suggestive.

The CAUSE or CAUSES of avian diphtheria, roup and sore-head have not been definitely determined. It appears that Loeffler's Bacterium and Harrison's Bacillus cacosmus and the Pseudomonas pyocyanae have some claim as casual factors. But the records and tests do not seem to place any one of them as always the primary or real cause. There is much evidence that the real or primary cause is an ultramicroscopic organism and belongs to that group of disease-producing organisms which are classed with the causes of small pox, cow pox, sheep pox, contagious foot-and-mouth disease, possibly yellow fever and some other diseases.

According to Ward exposure to air draughts does not cause "roup" in California.

Transmission and Dissemenation.—It is evidently infectious; because the disease in all its forms, spread rather rapidly from one chicken or pigeon to another. Ward, Harrison and others have transmitted, in some cases quite readily by carrying small amount of diseased material (exudate and blood), from a sore-head chicken to healthy chickens. It is also, quite certain that chicken pox and pigeon pox are identical or one and the same disease.

Mosquitoes, gnat flies, chicken mites, (ticks) chicken lice, chicken foot mites (sarcoptes mutans) and possibly cockroaches may sometimes be the carriers of the real virus. It seems quite certain that mosquitoes can transmit the virus from water or some other source, under certain conditions. Warm and wet weather seems to increase the virulency of the virus and favor the rapid transmission of the disease. It is not impossible that ants may have a role to play in the transmission or cause of sorehead.

Pathological Anatomy.—On the skin the small, greasy-like nodules, or hypertrophied nodules of the skin, contain epithelial cells that have in them "greasy" refractive bodies that stain yellow with picro-carmine and the nuclei of the epithelial cells become "reddish brown" in color. Nearly all of the epithelial cells in the nodule appear larger than normal and contain the refractive bodies. In the younger epithelial cells these bodies (young coccidia?) are relatively small and occupy one-fourth to one-third of the epithelial cell cavity. In the older or outer or cast-off epithelial cells these refractive bodies are said by Friedberger and Frohner to occupy the entire cavities of the epithelial cells. The invaded or infested epithelial cells are unusually larger than the epidermal cells of the healthy neighboring skin. Among the cast-off mass of epithelial cells are found round refractive bodies and numerous nuclei of leucocytes or pus cells. The subcutaneous connective tissue is hyperaemic (congested) and is infiltrated with cells (leucocytes and nuclei of disintegrated cells).

Possibly some of the small nuclei-like bodies among the cells in the subcutis (see fig. 7) may represent one stage in the development of cocidia. Many observers have, also, found various bacteria in the nodule and subcutis.

In the diphtheritic membranes on the mucuous surfaces of the mouth, pharynx, larynx and oesophogus, the epithelial cells are sometimes invaded by refractive bodies in the same manner as the epithelial cells of the skin and in the mass of diphtheritic exudate and cast-off cells on the mucous surface may be found the well formed coccidia, usually in the stages (a) and (b) as indicated in fig. 5. But the refractive bodies are not found in the epithelial cells of mucuous exudates or of skin nodules in every case. I have found them only in the early development of the nodule and the diptheretic exudate, and have never found the mature coccidium in the nodules of the skin.

When the exudate on the mucuous surface or the crust of the nodule of the skin is torn off the raw surface bleeds rather freely and a fresh mount of this blood contains a short oval bacillus, numerous round bodies (see fig. 7.) usually said ti be nuclei of leucocytes; and a few polynuclear leucocytes. Repeated inoculations in the comb, wattles, skin and conjunctiva and oral mucuosa of healthy chickens of various ages, with this blood, fresh from under a nodule or a diphtheritic exudate, has failed to produce positive infective results. I have also tested it on pigeons with like negative results.

The exudates on the mucuous membrane of the throat mouth or larynx appear to be very much alike in all forms of the disease.

The CLINICAL SYMPTOMS of sore head are quite clearly described in the quotation from Friedberger and Frohner on page 23 of this bulletin. The crust-like nodules on the skin of the head, comb, wattles, and eye lids are quite common. The mucuous membrane (conjunctiva) of the eye may be involved and a large amount of tears or serum and organized exudate fill the conjunctival sac or the cavity formed by the closure of the eye-lids. The cornea of the eye ball may become ulcerated and destroyed by pressure of the exudate and extension of the inflammation to the cornea. In some cases the entire eye ball may be destroyed by pressure of the exudate and inflammatory processes.

There may be croupy diphtheretic membranes in the mouth, pharynx, larynx, trachea and oesophogus; also in the nasal passages and air cells or cavities connected with these passages. When the larynx or trachea are affected there may be difficult breathing, as wheezing or rattling in the throat. When the nasal mucuosa is involved, a nasal mucuous discharge will appear; and when the lower orbital sinus becomes filled with semi-solid mass of pus, etc., a prominent swelling will appear under and around the eye; that half of the hard palate in the roof of the mouth becomes twice its usual width and bulges into the mouth cavity. At the first appearance of this enlargement, pressure on it may produce a discharge from the nostrils. At first this enlargement under and around the eye may be soft and if then opened will be found to contain quite a thick, pus-like liquid: but later the enlargement becomes hard, and if then opened is found to contain a mass of white or yellowish granular or flaky pus, more or less dry.

If the inflamed process has been progressing for sometime about the mouth, throat, etc., the infection may extend to the intestinal mucosa and there diphtheritic infiltration may appear attended by diarrhoea with watery, bad smelling feces, sometimes the feces becomes mucilaginous, or bloody. This usually causes stupor, dullness, depression and death. If the head only is involved, the affected chicken may retain its good appetite and general health and make a nice recovery in 10 to 20 days. In some badly affected cases of the nasal form (roup) the appetite will remain good, but the affected bird becomes gradually more and more emaciated.

The PERIOD OF INCUBATION is said to vary all the way from 2 to 20 days. In December I placed a newly-purchased barred Plymouth rock cock (18 mos. old) in a yard with my chickens, many of which were recovering from sore-head, and in 24 hours this cock developed a good case of sore-head on the wattles, comb and eye-lids. There were mosquitoes in the roosting house. The period of incubation varies with mode of transmission, virulency of the virus, the weather (rapid in damp warm weather and slower in cool and dry weather,) and the age and condition of the chicken or pigeon. Chicks from broiling size up to 7 or 8 months old seem to be most susceptible. Chickens with large combs seem to be more susceptible than birds with small combs and wattles.

Affected birds may recover in 2 to 8 weeks.

The mortality is said to vary from 50 to 70 per cent. of the affected birds. I judge this a low per cent. of losses if birds are left to themselves without proper care or treatment. But if individual treatment is patiently and regularly applied the mortality can be cut down to less than 20 per cent. If only the skin of the head, and the comb and the wattles are involved, one should lose less than 10 per cent. If the mouth and pharynx are also involved, less than ten per cent. should die. But if the nasal passages and infra-orbital sinus is filled with pus, or the larynx and trachea are involved, or the intestines become involved,—good care and treatment may save 50 to 80 per cent.

Immunity.—It is possible that one attack of sore head makes the bird insusceptible to a second attack. I have noticed that old chickens that have passed, at least two summers, are rarely affected and I have been unable to infect chickens that have had one attack of any form of the disease, except in a few cases.

Treatment.—Iodoform, creolin, lysol, creosote, carbolic acid, permanganate of potash, corrosive sub limate, chlorate of potash, chloride of lime, nitrate of silver, boric acid, tincture of iodine, sulphate of copper, sulphate of iron, zinc sulphate, solicylic acid, and many other drugs have been recommended. It is possible that a number of the above drugs may be useful if properly applied. Friedberger and Frohner advise "the application by brush of a solution of corrosive sublimate (1 or 2 parts in 1,000 of water), or one of creolin (1 to 2 in 100 of water)." This they say is especially effective when the disease is localized.

I have found nothing better or more effective than iodoform by itself; or iodoform 1 part and tannic acid 1 part;or iodoform 1 part, boric acid 1 part and tannic acid one part. It is best to wash the head, wipe out the mouth and throat with a weak solution of creolin (1 or 2 to 100), using a boiled cotton or medicated absorbent cotton swab. Next remove the crust on the skin, comb, wattles and eye-lids and the exudate from the eyes, the mouth and throat. Then with sterilized or boiled or absorbent cotten wipe away the blood on the raw surfaces until they cease to bleed; then with cotton swab cover the raw places with iodoform or either of the iodoform powders above mentioned. Do not be afraid to put iodoform into the eye or the conjunctival sac. The next day or the same day a few hours later, apply freely vaseline or fresh lard all over these places. In some cases it may be necessary to apply the iodoform or iodoform powders once a day for two or three days, and thereafter apply freely only lard or vaseline every day. In other cases, one application of the iodoform and daily applications of lard and vaseline are all that is required. In bad cases, especially where they do not improve as rapidly as they should, give internally, as much as a teasponful of vaseline, containing a few drops of creosote, or 10 to 30 grains of Epsom Salts in 1 tablespoonful of water. This may be given once per day or once every other day; it usually prevents intestinal infection or complications.

In cases where "roup" predominates, or where the sub-orbital sinus becomes filled with pus and the eye is greatly distended,there are several lines of treatment that may be followed. In the early stages apply sweet oil or olive oil to the nostrils and if possible inject some of this oil into the nasal passages by using a small nozzle and syringe. After injecting or applying the oil, apply pressure over the distended parts and thus expel as much of the pus as possible. This may be repeated twice per day. Also in the early stages of roup, the diseased birds may be placed in a moderately tight room and there steamed in this way: Fill a large bucket or a kettle a little more than one-half full of hot water; now put into the bucket 1 tablespoonful of creolin and the same quantity of turpentine; then drop into the bucket a red hot iron, weighing 5 to 10 pounds. Let the affected chickens breathe this steam for 10 to 20 minutes. If the room is too small or too close, you might scald or suffocate the chickens; this can be prevented by regulating the entrance of fresh air at the door or windows. This may be repeated once per day, for a week or longer if it improves the condition of the birds.

When the distension is hard or firm, there is no way to remove the dry pus from the sub-orbital sinus except by opening the sinus.. This can be done by cutting into it below the lower eye-lid and parallel to the border of the lid; remove the pus: wash out with weak creolin or other disinfectant and stitch it up.

Chickens with affected eyes must be fed by hand.

Prevention.—No doubt, it can be introduced into a flock of birds by bringing in an affected bird, and this should always be avoided. But I have seen it appear on farms and in yards where no new birds had been introduced for 6 months or more. However, in such cases, pigeons or other wide ranging birds may have introduced it. Sore-head has occurred in Alabama,so widely extended as t embrace nearly every county, every year for the past 15 years. The cause or virus may live over from year to year or it may pass the winter in a second host. Isolation of sick from well birds is advisable and wide ranges, dry, well ventilated and clean roosting houses will materially aid in checking the extension of the disease. The conditions that favor the propagation of mites, ticks, lice, mosquitoes and roaches are favorable to the extension and excessive virulency of sore-head in all its forms. Hence, old and filthy nests, damp, hot and filthy roosting houses; filthy and close brooding coops; poorly drained and small,, unclean yards; dirty water and filthy water and feed vessels; sour, fermenting, rotten, musty, or spoiled feed of any kind—should all be avoided; not only as means of preventing sore-head in all its forms, but also to help keep out all other infections and maintain the vigor and health of the flock. Cleaning, white-washing, spraying with disinfectants, should be practiced at least once per month during outbreaks of sore-head, and once every two or three months as wise and profitable sanitary and preventive measures.

Some of the Cases Treated.

1. Plymouth rock cockerel, 5 months old. Had several scabs on head. Removed the crusts once and applied vaseline every day. Recovered in two weeks.
2. Plymouth rock grade, 4 months old. Several crusts on head. Removed crusts once and applied vaseline and 5 per cent creolin. Recovered in 2 weeks.
3. White Leghorn hen, 2 years old: had sore-head crusts all over comb and large yellow exudate in eye. From the eye almost pure culture of *psendomonas pyacyanae* was obtained. Removed crusts from comb and exudate from eye: applied equal parts of iodoform and tannic acid to comb and put into eye. Repeated every day for three days;then used vaseline every day. Recovered in 18 days.
4. Rhode Island Red cock, 1 year old. Had sorehead and eyes were distended from a collection of dry pus in suborbital cavities. In other words this cock had sore-head and roup. Applied vaseline to crusts on head and gave

vaseline per mouth, and tried to work it into nostrils. This cock recovered from skin sores on head and at times appeared to improve in the roup conditions in nasal sinuses. He never lost his appetite but was continualy poor or thin in flesh. He died or was killed one night by some animal.

5. Common hen with distended eyes from pus in one nasal sinus. Opened below eye and removed pus; washed with 3 per sent. creolin; stitched up; recovered in 10 days.
6. Light Bramah hen, 2 years old; head one mass of crusts; both eyes filled with exudate and closed. First removed crust from skin of head and exudate from eyes. Applied iodoform and tannic acid to the head and eyes, once per day for three days: then applied daily vaseline. Recovered in 18 days. Had to feed this hen by hand for several days until she could see to eat.
7. Common hen with crusts on head and diphtheritic exudate in mouth and throat. Removed the crusts from the head and exudates from the mouth and throat. This always leaves raw bleeding surfaces. Applied iodoform and tannic acid to raw surfaces. Repeated this for 4 days; then applied vaseline once each day, some days gave one-half teaspoonful of vaseline and a little 3 per cent creolin internally. This is done to destroy and eliminate germs or parasites that may pass into the alimentary canal when the throat and mouth are at first involved. This hen recovered in 15 days.
8. In flock of 75 White Bramahs and White Leghorns, a large number of the young chickens 2 to 8 months old and many of the old hens contracted "sore-head." The disease appeared in June and cases appeared among these chickens from that time until the last of August. Many of the chickens were very badly involved. The disease was confined usually to the skin of the head, to the eyes, the comb and wattles. A few cases had the mucosa involved and there diphtheritic exudates appeared. Quite a

number of cases developed nasal discharge. These cases were treated with vaseline. The crusts were removed and veseline applied. Thereafter vaseline was applied once per day for 3 or 4 days and then every other day. The exudate in the eyes mouth and throat was forcibly removed and vaseline applied freely. Ninety per cent. recovered.

9. In a brood of 9 chicks, hatched in October, when three weeks old, 6 of them developed sore-head and sore mouth. The eye-lids and the eyes (conjunctival sac) and the mouth and throat were involved. In this case the chicks had what is usually called sore-head with sore mouth or diphtheria of mouth and throat. This combination is not uncommon. In fact nearly every case of chicken pox or sore-head has sore-mouth in some form and also some discharge from the nasal openings indicating the presence of "roup." These chicks were treated with iodoform and tannic acid once per day for 3 days and then pure fresh lard was applied daily. All but one recovered in three weeks.

10. In large number of White Leghorns sore-head and distended eyes from roup exudate in nasal passages appeared. Nearly all died where the dried exudate collected in nasal passages but large per cent. of the cases of sore-head recovered by removing the crusts and applying fresh lard.

11. One man reports trying "Mercurial Ointment" on sorehead chickens and that it failed to cure them.

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EXPLANATION OF PLATES.

Fig. 1—Sore-head crusts on comb, eyelids and skin.

Fig. 2.—Head of hen that recovered from bad case of sore-head. The bare places on the skin around the eye give some idea of the extent of the crusts. This case was treated with creolin and vaseline.

Fig. 3.—A case of sore-head with eyes badly involved and a large diphtheritic ulcer with prominent exudate on roof of mouth or hard palate.

Fig. 4.—Same case as fig. 3 with mouth opened to show the exudate on hard palate.

Fig. 5.—(By Johne in Birch-Hirschfeld's Pathological Anatomy). It represents the stages in the life history of coccidia. See description on page 27.

Fig. 6.—Shows epithelial cells of the skin from sore-head case. The coccidia are supposed to enter the epithelial cell and destroy its contents or take the place of the body of the epithelial cells.

Fig. 7.—Illustrates the cells found in blood taken from immediately under a sore-head crust. rbc. are nucelated red blood cells. wbc. are white blood cells or leucocytes. sf. are the nuceli of white blood cells or are free "sporozoits" or a free spore-like stage of coccidia.

Fig. 8.—Section of the mucous membrane of pharynx of chicken. d. is the diphtheritic exudate (early stage) containing coccidia. m. is the mucuous membrane. mg. are mucuous glands.

Fig. 1.

Fig. 2.

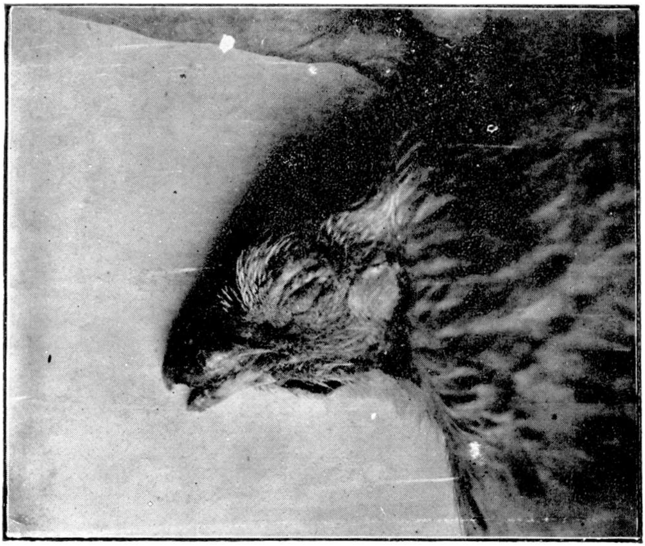


Fig. 3.

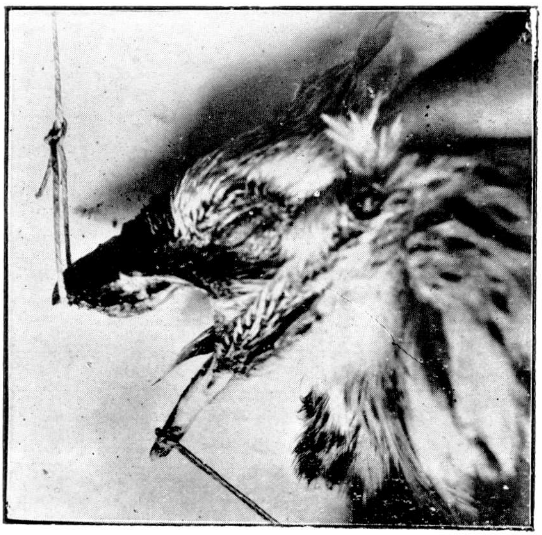
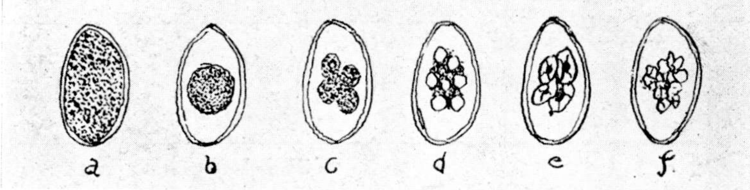


Fig. 4.



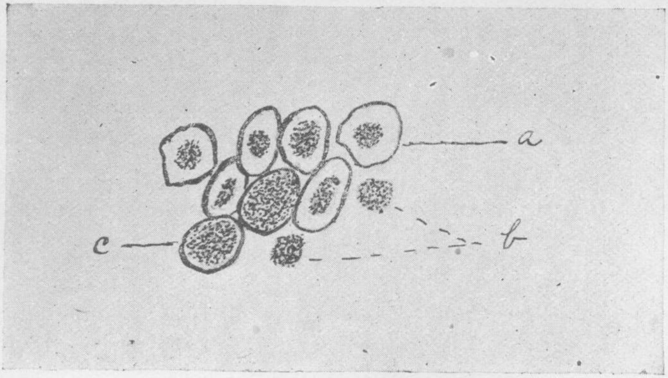


Fig. 6.

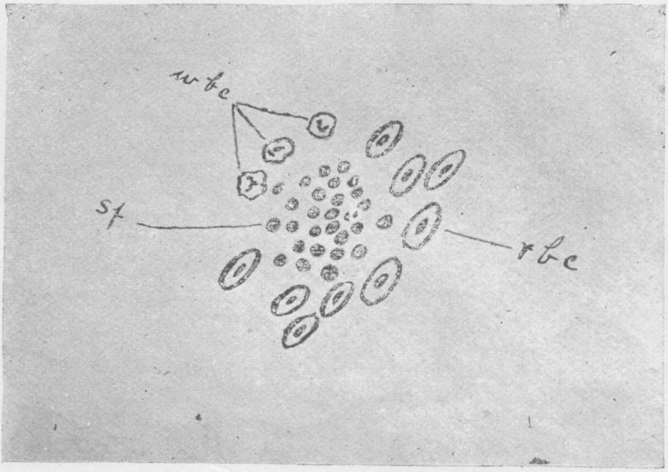
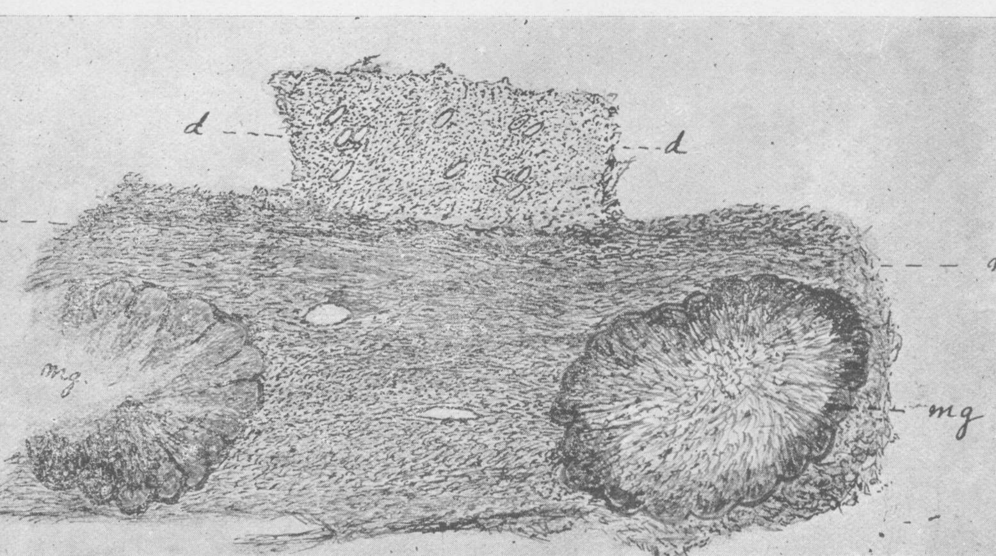


Fig. 7.



APPENDIX.

A few words on sanitary conditions in the poultry business may help some poultrymen out of difficulties.

The *water supply* for poultry should be the very best. Fresh water in clean, uncontaminated vessels should be kept constantly within reach of the chickens, or all kinds of poultry, especially during the hot weather. Good well water is preferable to running surface water. Protected earthen-ware vessels, or any form of water vessel, should be so constructed that it can be cleaned. In fact it should be cleaned daily with boiling hot water.

The *Feed* is responsible for the health, growth and flesh of poultry. Young chicks are often over-fed and usually fed in filthy places or in unclean troughs or vessels. More young chicks die from over-feeding, and sour, fermenting, discomposing feed than from any other cause. Especially is this true where mashes or liquid or moist feed is used. Some poultrymen use milk with bread or coarse meal in it. Milk is a good food; but if given to chickens it must be fresh or it should be boiled or cooked with the bread or meal in it, and fed as soon as sufficiently cooled. Always feed it in clean vessels, not in too large quantities and never leave the excess to sour. In feeding milk and all forms of moist feeds to chickens be sure to thoroughly clean and boil or scald out the feeding vessels once or twice per day during hot weather. Look well to the chick feeds. Many of them are made of refuse corn, wheat sorghum and other grains. As a rule it is best to make your own mixed grain feeds and then you will know the quality of each grain ingredient and will not be compelled to pay grain prices for the heavy grit that is so plentiful in the average mixed chicken feed. It is cheapest and safest and best for the health and growth of the chickens or other fowls to buy the separate grains and the grit and do your own mixing.

The chicken houses should be separated from all other buildings and all the sides should be of lattice work or quite open during the summer; the north. east and west may be closed during late fall and winter. The floors, roosts and nests should be so arranged as to be readily removed, cleaned and disinfected. Portable or movable chicken houses are useful if so built that they will not come to pieces when moved. In case of infection with disease germs or of infestation with mites, intestinal parasites. lice, etc.. it makes the work of disinfection and eradication of parasites more easily and quickly and permanently done, if the house can be quickly moved to a new uninfected locality.

Most chicken coops are too close, too heavy and too inconvenient to clean. Some one should invent a "knockdown" brooding coop that can be cleaned readily and one that will not easily break and retain firmness and solidity when set up.

The yards and runs are usually too small and insufficient in number. Poultrymen can greatly lessen their work by having large runs or yards and many of them.

The placing of 20 to 40 chickens in a small yard (say 50 x 100 feet) and keeping them there 8 to 12 months in a year is one of the means of intensifying the propagation of intestinal parasites of all kinds. The degree of infestation of a yard or run or poultry house depends upon the size the number of poultry kept in them; the length of time poultry are kept in them; and, to some extent, on weather conditions. A large area, as a yard or pen, will not become alarmingly infested with intestinal or other parasites as quickly as a small area. Likewise, the fewer the birds and the shorter the time the birds are kept in a given place, the less, in degree, the infestation. This often explains why a man with very few chickens having good feed and wide range, can raise fine, healthy birds. But when this same man attempts to raise a large number on a small range, yard or run, he fails and his chickens are less vigorous or healthy and consequently less profitable. The number of houses, coops, yards and runs should always be in excess of the immediate demands. Suppose a man has yards, runs, houses and coops for 3 different lots of chickens. He should at least have 3 extra yards and runs into which he could shift the disinfected houses coops and birds as soon as the the other yards or runs became infested. It would be best to have yards and runs sufficient in number to enable the poultryman to make three or four shifts before coming around or back to the first. This may seem extravagant but it is the only means by which you can breed healthy, vigorous birds without an immense outlay in cleaning and disinfecting yards or runs. Immediately after vacating a yard or run, plow it up and seed it down to wheat, rye, oats, barley, cowpeas, sorghum or anything that will make a growth upon which the chickens can graze when brought back to this yard or run. Young chicks should not be allowed to range over ground where old chickens run; if it be possible, have the young chicks in a run or yard where no old chickens have been for 6 or 8 months. This will prevent young chicks from becoming infested with round worms and tape worms.

In purchasing a new chicken, or a new lot of chickens, have them confined in some place remote from the flock for one to four weeks. During this time you will determine the presence or absence of such an infectious disease as fowl cholera. This precaution may save your flock and the difficulty of disinfecting houses and yards.

Chicken mites are the most common pests in nests and houses. Cleanliness is the best means of preventing their multiplication. They developed best in filthy nests and in cracks and under boards in chicken house. Clean the house (move if portable) and then spray the house with kerosene oil emulsion. If possible apply tar in the cracks and under roosting boards and this will catch many which escape the spray. Clean and spray the infested houses and coops once per week and dip the infested chickens in weak kerosene oil emulsion, or a 2 to 4 per cent creolin solution. Never dip chickens in a poorly mixed kerosene solution. It will blister the skin, if the kerosene is not thoroughly emulsisified. The copper sulphate solution if applied hot will kill mites. It should not be applied on the chickens.

Every farmer or poultryman in Alabama should take one or more good poultry journals, and get all the bulletins on poultry from the department of agriculture at Washington, D. C., and the bulletins on poultry published by the state experiment station and also secure Salmon's book on Poultry Diseases. Please report to me all the outbreaks of poultry or other infectious animal diseases that may occur in your vicinity or on your farm. Make these reports, at least once every year.

Kerosene oil emulsion is made as follows:

Dissolve 1-2 pound of hard soap in one gallon of hot water; add 2 gallons of kerosene and stir or churn until a milky mixture (or emulsion) is formed: now add 8 to 10 gallons of water; stir or mix with a spray pump, or keep the first emulsion of soap, water and kerosene and use as much of it as you desire after diluting with 8 to 10 parts of water.

Copper Sulphate Solution.—Dissolve 4 to 6 pounds of copper sulphate (blue stone) in 20 to 50 gallons of water. Spray this over dusted or cleaned boards, walls, nests or other places. When dry, or the next day, whitewash with spray or brush. If applied hot this copper sulphate solution will kill mites.

Government White Wash.—"Half a bushel of unslaked lime, slaked with warm water. Cover it during the process to keep the steam. Strain the liquid through a fine siene or strainer. Add a peck of salt previously well dissolved in warm water, three pounds of ground rice boiled to a thin paste and stir in boiling hot a half pound of powdered Spanish whiting (Plaster of Paris) and a pound of glue which has been previously dissolved over a slow fire, and add five gallons of hot water to the mixture. Stir well and let it stand for a few days. Cover up from dirt. It should be put on hot. One pint of the mixture will cover a square yard if properly applied. Small brushes are best. There is nothing that compares with it for outside or inside work and it retains its brilliancy for many years. Coloring may be put into it and made of any shade, Spanish brown, yellow or common clay."

This is good for chicken houses, etc.,to fill up small cracks and make a smooth surface. To it may be added two pints of carbolic acid, which will make it a disinfectant.

List of a few drugs and their uses for the poultryman:

For Intestinal Worms:

1. Isolate infested birds and destroy or disinfect their droppings while being treated.
2. Put one to 2 drams of copper sulphate in each gallon of drinking water, for one week: or
3. Powered Pomganate root bark (for tape worms) followed by 2 or 3 tablespoonfuls of castor oil: or
4. Oil of turpentine, 1 to 2 teaspoonfuls, followed in 4 to 6 hours with castor oil.
5. Powdered santonin in 5 to 8 grain doses is especially good for round worms.
6. Chopped-up pumpkin seed for tape worms.

For worms in the air passages:

1. Turpentine introduced by stripped feather, into the windpipe.
2. Steaming with creolin and turpentine in the hot water.
3. Feeding garlic in the food.

For Diarrhoea:

1. Subcarbonate of Bismuth. 1 to 4 grains. 2 to 3 times per day; or
2. Pulv. cinchona bark. 1 to 2 grains 3 times per day and
3. Quinine 1-8 to 1-2 grain 2 times a day.
4. Dry feed or cooked and slightly moist feed.

Constipation:

1. Epsom Salts.—20 to 30 grains in 1 tablespoonful of water; or
2. Castor oil, 1 to 2 teaspoonfuls; or
3. Calomel, 1 to 2 grains; and
4. Soft feed.

For Lice:

1. Lard,or vaseline over head, under wings and around anus.
2. Dipping in 15 per cent. kerosene oil emulsion; or
3. Dipping in 2 to 5 per cent creolin solution.
4. Pyrethrum powder dusted among the feathers.
5. Clean nests yards and houses.

For intestinal disinfectant:

1. One-half to 2 drams of copper sulphate in one gallon of drinking water; or
2. One-half to 2 drams of iron sulphate in 1 gallon of drinking water; or
3. Salol 1-2 to 1 grain, once or twice daily.
4. Napthol 1-2 to 1 grain, once per day after eating.
5. Resorcin 1-4 to 1-2 grain once per day after eating
6. Hyposulphite soda, 4 to 10 grains in one tablespoonful of water

FOR CHICKEN MITES.

1. Lard or vaseline on legs, feet and head applied once or twice per week. Wash off scales.
2. Kerosene Emulsion sprayed on walls, roosts, floors and nests once per week for what is commonly called chicken mites or chicken ticks.
3. Two to 5 per cent creolin solution sprayed on same places as (2).
4. Formalin 1 part to 200 parts of water sprayed as (2).
5. Corrosive sublimate (very poisonous) 1 part to 1000 parts of water sprayed as (2).
6. Boiling hot water freely applied by pouring over walls, roots, nests and floor.
7. Clean Chicken house every day until mites are gone.

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ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

Experiments With Oats

By

J. F. DUGGAR,

Director

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

EXPERIMENT WITH OATS

By

J. F. DUGGAR.

SUMMARY.

Experiments extending over a period of ten years are summarized in this bulletin.

The oat may be made a much more profitable crop in Alabama than it now is, provided farmers will make the two following innovations in the usual method of caring for the crop; (1) **Sowing in the early or middle fall. (2)** Applying nitrate of soda as a top dressing in March, or sowing on land where a soil-improving crop like cow peas has recently grown.

In tests of varieties extending over a number of years there was little difference in the yields of Red Rust Proof, Appler, and Culberson when sown in the fall. These three varieties are practically identical.

When sown after Christmas the **Burt or May oats averaged** 7 per cent. less **grain than did the Red Rust proof** variety.

Turf or Grazing oats sown in November afforded only 59 per cent. as much grain as Red Rust Proof oats sown at the same time. The order of ripening of the principal varieties sown in the fall was Burt, Red Rust Proof, and Turf.

Red Rust Proof oats may be distinguished from other varieties usually grown in the South by the long beards which are usually present on both grains, by the brownish yellow color, by the plumpness of the grain, and still more positively by the greater length of the tiny hairs or bristles located at the base of the lower grain.

Red Rust Proof and related varieties or strains, Appler and Culberson, constitute the best general-purpose type of oats for this region, being suitable for either fall or February sowing, and having stiffer straw and greater rust-resistance than any other variety tested.

The Burt oat, (synonym May oat), is chiefly valuable for its earliness, and hence for sowing at a rather late date in spring. When sown in November it was almost completely winter killed in the severe winter of 1904-5, but it was uninjured during the mild winter of 1905-6.

Winter killing of oats may be greatly reduced and the crop almost insured against ordinary winters by using one or more of the following methods:

(1) Sowing in deep drills.

(2) Sowing in October.

(3) Sowing with a grain drill.

(4) Use of a roller after the plants have been heaved and their roots exposed.

(5) The use of Turf oats in the northern part of the cotton belt.

The average of seven experiments made in seven different years shows that Red oats sown in November averaged 11.3 bushels per acre more than when sown in February. This is a profit of $5.65 per acre, or an increase of 73 per cent. as the result of sowing in the fall. October is advised for fall sowing, and the first few days in February for spring sowing in this latitude.

Oats sown in deep furrows, about two feet apart, yielded more than broadcast sowing, the increase being 3.2 bushels per acre when the deep furrows were only partly filled, and 2.3 bushels when the furrows were almost completely filled. Planting in deep furrows only partially filled is recommended only for well-drained soils.

Smut of oats can be entirely prevented by moistening the seed in a mixture of one ounce of formalin and three gallons of water.

Nitrogenous fertilizers have been much more profitable than phosphate or potash on the sandy and loamy soils at Auburn, but it is recommended that on such soils at least 100 pounds of acid phosphate be applied at the time of sowing oats.

Among the various nitrogenous fertilizers a pound of nitrogen or a dollar of investment has been most effective in nitrate of soda, and somewhat more effective in the form of cotton seed meal than of cotton seed. When either cotton seed or cotton seed meal is used it should be applied at the time of sowing, but nitrate of soda is most useful when used in March after growth begins.

Barnyard manure greatly increased the yield of the crop of oats to which it was applied, and exerted some effect on the next crop. In one experiment it required 43.1 pounds of nitrate of soda and 103 pounds of acid phosphate (costing together $1.93) to afford the same increase as one ton of fine, fresh, unleached horse manure.

In thirteen experiments with nitrate of soda the yield and total profit per acre increased with the amount of nitrate applied up to 200 pounds per acre. However, the smaller applications were more economical. The cost of nitrate of soda required to produce one additional bushel of oats was 14.5 cents from the use of 63 pounds per acre; 17.7 cents when nitrate was applied at the rate of 100 pounds, and 21.1 cents when 200 pounds of nitrate of soda was used per acre. The smallest application afforded a profit over the cost of fertilizer of 249 per cent.; the use of 100 pounds of nitate per acre returned a profit of 206 per cent. on the cost of the fertilizer, while the heaviest application resulted in a net profit of 140 per cent. The three different amounts of nitrate of soda gave profits per acre of $4.73 for the light application, $6.19 for the 100-

pound application, and $8.40 for the 200-pound application. Sixty to 100 pounds of nitrate of soda is recommended to be applied as a top dressing to oats in March.

No nitrogen need be purchased for oats, provided the oats be sown after a crop of cow peas, velvet beans, peanuts, or soy beans, all of which crops, whether only the stubble or the entire growth was plowed under for fertilizer, afforded an increase in the succeeding oat crop of from 6.2 to 33.6 bushels per acre. From 5 to 15 bushels increase in the succeeding oat crop is considered an average result of the use of the stubble or vines of leguminous crops employed as fertilizer.

THE OAT CROP OF ALABAMA.

Official estimates credit Alabama with only 197,787 acres of oats in 1904, as compared with 2,791,811 acres of corn. Is there any adequate reason why the farmers of Alabama should plant only one acre of oats for every fourteen acres of corn? For the ten-year period ending with 1904, the average yield of corn in Alabama was 12.7 bushels, and the average yield of oats was 13.9 bushels. Reducing both to pounds, we have a yield of 714 pounds of shelled corn and 445 pounds of threshed oats per acre.

The small production of oats per acre in Alabama would be a sufficient reason for the neglect of this crop were no improvement in yield practicable. However, it is a comparatively easy matter to double or treble this yield, and at very slight expense, as indicated in the experiments described in this bulletin.

In view of present and prospective agricultural conditions in Alabama there is urgent need for a very great extension of the area devoted to oats. A decreasing supply of labor calls for an increasing proportion of crops that, like oats, can be handled largely by machinery, and that require little labor per acre. The continual impoverishment of the soils of the Southern States argues for the more general introduction of crops that will improve the soil. This improvement can be effected universally by the growing of cow peas, but most cotton farmers will not grow any considerable area of cow peas except on the land from which a crop of small grain has been harvested. Hence the extension of the culture of the small grains means an increase in the acreage of cow peas, soy beans, velvet beans, and peanuts, and hence the upbuilding of the soil.

YIELD OF OATS COMPARED WITH THAT OF CORN.

We have seen from a preceding paragraph that corn and oats average respectively in Alabama 714 and 445 pounds per acre. This comparison is scarcely fair to oats, for the reason that this crop is usually assigned to the poorest land on the farm, and is seldom fertilized. To ascertain the relative yields of oats and corn on adjacent plots, a careful study has been made of the results of an unpublished rotation experiment that has been in progress on the station farm at Auburn during the past ten years. We are able to make a satisfactory comparison for three years when all conditions of fertilization, season, and time of sowing were normal or identical for the two crops.

The average yield of oats from fall sowing (October 16 being the average date of sowing) was 24.6 bushels per acre, as compared with 13.8 bushels of corn planted April 6 to 8 each year. No uitrate of soda was used.

Reducing both crops to pounds of grain per acre we have 787 pounds of threshed oats and 772 pounds of shelled corn. This indicates that the yields under these conditions were practically identical in the following rotation:

1st year: Cotton.

2nd year: Corn, with cow peas between the rows.

3rd year: Fall sown Red oats, followed by cow peas.

In this rotation corn has a slightly more favorable position than oats, but this is doubtless offset by the fact that the fertilizer used was not the one which affords the largest yield of oats.

In one experiment in which oats were compared with other small grains, all sown in the fall, the yields were as follows:

Oats versus wheat versus barley for hay and for grain in 1904.

CROP.	Yield per acre,		
	Unthreshed.	Grain.	
	Lbs.	*Lbs.*	*Bus.*
Alabama Blue Stem Wheat	2620	990	16.5
Red Rust Proof Oats	1950	1150	36.0
Bearded Barley	1400	600	12.5
Culberson Oats	1400	700	21.9

This shows a greater number of pounds of grain yielded by oats than by wheat or bearded barley. However, the weight of unthreshed grain and straw combined was greater with wheat, which indicates that wheat affords a larger yield of hay than does oats.

In a comparison of Red Rust Proof oats and Beardless barley both sown February 25, the yield of oats was 25 bushels (800 pounds) and of Beardless barley 18.7 bushels (880 pounds), the yield of barley being greater than we ordinarily secure.

VARIETIES.

While the list of varieties of oats grown in the Northern States and in Europe is a long one, there are but few kinds that thus far have proved suitable for the Gulf States. Our tests of varieties have been concerned almost entirely with the standard southern kinds, namely: Red Rust Proof, Appler, Culberson, Burt, and Turf or Winter Grazing oats. The first table that follows gives the yields of varieties sown in the fall. The average date of sowing has been November 14, which is too late for maximum yields, and especially much too late for the Turf oats. The next table gives the yields resulting from sowing oats in February or March, the average date of these spring sowings being February 20, which is several weeks later than the date preferred by the writer for oats sown after Christmas.

The third table following is calculated from the other two and is the most important of the tables, giving the relative yields of varieties in terms of percentage and average results of experiments extending through a number of years.

Tests of varieties of oats sown at Auburn in the fall.

Variety	Per ct. Grain	Yield per acre	
		Straw	Grain
Sown Nov. 6, 1897		*Lbs.*	*Bus.*
Red Rust Proof	41.3	1,800	30.8
Hatchett's Black	38.7	1,057	20.8
Beardless Red	42.9	1,155	27.1
Early Siberian	28.5	1,129	13.9
Gray Winter or Turf	29.6	1,232	16.1
Deleware Winter	30.4	783	10.6
Sown Nov. 23, 1899.			
Red Rust Poof	48.6	869	13.5
Gray Winter or Turf	31.2	769	7.5
Hatchett's Black	45 9	675	14.0
Sown Nov. 13, 1903.			
Red Rust Proof	32.6	1,320	30.0
Appler	37.8	1,720	32.7
Culberson	38.3	1,440	28.0
Gray Winter or (Va. Gray)	32.5	1,400	21.0
Sown Nov. 10, 1904.			
*Red Rust Proof(spring strain)	44.4	1,120	28.0
*Appler	52.0	836	28.3
*Culberson	45.1	1,144	29.4
Sown Nov. 18, 1905.			
Appier	48.9	2,080	52.6
Burt	37.4	2,784	52.0
Culberson	45.7	2,088	48.0
Red Rust Proof (fall strain)	47.7	1,974	48.4
Sown Nov. 14, 1905.			
Burt (av.fall and spring strains)	44.9	1,784	46.1
May	46.9	1,880	51.9
Red Rust Proof (av. fall and spring strains)	46 8	1,575	58.2

*Partly winter killed.

Tests of varieties of oats sown at Auburn in the spring.

Variety.	Percent Grain.	YIELD PER ACRE Straw	Grain
Sown Feb. 17, 1898.		*Lbs.*	*Bus.*
May	39.9	1,790	35.9
Burt	41.7	1,658	41.4
Gray Winter or Turf	20.0	690	5.5
Red Rust Proof	42.9	1,276	30.6
Sown Mar. 7, 1902.			
Burt	27.6	616	7.3
Culberson	43.1	620	14.7
May	47.1	370	10.3
Red Rust Proot	33.6	870	13.7
Sown Feb. 5, 1903.			
Burt	25.7	896	9.7
Culberson	34.3	557	9.1
May	40.9	605	13.1
Red Rust Proof	33.3	880	13.7
Sown Feb. 23, 1905.			
Red Rust Proof	42.1	1,384	31.5
May	36.4	1,929	35.0

Relative yields of grain of varieties of oats at Auburn, taking yield of Red Rust Proof oats as 100.

	1898	1900	1902	1903	1904	1905	1906 **	1906 **	Average
Sown in November.									
Red Rust Proof	100	100	....	....	100	100	100	100	100
Beardless Red	88	....	...	....	....	....	....	....	88
Appler	....	....	....	....	109	100	109	....	106
Culberson	...	....	....	....	*93	106	100	....	100
Early Siberian	45	....	....	....	....	....	....	....	45
Gray or Turf	52	56	....	....	70	....	....	....	59
Burt	....	....	....	....	....	....	108	78	93
May	....	....	....	....	....	....	....	81	81
Av. Burt and May	....	....	....	....	....	....	....	....	**89**
Hatchett's Black	68	104	....	....	....	....	....	....	86
Deleware Winter	31	....	....	....	....	....	....	....	31
Sown in February.								....	
Red Rust Proof	100	....	100	100	....	100	....		100
Burt	135	..	53	66	....	....	....	....	85
May	117	....	75	100	....	111	....	....	101
Av. Burt and May	....	....	....	....	....	....	....	....	**93**
Culberson	....	....	107	66	....	....	....	....	87
Gray or Turf	15	....	....	....	....	....	....	....	15

*Yield reduced by smut.

**Different fields and different dates of sowing.

The last table deserves careful study.

The variety Red Rust Proof, also known as Texas Rust Proof, Texas Red, and simply as Red oats, has in these tests, as usual, proved worthy of its position as the most popular or standard variety for the Gulf States. It has been relatively satisfactory whether sown in the spring or the fall, though fall sowing is decidedly preferable in the central and the southern parts of Alabama.

Appler, a selection from the Red Rust Proof, cannot be distinguished from its parent, but in the three tests made at Auburn, the Appler has afforded 6 per cent. more grain than the Red oat.

Culberson is also like Red oats in appearance of grain, and the yield when sown in the fall has averaged the same. With us it proved a little more hardy than the Red oat, a slightly larger proportion of the Culberson plants surviving the trying winter of 1904-5. It is apparently a strain of the Red Rust Proof variety. Both Culberson and Appler are at least equal in merit to the parent strain.

Winter Turf, also variously known as Gray Winter, Virginia Gray and Myers' Turf, has been relatively unproductive here, averaging only 59 per cent. as much grain as Red oats when sown as late as November 14, and apparently not equaling Red oats when sown at its proper season, September or October. Sown here in the spring, the Turf oat is an entire failure. It ripens about two weeks later than Red oats sown at the same date, and hence is especially liable to fail to fill out well, either because of rust or of drought. This oat is only to be considered for grazing or hay, or for grain on the very best land, or in those localities in the northern part of the cotton belt where Red oats are usually winter killed. It has been recommended as a good variety to sow for hay with hairy vetch, but this is only true on rich land, for on our poor sandy uplands at

Auburn, Turf oats do not throw up seed stems in time to support the slender vetch plants. Here we find that a beardless variety of wheat or the Red Rust Proof oat makes a more satisfactory combination with hairy vetch.

Burt and May are apparently the same variety, the latter being the local name near Auburn. This is a spring variety and is seldom sown in the fall; however, it passed without any winter killing whatsoever through the mild winter of 1905-6, and afforded an average yield of 89 per cent. as much grain as the Red oat. In the severe winter of 1904-5 only 5 or 10 per cent. of a stand survived from a sowing made November 10, 1904. When sown in the spring the grain yield of Burt or May oats averaged 93 per cent. of that of Red oats, some years the advantage being with one variety and some years with the other. It is generally believed that Burt can safely be sown later in the spring than Red oats, and while our sowing of March 7, 1902, does not support this opinion, yet the view seems reasonable and correct because of the quicker maturity and longer straw of the Burt.

DESCRIPTIONS OF STANDARD SOUTHERN VARIETIES OF OATS.

Red Rust Proof:—Plants medium height; straw large and strong; berries or "grain" bearded, beards borne on both grains in most spikelets; beards large and long, usually inserted low down on the larger grain, that is, half way between the base and the extreme tip, but nearer the tip on the small grain; color of berries yellowish-brown, darker near the base, and darkening on exposure to moisture. A characteristic of Red Rust Proof oats is the greater length of the slender bristles or hairs at the base of the spikelet (that is at the lower end of the larger grain), which bristles in other varieties commonly grown in the South are either wanting, or occur on only a few of the spikelets, or are shorter than on Red, Appler, and Culberson oats. The grains are very large and very plump. This variety is sometimes attacked by rust, but is less injured by this disease than the other varieties tested.

Appler:—This is a selection from the Red Rust Proof oats, and most of the spikelets are not to be distinguished from the parent variety. As grown at Auburn in 1906 it was even less uniform than the Red, containing a large admixture of black grains and a considerable proportion of spikelets of which only the larger grain was bearded.

Culberson:—This appears to be a strain of Red oats. The straw is perhaps a little taller. The grains are strongly bearded, both grains being usually bearded. In color, size and plumpness the grain is not distinguishable from the Red oat. The bristles at the base of most spikelets are relatively long, as in Red oats.

All three of the above varieties, constituting the Red Rust Proof group, are decidedly mixed, or lacking in uniformity of grains, which indicates the need of breeding for pure strains, a work that this station now has in progress. In the Red Rust Proof group about half the weight of sheaf oats consists of straw and half of grain, though the proportion of straw exceeds this on rich land.

Burt:—The majority of spikelets bear one bearded and one beardless grain, but some are doubly bearded and a few entirely beardless. The grains are more slender than those of Red Rust Proof oats, of a paler cream or brownish-yellow color. Most spikelets have only short bristles, or none. The straw is taller and weaker than that of Red oats, and the date of ripening is earlier. This variety is tender and is adapted to spring sowing.

Turf:—This variety is beardless. The grains are slender, light cream or gray in color, of a lighter shade than Burt oats, and the two berries usually break apart in threshing. The percentage of grain is small, there being usually about twice as much straw as grain.

Since there are so few varieties of oats adapted to the Gulf States, it is important that some distinguishing marks be found by which Southern farmers may be able to identify seed oats of a few leading varieties. With this end in view careful examination has been made of the four most popular varieties in the South, and we have found what seems to be a means of positively distinguishing the seed of the Red Rust Proof group from the other well-known southern varieties. The greater plumpness of grain of the Red oats and the larger proportion of spikelets in which both grains are bearded will serve to separate the Red oat group. A still more positive indication that a sample of oats is the genuine Red Rust Proof is the presence of a bunch of fine hairs or bristles at the base of the lower grain and the *greater length* of some of these bristles in this variety than in other varieties in which bristles occur.

WINTER KILLING OF OATS.

Oat plants from sowings made in the fall are liable to be killed by cold weather at any date between December 1 and March 1 in the central part of Alabama. As illustrating the earliest and the latest dates on which severe winter killing has occurred within the memory and observation of the writer, I would say that March 1, 1890, was one of the coldest days of the winter, and oats growing on rich land, which had already thrown up tender seed stems, were entirely killed, while other plants at an earlier stage of growth were severely injured.

The earliest date recalled on which oats were injured was on December 15, 1901, when the temperature suddenly dropped below the freezing point, following a period of heavy rains. There were severe freezes at night and complete thawing during the day for nearly a week, thus affording extremely favorable conditions for the heaving and destruction of oat plants.

The lowest temperature ever recorded in Alabama, and probably the most complete destruction of oats by cold was experienced in February, 1899, when on the station farm practically all Red oats were killed except near woods or protecting fences, where a part of a stand survived. That cold weather, during which the minimum temperature was —6 Fahrenheit, not only killed Red oats, but Turf oats as well.

The following precautions used singly or together will greatly reduce the danger of winter killing and practically insure in this latitude the survival of a fair stand of oats, except in unusually severe winters:

(1) Sowing the seed in deep drills not completely covered, as discussed in a later paragraph.

(2) Sowing in October so as to give the plants time to form a strong root system as an anchor before severe freezes occur.

(3) Sowing with a grain drill, which leaves the land slightly ridged and the plants close together, thus apparently furnishing a small amount of mutual protection.

(4) Passing a roller over a field on which the plants have been heaved and the white roots exposed by alternate freezes and thaws.

(5) The sowing of Turf oats, which are hardier than Red oats, but are not to be preferred where the Red oats ordinarily succeed.

Cold weather may kill oat plants in either of two ways, directly by the action of the cold on the foliage and crown or indirectly by the heaving or lifting effects of alternate freezes and thaws. The first method of prevention mentioned above is effective against both results of cold, but is chiefly useful in preventing heaving. The use of the roller just after a succession of freezes is intended to counteract the results of heaving, since the roller presses the exposed crowns into contact with the soil, thus favoring the development of new roots. We have repeatedly used this method with good results. It should, however, be remembered that the use of the roller while the land is still wet may result in unduly compacting the surface.

Before deciding whether it is best to rely chiefly on fall sown or on spring sown oats it is worth while to recall how many complete failures due to winter killing and how many partial killings have occurred within one or two decades in any given locality. Applying this test to the fall sown Red Rust proof oats on the Station farm at Auburn we find that during the past eleven years there has been but one winter in which practically all red oats have been killed, namely in 1899. In 1902 in spite of the trying weather of the preceding December, a part of the oats on the Experiment Station farm afforded a fair yield. The winter of 1904-5 was perhaps the third most unfavorable year as regards winter killing. Although the stand was very much thinned, yet the yields of our variety plots that year averaged about 28 bushels per acre. It is believed that farmers overestimate the danger of winter killing of oats or the frequency with which the stand is reduced to a point where the yield would be less than with oats sown in the spring. This tendency is natural, since few have put in effect the above-mentioned measures that may be taken to reduce the amount and frequency of winter killing.

TIME TO SOW OATS.

A large proportion of the oats grown in Alabama are sown in February. While this may perhaps be considered necessary for Red and Burt oats in those parts of the state in which experience indicates that fall sown oats are usually winter killed, yet this is the wrong time to sow most fields of Red oats in the central and southern parts of the State. Our experience, which is partly tabulated below, indicates that the yield from fall sowing is far greater than from sowing Red oats after Christmas. In all the experiments tabulated below the same amount of fertilizer was used for the February sowing as for the November sowing, and all conditions were equal except the date of putting the seed into the ground.

Average results of fall sown vs. spring sown oats.

DATE OF SOWING	Percent grain in sheaf oats	Yield of grain per acre	Yield of straw per acre	Increase of grain from fall sowing
Experiment No. 1.	*Percent.*	*Bus.*	*Lbs.*	*Bus.*
November 18, 1896	45	21.7	895	**7.9**
March 1, 1897	43	13.8	587	
Experiment No. 2.				
November 23, 1897	38	18.2	958	**11**
February 9, 1898	47	6.4	228	
Experiment No. 3.				
November 26, 1897	43	23.8	994	**9.7**
February 9, 1898	51	14.1	440	
Experiment No. 4.				
November 13, 1902	40	27.2	1328	**13.5**
February 5, 1903	34	13.7	1024	
Ezperiment No. 5.				
November 19, 1903	57	15.9	384	**2.6**
February 23, 1904	55	13.3	416	
Experiment No. 6.				
November 10, 1904	44	*26.9	1068	**—*5.1**
February 23, 1905	43	32.0	1360	
Experiment No. 7.				
November 14, 1905	52	53.8	1560	**38.8**
February 16, 1906	....	15.0	....	
Average 7 Experiments				**11.3**

*Fully 25 winter killed.

The average of seven experiments shows a gain of 11.3 bushels or 73 per cent from sowing Red oats in November as compared with sowing them in February. Who can afford such a loss? Who would not arrange to pay his notes three months ahead of maturity if thereby he could have 43 per cent deducted from their face? The two cases are arithmetically the same. If the "turning out" of cattle by common consent in winter prevents the sowing of grain in the fall, is the few months' winter range worth the sacrifice?

Other experience, often repeated, has shown us that the average date of fall sowing in the table above, November 17, is too late for maximum yields of fall sown oats. We have found that sowing in October gives a larger yield and the plants endure cold better than do plants from sowings made in November. I would recommend October sowing, while realizing that any date between September 1 and November 15 may afford satisfactory yields. We find it advisable to discontinue entirely the sowing of oats about the first of December. For such fields as must be sown after Christmas I prefer on the uplands in this latitude to sow about February 1. For oats sown after Christmas only the richest lands are suitable and these are needed for other crops. On the other hand, oats sown in the fall may make a profitable crop on land that is quite poor, provided they be judiciously fertilized. Thus the advantages of fall sowing consist of (1) a much larger yield, even after deducting the losses from partial winter killing; (2) the utilization of poorer land by the fall sown crop, (3) the employment of teams at a time when they are not needed in preparation of land for cotton or corn, and (4) earlier maturity of fall sown oats, permitting the use of the crop and the use of the land at least two weeks earlier than when oats are sown after Christmas.

METHODS OF SOWING OATS.

A method of sowing oats that has proved highly satisfactory as the most effective known means of avoiding winter killing consists in opening deep furrows at intervals of 18 to 24 inches and drilling the seed and fertilizer in the bottom of these furrows, barely covering the seed with such earth as falls in as the one-horse planter and fertilizer distributor passes along. The primary object is to reduce the amount of killing by placing the plants in a position where they will not be heaved by alternate freezes and thaws.

For four years we have compared this method with a modification of the same, in which the deep furrows were covered nearly or quite full after the sowing of the seed, and with broadcast sowing.

In 1900 a harrow was run over all plots and dragged in more dirt than was intended. That year the "covered" drills were filled and the oats covered by the use of scooters on a double stock. In 1899-1900 the drilled oats were scarcely injured by cold, while the broadcast plots lost about 25 per cent of their plants, and yielded far less grain than either method of drilling. In 1904 the broadcast plots lost about 20 per cent of their plants from winter killing, while the loss from cold in the drilled plots was insignilcant; some plants in the deep, partially filled furrows were injured by sand washing in.

In 1905 there was some loss from cold on all plots, this being estimated at 20 per cent on the broadcast plots, 10 per cent on the plots sown in filled furrows, and only 5 per cent in furrows only partially filled.

In the average results and in three out of four years drilling oats in furrows two feet apart yielded decidedly more than did the sowing of the seed broadcast on the plowed ground and covering with a disc harrow or other similar implement.

No very severe winter occurred while this test was in progress, which probably accounts for the practical equality in resistance to cold of the plants in the filled and in the partly filled furrows.

For well drained soils there are decided advantages in drilling fall sown oats in deep furrows, especially when the winter proves severe. It is advisable where practicable to run the rows perpendicular to the line of the coldest winds, which would give the rows a direction from southwest to northeast, or east and west.

This method of sowing oats in deep unfilled furrows is evidently not adapted to prairie or other very stiff, poorly drained soil, where standing water in the furrows would drown the young plants, and it is slower than sowing broadcast or using a grain drill.

Yields of oats sown broadcast and in deep furrows, or entirely drilled.

Year	Yield per acre.			
	Broad-cast	8 in. drill	Deep furrow, slight covering	Deep furrow, covered
	Bus.		*Bus.*	*Bus.*
1900	19.9		24.3	29.1
1903	26.4		33.7	25.7
1904	16.0		19.2	20.5
1905	34.6	31.0	32.3	31.5
Average	24 2		27.4	26.7

INCREASING THE HARDINESS OF OATS.

In a severe winter the oat plants that survive the winter are either those best protected by their location or else those possessing in themselves a special degree of hardiness. If we could plant seed only from plants possessing this inherent hardiness we should doubtless be able within a few years to breed up a variety hardy enough to endure the severest winters. The Alabama Experiment Station has for several years been engaged in this attempt to increase the hardiness of our ordinary Red Rust Proof oats towards cold. Since we cannot separate those plants whose survival of winter's cold is merely accidental, or due to their environment, from those planst that have in themselves special hardiness, our task will doubtless take many years for its accomplishment. For though we select each year from plants that survived the previous winter and whose ancestors survived still earlier winters, yet among these continuously hardy plants are many tender plants that have endured the cold merely because of favorable environment. It will require the recurrence of several severe winters to eliminate all the tender plants.

In thus breeding the oat plant for improvement in hardiness we also had an opportunity to ascertain whether seed oats for sowing in the fall should come from a strain sown each year in the fall or indifferently from either fall or spring-sown ancestry. The following table presents the results of this inquiry to date.

Yields of oats from sowing in the fall seed from fall-sown vs. spring-sown ancestry.

Year	Variety	Date of sowing	Yield per acre: Fall strain, Straw	Fall strain, Grain	Spring strain, Straw	Spring strain, Grain
			Lbs.	*Bus.*	*Lbs.*	*Bus.*
1898	Red Rust Proof	Nov. 6	1050	25.3	996	28.6
1903	Red Rust Proof	Nov. 13	1110	21.3	505	11.3
1904	Red Rust Proof	Nov.	960	30.0	888	27.7
1905	Red Rust Proof (Broadcast)	Nov. 5	1352	35.5	1160	33.7
1905	Red Rust Proof (8-in. drills)	Nov. 5	1256	31.0	1128	31.0
1006	Red Rust Proof (8-in. drills)	Nov. 18	1936	50.9	2112	51.0
1906	Red Rust Proof (8-in. drills)	Nov. 14	1560	53.8	1590	62.5
1906	Burt	Nov. 14	1676	45.6	1892	46.5
	Average		1223	36.7	1283	36.5

Thus far the difference in yield is slight and accidental between a strain of oats that for several years has been continuously sown in the fall and other oats descended from crops alternately sown in fall and in spring.In the above table the fall strain of Red Rust Proof oats has been continuous, having been sown in the fall of 1902, 1903, 1904, 1905; in 1902 the fall sown seed were from the station farm where nearly all the oats are sown in the fall, and hence the habit of growing in winter extends back at least five years prior to 1902. The "spring strain" seed oats does not represent a continuously spring-sown ancestry, but usually only one generation of spring-sown oats. This experiment with Red oats will be continued. Until we can accumulate conclusive data we can advise only on theoretical considerations. These suggest the probable advisability of sowing in the fall seed from a strain that for several years has been sown in the fall. This is another argument for saving one's own seed oats, for we seldom know whether purchased seed oats are accustomed to fall or to spring planting nor whether grown in or near this latitude.

PREVENTION OF SMUT.

Smut is almost universally present in the oat fields of Alabama, blackening many of the heads and reducing the yield from 5 to 30 per cent. It can be prevented easily and cheaply. Several methods may be used, the most convenient being the use of formalin. Unfortunately this useful material is not generally found in the smaller drug stores but may be ordered from wholesale drug stores through local druggists. The cost should not exceed one dollar per pound including express charges, and in large amounts the cost is much lower. Pour one ounce of this liquid formalin into three gallons of water. Into this liquid the oats may be dipped and then drained and spread out to dry, or the liquid may be sprinkled over the pile of oats until the grains are thoroughly moistened. Then the pile of treated seed should be kept covered from two to ten hours, so that the gas generated may destroy the germs or "seed" of smut, which are present on the oat kernel. One ounce of formalin will treat a number of bushels of oats, making the cost only a few cents per acre. The saving or increase in the crop will usually be from 8 to 20 per cent, or say 2 to 8 bushels per acre. We cannot afford to plant oats without this or equivalent treatment.

In case formalin is not quickly obtainable smut in oats may be destroyed by the following method: Obtain an accurate thermometer. A dairy thermometer costing 25 to

50 cents will usually answer. Then dip the bags of seed oats into hot water which must be kept at a temperature of about 132 degrees, not dropping below 130 nor running above 135 degrees Fahrenheit. Keep the oats in this hot water for ten or twelve minutes, stirring them so that every grain becomes heated. Then remove the sack of oats and dip into cold water. After this cooling the oats should be spread out to dry, never spreading them on a floor on which untreated seed oats have been stored.

FERTILIZERS FOR OATS.

It is a custom far too common in Alabama to sow oats without any fertilizer. The experiments here recorded show that it pays to fertilize oats, and that the most profitable fertilizer is one that is rich in nitrogen. Omitting the long table of figures, the conclusions drawn from average results of a number of years' experimentation in Auburn are here given. On our sandy and loam soils rather heavily fertilized with complete commercial fertilizers for a number of years, the results were briefly as follows: Potash was practically useless; acid phosphate was of secondary importance, while nitrogen in whatever form applied, whether as stable manure, cotton seed, cotton seed meal, or nitrate of soda, gave a considerable increase in the yield of oats.

BARNYARD MANURE AS A FERTILIZER FOR OATS.

For several years an experiment has been in progress to determine the increase in various crops due to the application of manure during the current or previous season. Only such of these data as bear on the oat crop are here given. In the winter of 1900 heavy applications of cattle manure, obtained by the use of a ration of cotton seed meal or of cotton seed, were applied to fall-sown oats. The following table shows the results obtained the first year, in which the increase in yield was 29.6 or 31.5 bushels of oats per acre:

Immediate or first year effect of cattle manure applied to oats.

Manure per acre.	Manure from feeding.	Yield per acre.	Increase per acre.
Lbs.		*Bus.*	*Bus.*
43740	C. S. Meal, etc.,	40.7	31.5
30600	Cotton Seed, etc.	38.8	29.6
No manure		9.2	

The next year oats were again grown on the same field without additional fertilizer.

Manure per acre previous year	Yield per acre second year.	Increase per acre second year.
Lbs.	*Bus.*	*Bus*
43740	37.5	26.
30600	28.	16.5

Even on this sandy soil a heavy application of stable manure gave a large increase in the second crop of oats, as well as in the crop to which it was directly applied. The important matter is to determine what increase in crop was afforded by each ton of manure, and this information is contained in the following table, which deals not only with this experiment, but with two others in which very light applications of horse manure were employed.

Increase in first and second crops of oats per ton of manure.

Manure per acre	Kind of Manure	Increase per ton of manure		
		First year oats	Second year Oats	Total 2 years Oats
Tons		*Bus.*	*Bus.*	*Bus.*
21.87	Cattle; from feeding c. s. meal, etc.	1.4	1.2	2.6
15 3	Cattle; from feeding cotton seed,etc.	1.9	1.1	3.0
6.2	Cattle; from feeding c. s. meal, etc.	1.6	.5	2.1
2.0	Horse manure.....	8.8		
2.0	Horse manure	9.8		

From the above table it will be seen that where heavy applications of rich cattle manure were made to oats the aggregate increase in yield of the two following crops was 2.8 bushels per acre and that of this the second year's increase accounts for more than one bushel. On the other hand, when only two tons per acre of horse manure was used the increase the first year averaged 9.3 bushels per acre. This illustrates the greater efficiency per ton of the smaller applications, though the broadcast application of less than four tons per acre is scarcely practicable even by the use of the manure spreader. This expensive piece of farm machinery is needed where large amounts of manure are to be distributed, for it greatly reduces the amount of labor in handling manure, pulverizes the material finely, and enables a lighter application to be made where this is desired, the lighter application and the finer pulverizing making a given amount of manure go further and afford a larger increase in crop yield.

COTTON SEED VERSUS COTTON SEED MEAL.

In three experiments made in as many different years we have compared 200 pounds of cotton seed meal with 434 pounds of cotton seed, both furnishing equal amounts of nitrogen and both being applied at the time of planting in the fall. In every case cotton seed meal has given larger yields, the excess resulting from the use of meal as compared with seed being in different years respectively 2.1, .7 and 11.8 bushels of oats per acre, which would give an average advantage of 4.9 bushels per acre to the meal. If we reject the last figure as being so large as to excite suspicion of error we still have an average advantage of 1.4 bushels per acre in favor of the cotton seed meal.

While cotton seed has long been recognized as an excellent fertilizer for oats, especially when used in large amounts, the increased price of cotton seed and the superior effects of an equal value of nitrate of soda on oats make it unadvisable to apply cotton seed to the oat crop if nitrate of soda can be purchased.

Since the fertilizer requirements of wheat and oats are presumably about the same, I would add that in similar experiments with wheat cotton seed meal gave a slightly larger yield than cotton seed, both used in the amounts mentioned above.

NITRATE OF SODA AS A FERTILIZER FOR OATS.

Numerous experiments made under the writer's direction both on sandy loam soil at Auburn and on stiff lime lands at Uniontown show that this is by far the most effective commercial fertilizer for oats. The following table affords means of comparing nitrate of soda with cotton seed meal, cotton seed, and stable manure, which are the principal sources of fertilizer nitrogen available to the southen farmer.

Cotton seed meal, cotton seed, nitrate of soda, and manure as fertilizers for oats.

Amount per acre.	FERTILIZER	Yield and increase per acre 1901 Yield straw	1901 Yield grain	1901 Increase in grain due to Nitrate.	1906 Yield straw	1906 Yield grain	1906 Increase due to Nitrate	Average increase per acre due to Nitrogen.
Lbs.		*Lbs.*	*Bus*	*Bus.*	*Lbs.*	*Bus*	*Bus.*	*Bus.*
200 240	Cotton seed meal Acid Phosphate	827	24.9	8.0	1788	42.9	13.0	10.5
434 240	Cotton Seed Acid Phosphate	774	24.2	7.3	1136	32.1	2.2	4.8
240	Acid Phosphate	532	16.9	0.0	1160	29.9	0.	
100 240	Nitrate of Soda (in spring) Acid Phosphate	1130	36 3	19.4	1776	55.8	25.9	22.7
100 240	Nitrate of Soda (at planting) Acid Phosphate	1222	36.0	19.1	2128	54.4	24.5	21.8
4000	Manure	1152	34 4	17.5	2152	51.5	21.6	19.6

Referring to the figures in the preceding table, we have the following comparison between the results of 2 tons of fine horse manure and an application of 100 pounds of nitrate of soda together with 240 pounds of acid phosphate, the phosphate being applied at time of sowing in the fall and the nitrate being applied as a top dressing in March.

With two tons of fine horse manure applied in the fall the average increase was 19.6 bushels of oats per acre; with the commercial fertilizer mixture the average increase was 22.7 bushels of oats. In other words equal first-year results were obtained from the use of one ton of manure as from 43.1 pounds of nitrate of soda aided by 103 pounds of acid phosphate. With nitrate at $60 and phosphate at $12.50 per ton these amounts of commercial fertilizer cost $1.93. Hence the farmer could afford to invest at least this amount in the production or purchase and very thin distribution of one ton of fresh unleached horse manure, and still be ahead by the greater effect of manure than of chemicals after the first year. We have seen in a preceding paragraph that the second year effect of a ton of manure on our sandy loam soils is equivalent to more than one bushel of oats per acre.

While the application of stable manure to oats on poor land is to be commended, yet the limited supply of this material makes it necessary for the farmer to purchase nitrogen in commercial fertilizers. Probably even better use for manure can be made than to apply it on oats, thus making it necessary to purchase nitrate of soda for oats and other small grain.

The following table shows the results of 13 different experiments conducted under the writer's direction at Auburn and Uniontown, Ala., and bearing on the effects of nitrate of soda applied in March as a top dressing for oats:

Year	Date of sowing oats	Amt. of nitrate per acre	Date of applying nitrate	Yield per acre	Increase due to nitrate	
Fall sown		*Lbs.*		*Bus.*	*Bus.*	*Percent*
1904	Nov. 4,	200	March	49.5	32.3	188
*1903	Oct.	200	March	43.8	25.3	137
Av.		**200**		**46.7**	**28.8**	**163**
1906	Nov. 20	120	March 13	34.2	21.8	176
1901	Nov. 15	100	March 18	36.3	19.4	116
1906	Nov. 15	100	March 13	55.8	22.7	69
*1903	Oct.	100	March	34.0	14.8	77
*1904	Nov. 4	100	March	42.3	17.0	67
Av.		**100**		**42.1**	**18.5**	**82**
1896	Oct.	80	March 28	29.3	12.9	79
1906	Nov. 20	60	March 13	28.0	15.6	126
1904	Nov. 4	50	March	29.0	11.3	64
Av.		**63**		**28.78**	**13.3**	**90**
Spring sown						
1896	Jan. 27	120	March 28	20.3	9.9	95
*1903	March 19	80		29.0	8.0	38
1900	Feb. 20	76	March 25	19.7	7.4	60
Av.		**92**		**23.**	**8.4**	64

*On stiff lime land at Uniontown; from Bul. 22, Ala., Canebrake Exp. Station, by J. F. Duggar and J. M, Richeson.

In the following table the preceding data are so arranged as to show average results from the use of different amounts of nitrate of soda on oats:

Increase and profit from nitrate of soda and cost of fertilizer per bushel of increase.

Nitrate of soda per acre	Inc'ase due to nitrate per acre	Profit per acre from nitrate	Inc'ase due to nitrate	Lbs nitrate per bushel of increase	Cost per bu. of increase	Year	Soil
Lbs.	*Bus.*	*$*	*Per ct*	*Lbs.*	*$*		
Fall sown							
200	32.3	10.15	188	6.2	0.186	1904	Lime
200	25.3	6 65	137	7.9	0.237	1903	Lime
Av. 200	**28.8**	**8.40**	**163**	**7.0**	**0.211**		
120	21.8	7.60	176	5.5	0.165	1906	Sandy loam
100	19.4	6 70	115	5.2	0.156	1901	Sandy loam
100	22.7	8.35	69	4.4	0.132	1906	Sandy loam
100	14.8	8.40	77	6.9	0.207	1903	Lime
100	17.0	4.50	67	7.1	0 213	1904	Lime
Av. 100	**18 5**	**6.19**	**82**	**5 9**	**0.177**		
80	12.9	4.05	79	6.2	0.186	1896	Sandy loam
60	15.6	6.00	126	3.9	0.117	1906	Sandy loam
50	11.3	4.15	64	4.4	0.132	1904	Lime
Av:50to80	**13.3**	**4.73**	**90**	**4.8**	**0.145**		
Spring S.							
120	9.9	1.35	95	12.1	0.363	1896	Sandy loam
80	8.0	1.60	38	10.0	0.300	1903	Sandy loam
76	7.4	1.42	60	10.3	0.309	1900	Sandy loam
Av. Sp. S.	**8.4**	**1.45**	**64**	**10.8**	**0.324**		

In the above table the figures representing the averages are highly significant and worthy of careful study. They show that from 200 pounds of nitrate of soda the average increase was 28.8 bushels of oats per acre; -from an appli- ing 63 pounds of nitrate of soda), the increase was 13.3 bushels; and from the application of smaller amounts (averaging 63 pounds of nitrate of soda, the increase was 13.3 bushels of oats per acre. It is notable that when nitrate was applied to spring sown oats the results were less favorable than when used on fall sown oats, the application of an average of 92 pounds of nitrate on spring-sown oats giving an increase of only 8.4 bushels. The percentages of increased yield were respectively 163, 82, 90, and 64.

The fifth column of the table shows the number of pounds of nitrate of soda required per bushel of increase of yield, namely 7.1 pounds where 200 pounds per acre was employed, 5.9 pounds where the application was 100 pounds of nitrate of soda. and 4.8 pounds when an average of only 63 pounds of nitrate of soda per acre was used on fall sown oats. These figures again show the greater relative efficiency of the smaller applications. Notice again that it takes more fertilizer to add a bushel to the crop in the case of spring sown oats, namely, 10.8 pounds of nitrate of soda per bushel of increase, or nearly twice the fertilizer necessary to the same results on fall sown oats. The average cost of nitrate of soda to make one bushel of increase was 21.1 cents for the very heavy application; 17.7 cents when 100 pounds of nitrate of soda was applied, and only 14.5 cents when a very light application was made to fall-sown oats. When, however, a light application of nitrate was made to spring-sown oats each bushel of increase cost for nitrate of soda, 32.4 cents, a further proof of the greater profit from fall sown oats. If we will think of oats as worth 50 cents per bushel we will notice that after deducting the cost of the fertilizer, each bushel of increase made by fall-sown oats and due to nitrate of soda afforded a profit of from 28.9 cents to 35.5 cents, the greater profit per bushel being obtained from the smaller applications.

After all, profit is the important consideration, therefore, let us examine the financial returns per acre from the use of nitrate of soda. After deducting the cost of nitrate of soda at the rate of $60.00 per ton we have left a profit of $8.40 from an application of 200 pounds per acre; a profit of $6.19 from an application of 100 pounds; and a profit of $4.73 from a light application, averaging 63 pounds of nitrate of soda per acre. Surely farmers cannot afford to withhold this fertilizer when profits like these can be had by its judicious use.

These facts appear in still more striking form when we figure the percentage of profit on the amount invested in nitrate of soda. When this fertilizer was used at the rate of 200 pounds per acre the profit on the fertilizer investment was 140 per cent; 206 percent when the fertilizer was used at the rate of 100 pounds per acre; and 249 percent when a lighter aplication was made on fall-sown oats. These last figures illustrate the general tendency of fertilizers to return the largest percent on the investment in fertilizers when used in small amounts. But this alone should not govern, for preceding figures have shown that heavier applications afford a greater aggregate profit per acre, and hence are advisable for the farmer who has abundant capital to invest in fertilizers.

I recommend that nitrate of soda be used at the rate of from 60 to 100 pounds per acre, according to the amount that the farmer can afford to invest in fertilizers. From such an investment he should expect to realize a profit of $4.00 to $6.00, provided the application be made to fall sown oats. If the nitrate be used on spring sown oats the profit may be only about half of the above figures, but even here fertilization with nitrate of soda is advisable.

WHEN TO APPLY NITRATE OF SODA.

The experiments conducted in Auburn, and recorded in Bulletin No. 95 of this Station, indicate that nitrate of soda should be applied early enough to give at least 55 days before the time of application and the probable date of harvesting the grain. Any time in March is suitable. We have found nitrate of soda applied as a top dressing in March more effective with oats and wheat than when put into the ground with the seed in the fall. This superiority of the spring application has been greater with wheat than with oats and much greater on quite sandy soil than on gravelly soil containing considerable clay, on which stiffer soil both fall and spring applications have greatly increased the yield of oats.

All lumps in the nitrate of soda must be carefully pulverized. The fertilizer is strewn by hand, and distributed as evenly as seed oats or seed wheat would be. No covering or harrowing is necessary. This fertilizer is so readily soluble that a small amount of moisture in the soil will dissolve it and carry it downward to the plant roots. It is best to sow nitrate of soda when the ground is somewhat moist, but one should avoid applying it just before a rain, which might wash away a large part of the nitrogen. Hence if practicable we prefer to apply nitrate of soda just as the weather clears after a period of rainy weather. We usually apply this fertilizer to oats about the middle of March, though application at any date within that month is satisfactory.

LEGUMINOUS PLANTS AS FERTILIZERS FOR OATS.

Cowpea or velvet bean stubble or entire growth as fertilizers. We have seen that of the commercial fertilizers the one best adapted to oats is nitrate of soda, but since the use of this material involves a cash expenditure, we may well inquire whether some fertilizing material produced on the farm may not act as a substitute. The principal materials that might thus be used are barnyard manure, which has already been discussed, and leguminous plants, such as cowpeas, soy beans, velvet beans, etc. Both the entire plant and the roots and stubble alone of these legumes are rich in nitrogen and hence useful as nitrogenous fertilizers. The following table, quoted from Bulletin No. 95 of this Station, gives the result of an experiment in which the use of either the stubble or entire plant of cow peas or velvet beans afforded an enormous increase in the yield of the succeeding crop of oats, an increase larger than we can usually count on. The Red Rust Proof oats were sown in the fall of 1897 and the crop was cut May 18 following.

On all plots oats were fertilized with 220 pounds per acre of acid phosphate and 44 pounds of muriate of potash, no nitrogen being supplied except that contained in the remains of preceding crops of cowpeas, velvet beans, etc.

Yield per acre of oats grown after stubble or vines of cowpeas, velvet beans, etc.

Plot No.		Yield per acre	
		Grain	Straw
		Bus.	*Lbs.*
1	Oats after velvet bean vines	28.6	1206
6	Oats after velvet bean stubble	38.7	1672
	Average after velvet bean vines and stubble	**33.6**	**1439**
4	Oats after cowpea vines	28.8	1463
3	Oats after cowpea stubble	34.4	2013
	Average after cowpea vines and stubble	**31.6**	**1738**
2	Oats after crab grass and weeds	7.1	231
5	Oats after German millet	9.7	361
	Average after non-leguminous plants	**8.4**	**296**

From early spring there was a marked difference in the appearance of the several plots, the plants being much greener and taller where either the stubble or vines of cowpeas had been plowed under.

When the oats began to tiller, or branch, the difference increased, the plants supplied with nitrogen, through the decay of the stubble or vines of cowpeas and velvet beans, tillering freely and growing much taller than the plants following German millet or crab grass.

May 18, 1898, oats on all plots were cut.

In this experiment the average yield of oats was 33.6 bushels after velvet beans, 31.6 bushels after cowpeas, and only 8.4 bushels after non-leguminous plants (crab-grass, weeds and German millet.)

Here is a gain of 24.2 bushels of oats and nearly three-fourths of a ton of straw as a result of growing leguminous or soil-improving plants, instead of non-leguminous plants during the preceding season.

Undoubtedly this is an extreme, and not an average, case. An unexpected result of this experiment is the larger crop on the plots where only the stubble was left than on those where the vines of cowpeas and velvet beans were plowed under. The writer thinks that the difference in yield was almost wholly due (1) to the fact that the vines (especially those of the velvet beans) were not properly buried by the small plow employed, and (2) that the seed bed for oats was more compact where only stubble was plowed under, a point of advantage, doubtless, in such a dry winter as that of 1897-'8. In Bulletin No. 120, of this station, we have shown that the residual fertilizing effect of the entire growth of legumes is greater than that of vines and stubble. For example, the average increase in the second crop after plowing under *stubble* of velvet beans and cowpeas averaged 12 per cent, while the increase of the second crop was 24 to 54 per cent where the *entire growth* of legumes was plowed under.

When spring sown oats follow leguminous plants the increase due to the legume is smaller than is indicated above. For example, in one of our experiments the yield of spring sown oats following German millet was 12.4 bushels per acre, while on an adjacent plot where cow pea vines had been plowed under the yield was 22.8 bushels. This gives an increase of 10.4 bushels per acre, worth $5.20, as the fertilizing effect of a crop of cow pea vines of which the pods had been previously picked, yielding 11 bushels of cowpeas per acre. Thus the total value of the cow pea crop was about $16 in addition to any fertilizing effect that may have extended to the second crop.

Cowpeas, peanuts and soy beans as fertilizers for oats.

The following table shows the yield of oats in 1906 on one of the poorest tracts of land on the station farm, which would be classed as a poor grade of Norfolk sandy loam. It is a deep sandy soil, light gray in color. The table shows the yields of unfertilized oats when grown after each of the following crops: Sorghum, sweet potatoes, soy beans, chufas, corn, Whippoorwill cow peas, Spanish peanuts, and running peanuts.

Effects of preceding crop on yield of fall sown oats in 1906.

Preceding crop	Part plowed under	Oats per acre: Yield	Oats per acre: Increase compared with oats after corn
		Bus.	*Bus.*
Sorghum, drilled.	Stubble	12.4	—1.3
Sweet potatoes	Vines	12.4	—1.3
Chufas	Tops only	11.7	—2.0
Corn	Stubble	13.7	
Whippoorwill cowpeas (drilled, picked)	Vines after picking	19.9	6.2
Spanish peanuts	Shed leaves, etc	26.7	13.0
Running peanuts	All except nuts	30.0	16.3
Soy beans, drilled	Stubble	21.4	7.7
Soy beans, drilled	Entire growth	42.2	28.5
Sorghum; 60 lbs. nitrate of soda	Stuble on oats.	28.0	14.3
Sorghum; 120 lbs. nitrate of soda	Stuble on oats.	34.2	20.5

From this table we learn that a preceding crop of drilled Whippoorwill cow peas plowed under after the pods were picked and removed (yielding 17.5 bushels of cowpeas per acre), increased the crop of oats 6.2 bushels per acre as compared with the preceding crop of corn. This makes the crop of drilled cowpeas worth for seed and fertilizer at least $20.00 per acre. Where peanuts were grown the increase was 13 to 16.3 bushels per acre; when soy beans, sown in drills, were cut and used for hay the remaining stubble increased the following oat crop 7.7 bushels per acre. When the entire crop of soy beans was plowed under the increase was 28.5 bushels.

It is interesting to notice that so far as measured by the first crop of oats 60 pounds of nitrate of soda was worth more than the stubble of soy beans or the picked vines of cow peas and worth nearly as much as the picked vines of running peanuts; 120 pounds of nitrate of soda gave a larger immediate result than any of the leguminous plants except soy beans where the entire growth was plowed under.

From all the experiments detailed above and from others it seems safe for a farmer by growing a crop of cowpeas before oats, to expect to increase the yield of oats by from 5 to 15 bushels or more per acre, whether the peas are simply picked or cut for hay.

In another experiment oats constituted the second crop after the plowing under of the picked vines of drilled cowpeas on a good grade of reddish loam soil, with retentive sub-soil. The increased yield on plots where cowpeas had grown two years before was 9.75 bushels of oats per acre, as compared with adjacent plots on which cotton had grown continuously for several years.

OATS AS A HAY CROP.

Good hay is made from oats cut when in the early dough stage.

On deep, gray, sandy soil (Norfolk sandy loam) two plots of Hatchett's Black oats were sown October 24. Both were fertilized at the time of sowing with 360 pounds of acid phosphate and 48 pounds of muriate of potash. The plots receiving no nitrogen yielded 678 pounds of cured hay per acre. The plots fertilized March 20 with 80 pounds of nitrate of soda per acre yielded 2,120 pounds of hay, or about 3 1-2 times as much as the plots without the nitrogen. From this late variety of oats the hay was ready to cut May 15. With Red oats the date for cutting oat hay is usually earlier.

PLACE OF OATS IN THE ROTATION ON THE COTTON FARM.

The small acreage devoted to oats on most cotton farms makes this crop a negligible factor in the farm rotation. Undoubtedly as the supply of labor decreases and the presence of the boll weevil makes it necessary to reduce the acreage and to intensify the fertilization and cultivation of cotton, oats will be grown on a more extensive scale. Even under present conditions it will be profitable to greatly extend the acreage in oats. Among the arguments for this increase is the fact that farmers seldom reserve any large acreage for cow peas except the land occupied during the earlier part of the year by a crop of small grain. More oats means more cow peas and more cow peas means a larger crop of cotton on this land the following and succeeding years. A desirable rotation for a cotton farm on which it is considered necessary to devote half of the land to cotton is the following:

1st year: Corn, with cow peas between the rows.

2nd year: Oats, followed by cowpeas, which may be cut for hay, picked, or grazed, or simply plowed under in December, January, or February, as fertilizer for the succeeding crop of cotton.

3rd year: Cotton.

4th year: Cotton.

A still more rapid improvement of the land would result from sowing crimson clover, properly inoculated, or other suitable winter growing leguminous plant in September among the growing cotton plants, covering with a one-horse harrow used just after the first or second picking, when little or no injury would be done to the cotton.

On a farm where stock is kept and where cotton requires only one-third of the cultivated area the rotation would be that given above for the first, second and third years, that is, corn, with cow peas; then oats, followed by cow peas; then cotton, and the fourth year corn again.

HOME GROWN SEED OATS.

While this Station has made no experiments comparing southern seed oats with those grown further north or west, our experience shows that oats grown continously for a number of years in Alabama do not "run out."

We use our own seed of Red Rust Proof oats year after year and our average yield in recent years has been greater than it was ten years ago. On farms where fair crops of oats are grown it is far better to save one's own seed than to buy seed of unknown origin, which may contain Johnson grass or other seed, and which may be otherwise objectionable.

Acknowledgements are hereby made to the following parties who at various times have participated in the conduct of the experiments herein recorded.

T. U. Culver, formerly Superintendent of the Farm; C. M. Floyd, Superintendent of the Farm during the past three years; and L. N. Duncan, Assistant in Agriculture, who has aided in the preparation of the tables in this bulletin.

FIG 1.—*Burt oats, April 23, 1906; right sown in November; left sown in February.*

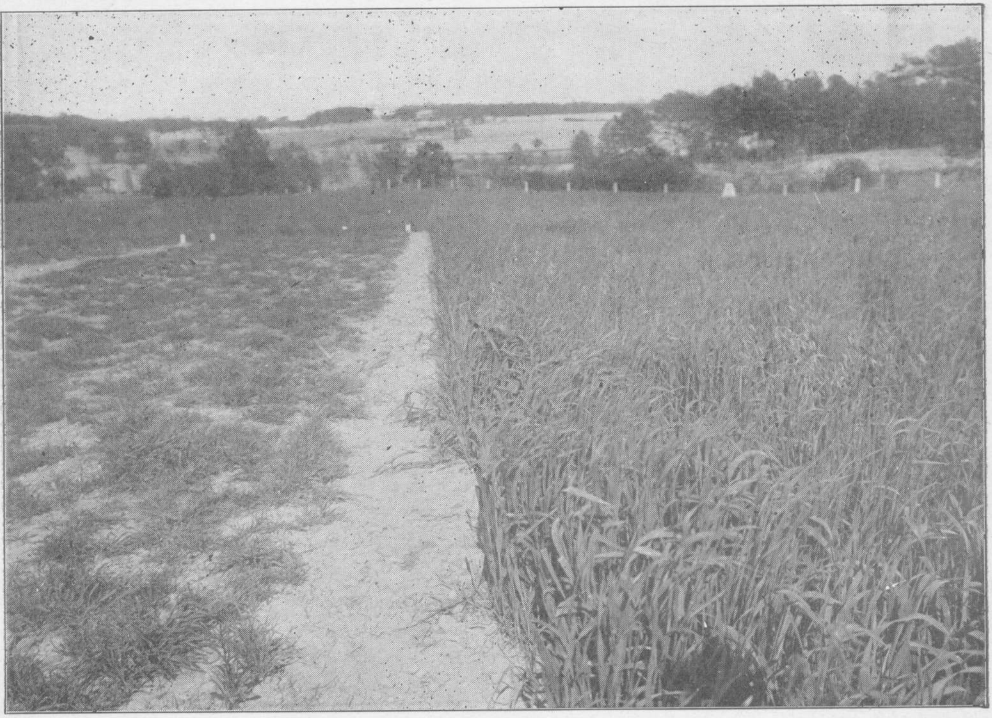

FIG. 2.—*Red oats, April 23, 1906; right sown in November; left sown*

Fig. 3 .—*Burt oats, May 10, 1906; left sown in November; right sown in February.*

Fig. 4.—*Red oats, May 10, 1906; left sown in November; right sown in February.*

BULLETIN NO. 138 DECEMBER, 1906

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

VARIETY TESTS WITH COTTON AND CORN.

Williamson Method of Corn Culture.

BY
J. F. DUGGAR, Director
AND
L. N. DUNCAN, Assistant in Agriculture.

Opelika, Ala.:
The Post Publishing Company,
1906.

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The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

VARIETY TESTS OF COTTON

BY J. F. DUGGAR, DIRECTOR AND AGRICULTURIST

AND

L. N. DUNCAN, ASSISTANT IN AGRICULTURE.

In order that the results of our unpublished variety tests of cotton may be in the hands of farmers in ample time for use in making plans for another year, this brief bulletin is presented. The results of other experiments made in 1905 and 1906 with cotton and corn will be reserved for future publications.

In addition to the varieties of cotton grown in plots of sufficient size to give an accurate measure of the yield per acre, a much larger collection of varieties has been grown, each on a small area, with a view to making descriptions of all obtainable varieties. We expect to publish a bulletin containing all these descriptions early next spring.

The two tables that follow give the yields in plot tests with 32 varieties of cotton in 1905 and with 20 varieties in 1906.

They were grown on ordinary upland. The soil where this test was made in 1905 was a stoney, reddish-gray sandy loam and the soil where varieties of cotton grew in 1906 was a gray sandy loam free from stones.

Yields of lint and seed and total value per acre of varieties of cotton in 1905.

Rank	Variety	Yield lint per acre	Yield seed per acre	Total value per acre*
		Lbs.	*Lbs.*	
1.	Toole	531.2	851.2	$67.04
2.	Cook's Improved	528.0	828.8	66.52
3.	Cleveland	520.0	840.0	65.68
4.	Bancroft's Herlong	488.0	948.8	61.76
5.	Christopher	480.0	916.8	61.62
6.	Schley	480.0	880.0	61.36
7.	Rowden	480.0	868.8	61.28
8.	Pullnot	480.0	768.0	60.58
9.	Layton	480.0	755.2	60.49
10.	Russell	464.0	896.0	59.63
11.	Strickland	459.2	902.4	59.12
12.	Willett's Red Leaf	452.8	792.0	57.61
13.	Crossland	456.0	723.2	57.50
14.	Hawkins	456.0	688.0	57.26
15.	Alex. Allen	440.0	832.0	56.42
16.	Culpepper (av. 5 plots)	433.6	812.5	55.55
17.	Haggaman	432.0	776.0	55.11
18.	Peterkin	432.0	688.0	54.50
19.	Texas Bur	424.0	806.4	54.40
20.	Southern Wonder	420.8	819.2	54.11
21.	Blue Ribbon	416.0	916.8	54.06
22.	Cameron	424.0	736.0	53.91
23.	Truitt	416.0	768.0	53.22
24.	Woodfin's Prolific	404.8	800.0	52.15
25.	Jackson's Limbless	411.2	691.2	52.13
26.	King No. 1	408.0	696.0	51.79
27.	Shine	400.0	792.0	51.54
28.	No. 148 (U. S. D. A. Selec.)	400.0	772.8	51.41
29.	Berry's Big Boll	392.0	824.0	50.85
30.	Welborn's Pet	376.0	680.0	48.00
31.	Rogers	324.0	611.2	41.54
32.	Dickson†	160.0	320.0	20.64

*Lint at 11 1-2c; seed at 70c.
†Ruined by boll rot.

The fertilizer used consisted of the following ingredients and amounts per acre, all applied before planting:

1905.		1906.
80 lbs.	Nitrate of soda	80 lbs.
160 lbs.	Cotton seed meal	80 lbs.
240 lbs.	Acid phosphate (14 per ct. available)	200 lbs
64 lbs.	Muriate of potash	48 lbs.
544 lbs.		408 lbs.

The crop was injured by excessive shedding late in the summer of 1906, and by a severe wind and rain storm in September, 1906, which considerably reduced the yield.

Yields of lint and seed and total value per acre of varieties of cotton in 1906.

Rank	Variety	Yield lint per acre	Yield seed per acre	Total value per acre*
		Lbs.	*Lbs.*	
1.	Cook's Improved	617.6	1076.8	$69.30
2.	Cleveland	608.0	1184.0	69.09
3.	Layton	612.8	1072.0	68.78
4.	Toole	608.0	1048.0	68.14
5.	Pullnot	596.8	1124.8	67.55
6.	King No. 1	592.0	1136.0	67.15
7.	Peterkin	588.8	1076.8	66.42
8.	Hawkins	552.0	1088.0	62.82
9.	Alex. Allen	536.0	1072.0	61.10
10.	Pride of Georgia	516.8	1200.0	60.08
11.	Willett's Red Leaf	512.0	976.0	58.03
12.	Christopher	504.0	1008.0	57.46
13.	Culpepper	503.3	1069.0	57.02
14.	Russell (U. S. D. A. Selec.)	488.0	1048.0	56.14
15.	Sunflower	472.0	1184.0	55.49
16.	Truitt	480.0	1008.0	55.06
17.	Russell (Ala.)	472.0	1016.0	54.31
18.	Floradora	460.8	1108.8	53.84
19.	Bancroft's Herlong	440.0	908.8	50.36
20.	No. 148 (U. S .D. A. selec.)	390.4	852.8	45.01

*Lint at 10c per pound and seed at 70c per 100 pounds.

The tables show that in total value of lint and seed the five leading varieties were in order in 1905, Toole, Cook's Improved, Cleveland, Bancroft's Herlong, and Christopher, and in 1906, Cook's Improved, Cleveland, Layton, Toole and Pullnot.

Sunflower and Floradora are long staple varieties and such staples commanded in Opelika in the fall of 1906 a premium of about four cents per pound.

By assigning a price of 14 cents per pound to these long staples, the total value of their lint and seed becomes respectively $74.37 and $72.27. However, the land on which these two varieties and Willett's Red Leaf grew is slightly lower and richer than that occupied by other varieties, so that even at a premium of four cents per pound it is not certain that the long staples head the list in total value of product. The bolls of these two long staple varieties being small picking is more difficult than with big boll varieties like Cook's Improved and Cleveland.

The Experiment Station has no seed for sale or distribution. Hence we give below the addresses of the parties from whom our seed was obtained:

Variety.	Seed from.
Alex. Allen	A. W. Allen, Temple, Ga.
Bancroft's Herlong	Edward Bancroft, Athens, Ga.
Berry's Big Boll	Harvey Seed Co., Montgomery, Ala.
Blue Ribbon	South Carolina Experiment Station, Clemson College, S. C.
Cameron	R. R. Cameron, West Green, Ala.
Christopher	R. H. Christopher, LaGrange, Ga.
Cleveland	J. R. Cleveland, Decatur, Miss.
Cook's Improved	J. R. Cook, Schley, Ga.
Crossland	U. S. Dept. of Agriculture, Washington, D. C.
Culpepper	J. E. Culpepper, Luthersville, Ga.
Dickson	Capers Dickson, Oxford, Ala.
Floradora	R. D. Tatum, Palmetto, Ga.
Haggaman	U. S. Dept. of Agriculture, Washington, D. C.
Hawkins	B. W. Hawkins, Nona, Ga.
Jackson's Limbless	Harvey Seed Co., Montgomery, Ala.
King No. 1	T. J. King Co., Richmond, Va.
Layton	R. D. Layton, Cresston, S. C.
No. 148 (U. S. D. A.)	U. S. Dept. of Agriculture, Washington, D. C.
Peterkin	J. A. Peterkin, Ft. Motte, S. C.
Pride of Georgia	U. S. Dept. of Agriculture, Washington.
Pullnot	J. E. Bradbury, Athens, Ga.
Rodgers	R. H. Rodgers, Darlington, S. C.
Rowden	J. A. Shine, Faison, N. C.
Russell	James Moore, Auburn, Ala.
Russell (U. S. D. A.)	U. S. Dept. of Agriculture, Washington.
Schley	R. D. Tatum, Palmetto, Ga.
Shine	J. A. Shine, Faison, N. C.
Southern Wonder	L. F. Grier, Oxford, Ala.
Strickland	U. S. Dept. of Agriculture, Washington, D. C.
Sunflower	M. Schaefer, Yazoo City, Miss.
Texas Bur	C. E. Smith, Locust Grove, Ga.
Toole	W. W. Toole, Augusta, Ga.
Truitt	G. W. Truitt, LaGrange, Ga.
Welborn's Pet	N. L. Willett Drug Co., Augusta, Ga.
Willett's Red Leaf	N. L. Willett Drug Co., Augusta, Ga.
Woodfin's Prolific	S. V. Woodfin, Marion, Ala.

TEST OF VARIETIES OF CORN.

All tests of varieties of corn except that made in 1906 were published in Alabama Experiment Station Bulletin No. 134, issued in December, 1905. The results of the experiment made in 1906 are given below.

Yield of shelled corn per acre in 1906.

Rank	Variety.	Per cent stand.	Yield per acre.
		Per ct.	*Bus.*
1.	Sanders	97	28.9
2.	Marlboro	97	28.3
3.	Mosby	93	26.0
4.	Henry Grady	97	25.7
5.	Local White Cob	97	25.4
6.	Albemarle	96	25.1
7.	Experiment Station Yellow	97	24.7
8.	McMackin's Gourd Seed	96	24.4
9.	Cocke's Prolific	97	24.3
10.	Boone County Special	97	24.0
11.	Boone County White (Tenn.)	97	23.7
11.	Boone County White (Ind.)	97	23.7
12.	No. 77 U. S. D. A. Selection	97	23.4
13.	Henry Grady (white cob select)	97	23.1
14.	Red Corn	97	22.3
15.	Hickory King	97	22.0
16.	Leaming	97	18.6
16.	Reid's Yellow Dent	97	18.6
17.	Silver Mine (Iowa)	97	17.9
18.	Riley's Favorite	97	15.7

The best yields were made by Sanders, Marlboro, Mosby and Henry Grady, all except the latter being prolific or several-eared varieties. Sanders, Mosby, and Henry Grady are the varieties which in previous experiments made here have taken high rank. The early northern varieties are again shown to be worthless for Alabama conditions, the yield being low and the grain of very inferior quality.

The fertilizer used per acre consisted of

80 lbs. Nitrate of soda.
80 lbs. Cotton seed meal.
240 lbs. Acid phosphate.
40 lbs. Muriate of potash.

440 lbs. Total

The soil was a reddish-gray, stony, sandy loam, and this upland field was the same on which the test of varieties of cotton was made in 1905.

We obtained seed of Albermarle from J. E. Stone, Sylacauga, Ala.; Henry Grady from W. J. Headden, Austelle, Ga.; Experiment Station Yellow from Ala. Expt. Sta., Auburn, Ala.

Seed of other varieties except the local white cob and Experiment Station Yellow were furnished by the U. S. Dept. of Agriculture, Washington, D. C., the early varieties having been grown in the North.

WILLIAMSON METHOD OF CORN CULTURE.

The press of the southern states has given much space during the past year or two to a discussion of a method of corn culture successfully practiced and ably advocated by Mr. McIver Williamson, of Darlington, S. C.

The distinctive features of this method are as follows:

(1) Dwarfing the corn plant by withholding fertilizers until the plant is several feet high and by omitting all cultivation from the time the plant is about eight inches high until it is about eighteen inches high.

(2) Thick planting in the row, which is made possible by the small size of the plants.

(3) Use of the turn plow in the last cultivations.

(4) Planting on land enriched by plowing under the entire growth of cowpeas.

To determine whether the dwarfing of plants and thicker planting have a favorable effect on the yield of corn two plots of poor gray sandy upland soil on the Experiment Station farm at Auburn were prepared alike and in accordance with Mr. Williamson's plan, the details being as follows: A fair growth of velvet bean vines was plowed under on both plots with a two-horse plow in February. Then rows were laid off 6 feet apart and bedded out, the water furrow thus formed being subsoiled, by using a Dixie turn plow with wing removed. Then with the same plow a slight list was formed in the water furrow. This list was opened and corn planted and covered on both plots without fertilizer, planting it thick on the Williamson plot and about half as thick on the check plot. Unfortunately we were not able to plant this experiment early, as is recommended. The first and last cultivations of the two plots were similar. Fertilization of both plots was identical, namely the very heavy application, as advised for the Williamson method, of 200 pounds of cotton seed meal, 200 pounds of acid phosphate and 400 pounds kainit per acre applied to both plots June 23; and 200 pounds nitrate of soda applied to both plots in side furrows July 7.

The details of cultivation were as follows:

Williamson plot.	Check plot.
April 19 planted.	Planted.
May. Middles cultivated shallow.	Middles cultivated shallow.
May 21	Two trips to row with Diverse Cultivator.
June 1	Hoed and thinned to 1 plant every 33 inches.
June 7	Cultivated with scooter and scrape 5 furrows per row.
June 21. Hoed and thinned to 1 plant every 16 inches.	....
June 23. Two side furrows with scooter and scrape.	Two side furrows with scooter and scrape.
June 23. Applied 800 pounds complete fertilizer per acre in side furrows.	Applied 800 pounds complete fertilizer per acre in side furrows.
June 23. Finished cultivating middles deep with Dixie turn plow.	Finished cultivating middles with scooter and scrape.
July 7. Cultivated with scooter and scrape, plowing in cowpeas.	Cultivated with scooter and scrape, plowing in cowpeas.
July 7. Applied in both side furrows 200 pounds nitrate of soda per acre.	Applied in both side furrows 200 pounds nitrate of soda per acre.

A study of the statements above will show that the treatment of the two plots was identical except in the following points:

(1) Later hoeing of the Williamson plot.

(2) Double thickness of planting on the Williamson plot.

(3) Omission of two cultivations on the Williamson

plot, namely, those given to the check plot on May 21 and June 7.

(4) Use of turn plow on the Williamson plot in cultivating middles on June 23.

The result of the thicker planting and the omission of cultivation between the early part of May and June 23 resulted in dwarfing the plants on the Williamson plot, which is the end aimed at in that system of culture. Its advocates claim that the dwarfing of the plant tends to promote the production of grain.

The yield of shelled corn was 30.5 bushels per acre on the Williamson plot and 29.5 bushels per acre on the check plot. This is a gain of one bushel per acre, or 3.4 per cent in favor of the Williamson method.

On the Williamson plot each plant averaged only about one-third (.346) of a pound of shelled corn; on the check plot the yield of grain per plant was almost exactly double this (.667 of a pound).

The ears were slightly larger on the check plot where the plants had greater distance, the average weight of shucked ear or nubbin being .54 of a pound as compared with an average weight of .45 of a pound on the Willimason plot. The variety used was Cocke's Prolific.

Naturally the plants with wider spacing on the check plots afforded a greater number of ears per plant, one hundred plants on the Williamson plot affording only 96 ears and nubbins as compared with 156 ears and nubbins per 100 plants on the check plot.

The average height from ground to the joint or node from which the ear or lower ear grew was 44 1-2 inches on the check plot and only 36 1-4 inches on the Williamson plot. The stalks on the Williamson plot were much more slender and broke down worse, the broken-over plants on the Williamson plot constituting 29 per cent, and on the check plot 14 per cent. This means a greater tendency for the corn to rot in the field on the Williamson plot.

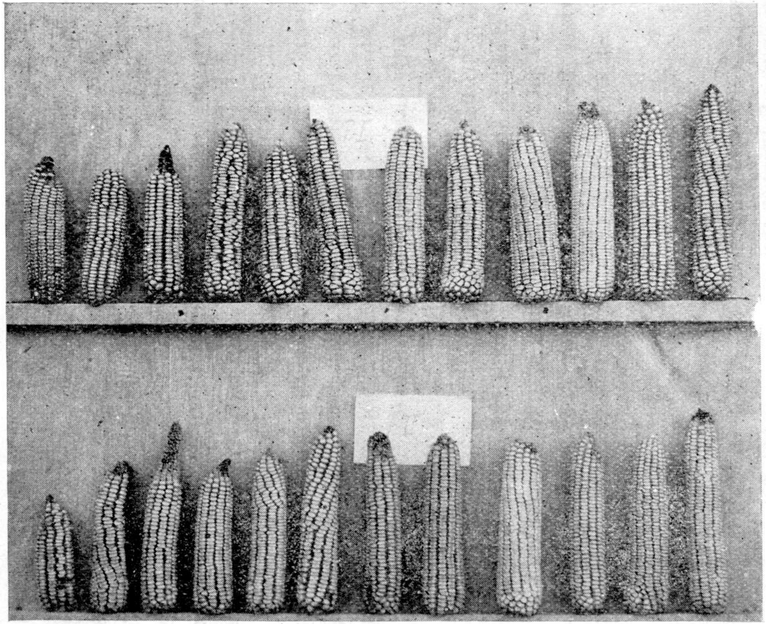

FIG. 1—*Ears and nubbins of which the average weight is the average weight for the plot.* (1, *above*) *From check plot;* (2, *below*) *From Williamson plot.*

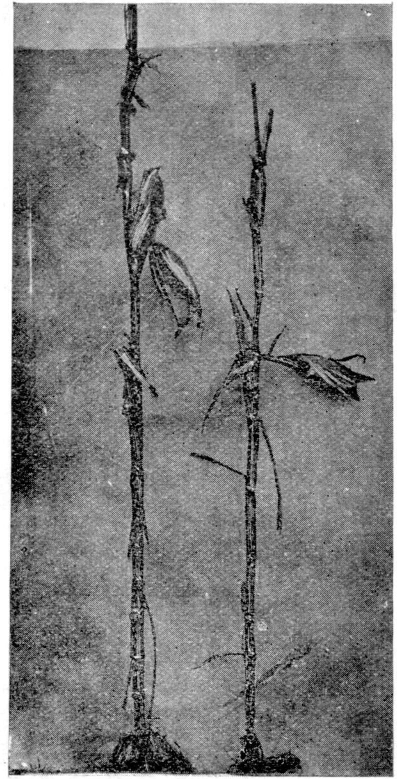

FIG. 2—*Stalks after harvest showing relative average height of ears and size of stalks; the smaller plant is from the Williamson plot.*

A study of the rainfall record for April, May, June and July indicates that at no time during the growing season did either plot suffer for moisture. The frequency of rains was doubtless favorable to the thick planting. Frequent rains at the time when cultivation of the Williamson plot was omitted prevented any injurious effect from this neglect. It is doubtful whether in average seasons such thick planting as was done on the Williamson plot (16 inches between plants) would have escaped disastrous firing.

It is obvious that we did not obtain profitable returns from this unusually large application of fertilizers; 1,000 pounds of commercial fertilizer cost $12.80, while the value of the crop at 70 cents per bushel was only $21.35. Our experiments in a number of localities in Alabama, and especially on a tract of gray sandy land similar and adjacent to that used for the Williamson experiment lead us to believe that the proportion of kainit in the Williamson fertilizer is too high.

It is an open question whether the unusually large yields obtained by Mr. Williamson on upland in South Carolina are not due more to the frequent plowing under of a crop of cowpea vines, to the liberal use of nitrogenous fertilizers, and to close planting, than to the dwarfing of the corn plant through omission of cultivation and withholding until late the application of fertilizers. Our previous experiments lead us most heartily to recommend plowing under a crop of cowpeas or other legumes as a fertilizer for corn, or the liberal use of nitrogenous fertilizers, and in many cases somewhat thicker planting than is customary, but a single year's test does not permit us to recommend all the details of the Williamson method. The experiment will be repeated, and in such a way as to inform us which of the details of the method are the really essential ones and responsible for the large yields sometimes secured.

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Agricultural Experiment Station

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AUBURN.

INJURIOUS INSECTS AND THEIR CONTROL.

BY

WARREN T. CLARKE,

Entomologist

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The Post Publishing Company,
1907.

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*On leave.

INJURIOUS INSECTS AND THEIR CONTROL.

By

Warren T. Clarke.

The agriculturist, no matter what crop he may be interested in, usually finds that he has to take into account and overcome, if may be, the ravages of insect pests. Sooner or later the question of means of control is sure to present itself to him, and on the solving of this question will depend the possible profit or loss in his farm operations. An intelligent knowledge of the fundamental principles governing the study of insect pests and an acquaintance with the best and most economical ways of applying these principles becomes therefore each day more necessary. The orchardist, the grower of field crops, the truck gardener, each of these must, to a certain extent, work out the problem in his own environment. The fact recognized that some insect is destroying entirely, or greatly reducing, the value of his crop is not sufficient knowledge upon which to base remedial measures. An acquaintance with the way in which the insect makes the damaging attack is necessary, and then the general character of the remedy to be used under these observed conditions must be known for effective work to be done.

It is not in the intention nor scope of the present Bulletin to give a complete treatise on the injurious insects of this state nor to lay down rules of procedure that will be entirely applicable in every case of damage that may arise. Indeed, there are questions in the control of certain insect pests that are today not solved, so we can only at present call attention to well known principles of procedure in such cases. On the other hand, there are many such questions that have received, either here or elsewhere, an adequate answer, and, in a brief way, we may call attention to certain such specific cases.

Method of Injury.

The injury done by insects to cultivated crops may, for the present and in a general way, be considered as resulting from the insect's effort to get food. There are, undoubtedly, injurious effects to the plant frequently accompanying this food-getting effort that cause more damage to it than can be laid to the mere loss of material taken by the insect. However, the primary damage, from which these other causes of loss spring, is done by the insect in feeding upon the plant. It therefore becomes of importance to know just how the insect feeds, so that the character of the damage may be understood and further, that economical and practical means of control may be applied. The insect's method of eating largely determines the character of the control means to be used. Insects feed upon plants in one of two ways, and on these feeding methods the whole series of injurious insects can be divided into two great groups. Either the insect that is causing damage to our crops has *biting mouth parts* and obtains its food by eating out portions of the attacked plant, from the fruit, the leaves, the branches and trunk, or from the roots, or it has *sucking mouth parts* and obtains its food by piercing the tissue of the part of the plant attacked, and sucking the sap. These two very different methods of feeding are readily recognizable. The work of the leaf eating caterpillars, cut-worms; the damage caused by certain leaf attacking beetles; the feeding marks of grasshoppers upon twigs and branches; the gnawing out done by mole crickets in Irish potatoes; the burrowings and minings of various borers; these forms of damage are characteristic of the work of insects with biting mouth parts. It does not require a high degree of expert knowledge to determine the facts as to eating methods in such cases as these, yet on these facts will depend, in large measure, the method of control most likely to be effective. On the other hand, we shall find that the method of attack of the insects with sucking mouth parts is quite as characteristic and easily recognized.

Poisoning.

If we determine that the insect in which we are interested, is of the biting type, devouring foliage, perhaps, then we know that it actually takes in particles of the plant as food, and we can infer that if poison is placed on this foliage it will become a part of the insect's diet and cause its death. On this determination will depend our use of such poisons as Paris green, arsenate of lead and similar toxic agents. These are known as internal or stomach poisons, are effective only when taken into the digestive tract, and do not trouble the generality of insects when in contact with them externally.

Spraying With Paris Green.—Paris green is an insoluble compound of arsenic and copper, and has received more attention and use in farm practice than has any other arsenical. If properly prepared it should carry but an extremely small percentage of free arsenic, and under these conditions it is generally not injurious to foliage, while being a very effective insecticide. It may be used as a spray in water or may be dusted on the plants or trees to be protected. When used as a spray the mixture should be made as follows:

Paris green	1 pound
Stone lime	4 pounds
Water	200 gallons

Mix the Paris green to a paste in a small quantity of water and then put in the spray tank with nearly the total amount of water to be used. Slack the lime in enough water to break it down completely, being careful, however, not to use enough water to "drown" it. Strain the milk of lime thus obtained through a sieve into the spray tank. Keep the whole mixture thoroughly and constantly stirred while spraying. In using this material as a spray, care must be exercised not to put too much upon the tree to be protected. While enough should be sprayed on to cover the leaves and fruit with a film of the material, if the operation is continued beyond this point and dripping ensues, the leaf edges, and occasionally the entire leaf, will be destroyed by what may be termed arsenical burning. This is caused by an excessive amount of the arsenical being deposited where the running together and dripping occurs.

Dusting Paris Green.—Paris green is also used successfully in certain cases by dusting it upon the plant. This method is especially to be recommended where low growing plants, such as Irish potatoes, are to be protected from leaf-eating insects. When the dusting method is employed the poison should be mixed with some diluting material, such as hydrated lime (lime dust) flour or even fine roadside dust. The poison should be used in not greater quantity than four pounds of Paris green to fifty pounds of the dilutant and generally one half this strength will be found effective. The mixture can be successfully and economically applied to such low growing plants by placing it in a bag made of some loosely woven material and then shaking the bag over the plant that we desire to protect. The work should be done in the early morning while the plants are yet wet with dew so that the poison will stick to them. This is of course a primitive way to distribute poisons in the dust form but there are very effective dusting machines made and obtainable by those who desire more up to date appliances.

Arsenate of lead.—The arsenate of lead is also an insoluble arsenic compound and in the matter of possible damage to foliage is rather to be preferred over the Paris green. It is slightly more expensive than the latter material but requires no lime for its preparation and, when fresh, is somewhat easier to mix with water than is Paris green. It can be used as a spray at the rate of one and one half pounds arsenate of lead to one hundred gallons of water. At this rate its insecticidal value is good. Arsenate of lead is sold under various trade names and is commercially prepared for spraying purposes. It is not made in a dry form and cannot be used in the dusting method.

Poisoned Baits.—The use of arsenicals either as a spray or in the dust form is to be recommended then, in the majority of cases where the injury is distinctly caused by some leaf or twig eating insect with biting mouth parts. There are, however, exceptional cases where neither the dusting nor the spraying method will answer the purpose satisfactorily. This is especially true where so-called "cut-worms," larvæ of certain moths, are causing the damage. When our problem is the control of these insects in vegetable patches or truck gardens, then the most satisfactory results will be obtained by what are known as "poisoned baits." These depend for their killing principle upon either ordinary white arsenic or upon some one of the arsenical compounds as Paris green, London purple, or lead arsenate mixed with or put upon some food that is especially liked by the insects in question.

A quite effective poisoned bait may be made by dipping succulent leaves, such as cabbage leaves, in water in which either arsenic or some arsenic compound has been placed. The amount of the arsenical used may vary quite largely and the result still be satisfactory.

The writer has found the following proportions effective: One quarter pound white arsenic, or one half pound Paris green, to five gallons of water. The mixture should be kept well stirred and the leaves to be poisoned dipped in it. These leaves should then be placed on the ground near the plants to be protected. The work should preferably be done in the late afternoon for usually cut-worms feed in the evening and at night, and the bait will be more attractive to them when fresh. When such succulent leaves are easily obtained in quantity, the method above outlined is recommended.

In many instances, however, such leaves cannot be obtained and when this is the case a poisoned bait made as follows will be found to be thoroughly satisfactory:

Bran	40 pounds
Molasses	2 or 3 gallons
Arsenic (powdered white)	3 pounds

Water .... 5 or 6 gallons

Mix the bran and arsenic together thoroughly while dry so that the poison will be well distributed in the whole mass. Add the molasses, mixing it and the poisoned bran well together. To this add enough water to make a fairly consistent mash. When a handful of the material will hold together in a ball, not too stiffly, enough water will have been added. Spread this bait about in small heaps near the plants that are to be protected. Usually cutworms will feed rather greedily upon this material and their destruction ensues. This bait can be freshened by sprinkling a little water upon it as it lies on the ground. If Paris green is used instead of arsenic the weight of the former poison should be *five* pounds in the formula.

Caution.—Care should be exercised in all instances where arsenic or any of its compounds are used for insecticidal purposes. Domestic animals, cows, horses, swine, hens, turkeys, geese, etc., should not be allowed to feed or browse where these poisons are used. The materials should not be left where human beings might accidentally obtain a poisonous dose. No danger to human beings exists when the arsenic compounds are properly used as a spray to protect fruit or trees from insect ravages. The amount of the poison present on sprayed fruit is usually too small to constitute a dangerous factor. Obviously, no possible danger can exist so far as the edible product is concerned when poisoned baits are used.

Mechanical Methods of Destroying Insect Pests.

The use of poison sprays and baits, while generally valuable in the control of insects with biting mouth parts, is not effective in all such cases that may arise. When we have to deal with insects of this type, but which feed upon the internal parts of the plant, the use of these poisons is of no value inasmuch as it is impossible to place the poison in the situation where the insect is feeding. This restriction applies mainly to those insects known as "borers," the most destructive representative of which class that we have to deal with in this state being the well known Peach Tree Borer. Where our problem consists of an attempt to control such pests as these, then mechanical means, so far as our present definite knowledge goes, must be resorted to. Using the insect just referred to, the Peach-Tree Borer, as representing this class of insects the mechanical means to be used, resolve themselves, finally to the actual cutting out and destruction of the individual insects. This may be accomplished by the use of very primitive tools, a good strong knife, indeed, doing effective work when properly handled or more elaborate implements may be employed. The so-called "Porter Hook," invented by Mr. C. M. Porter, of Douglas, Ga.,will be found to be one of the most effective of "worming" tools. It consists essentially of a handle some twelve inches in length into which is firmly set a curved or "hook" blade. This blade is about six inches in length, not including the shank which is inset in the handle, and is well curved so that the straight distance from base of handle to point of blade is four and one half inches. The destruction, by mechanical means, of the borers being here considered can best be done in the fall or early winter. "The larvae are at this time—some eighty-odd per cent. of them—extremely small, and are, for the most part, still on the outside of the tree feeding on such tender spots as they may have located between the ridges and crevices of the bark, and generally involved in a mass of gum and excreta. This, and most of the larvae with it, may be cleaned away by a few rapid sweeps with a steel hook" (i.e., the Porter hook or some similar implement). "The mass of gum, with its content of wriggling caterpillar life, should be thrown or jerked from the hook to a distance of several feet from the tree, in order that the larvae may find it difficult to return and be subjected to capture by predatory agencies. The process of "worming" thus executed is most expeditious and economical and may be conducted on an extensive scale with most satisfactory results."*

Whatever mechanical means may be employed for the

*Georgia Experiment Station Bulletin 73.

destruction of this or other borers, care must be exercised by the operator not to excessively wound or cut the tree. As much damage may be done the tree by careless or inefficient manipulation as would have been done by the borers that may have been destroyed in the operation.

The time above given and the method of work outlined does not, of course, apply to all the various species of borers attacking the different growths in which we may be interested. The general statement, however, may here be repeated that the work of control resolves itself into the careful cutting out, or probing for, the borer and the destruction of the individual pests and we may further emphasize the fact that the use of the arsenical poisons in such cases offers small hope of any success.

Certain injurious insects, notably the plum (or peach) curculio (*Conotrachelus nenuphar* Herbst.), have a habit of dropping to the ground and feigning death when disturbed. This habit is taken advantage of to destroy the insect. Sheets of cloth, upon light wooden frames, are placed beneath the affected trees which are then rather violently shaken or jarred. The disturbed insects fall on to the sheets and are collected from these and destroyed. The work should be done in the early morning when the insects are least active. The jarring process to be at all successful must be begun as soon as the insects are first noted upon the trees and fruit and must be continued until jarring fails to bring down enough to pay for the labor involved. This purely mechanical means of destroying these pests while being fairly satisfactory, so far as it goes, does not fully answer the question of their control. The writer has had occasion to note quite satisfactory results in controlling this pest by *spraying*. In the instance in question, the peach orchard was being sprayed with Bordeaux mixture to control the "brown rot" (Monilia fructigena.) The Bordeaux mixture was properly made by dissolving four pounds of copper sulphate (bluestone) in twenty gallons of water and by carefully slacking five pounds of clean stone lime and stirring the milk of lime or lime paste thus obtained in twenty gallons of water. The copper sulphate solution and the lime water mixture were then poured together through a strainer into the spray tank and to the resulting Bordeaux mixture was added one pound of lead arsenate dissolved in a small quantity of water. The whole mixture was kept thoroughly stirred while being sprayed on the trees.

In the case noted this operation of spraying was repeated three times during the season and mainly to control the "brown-rot." The first application was made just before the blossoms opened and no poison added to the mixture; the second application, this time with the poison added, was made when the fruit had set, while a third application, again with poison, was made some three weeks later. The control obtained indicated considerable value in the method as above outlined. This spraying method of control, however, cannot as yet, be considered as superceding the method of mechanical control of the series of insects now being considered and until further data is at hand jarring for the curculio is the practice to be recommended.

The two methods of mechanical control of insect pests outlined in the preceding paragraphs, that is the destruction by individuals of borers and the shaking down and destroying in numbers such insects as the curculio, indicate lines of work that may have to be employed in certain specific cases. Necessarily the method of work employed will be governed by a study of the insect itself and its habits of life.

Trap Crops.

While the methods of work heretofore outlined offer means of control for many insect pests, when these methods have been adapted to the local conditions where the work is to be done, yet there are certain insects that cannot be reached by any of the ways noted. Such of our truck gardeners as are interested in the production of early tomatoes know the damage done by worms to the "bottom" or earliest crop of this vegetable. When this portion of the crop can be brought off uninjured the largest profit accrues to the grower.

The insect causing the greatest part of the loss to this portion of the tomato crop in this state, is the larval or caterpillar form of a moth scientifically known as *Heliothis obsoleta.* In the caterpillar form it is best known as the boll worm of cotton or as the corn worm. It is a destructive enemy of corn and especially of sweet corn and seems to prefer this latter to any other diet. The appearance of the larva or "worm" is familiar to all who have handled sweet corn "in the ear." This food preference can be successfully taken advantage of to control this pest in tomato fields where the saving of the "bottom" crop is a matter of importance, by planting sweet corn as a trap crop. The method to be used is as follows; Prepare the land fully four weeks before the tomato plants are to be removed from the frame and put out in the field. As soon as the land is prepared plant rows of sweet corn about twenty feet apart across the field. The corn should be planted in hills in the rows, these hills being a convenient distance apart for cultivating, so that they may not interfere with this operation after the tomatoes are set out. The sweet corn should be well up and growing before the tomatoes are placed in the field. The adult moth laying the eggs from which are produced the damage causing "worms" are attracted by the sweet corn and oviposit upon it and the tomatoes, in very large measure, escape injury. Of course no paying crop of corn need be expected under these conditions for the product will be too "wormy" to market. It will, however, have well served its purpose as a trap crop and can, at the proper time, be cut for fodder.

This "trap crop" method of controlling certain pests that are not controllable in any other way, deserves study and use upon the part of the truck gardener. It is, however, not to be considered as offering a ready means of relief in every case of insect injury that may arise.

Farm Practice.

Closely related to the "trap crop" method of control of certain insect pests, in a method that may be designated under the rather broad title of "farm practice." There are some insects which, owing to the fact that their place and way of feeding does not admit of it, cannot be well controlled by any of the methods outlined in the previous paragraphs. In certain such cases a study of the life history of the injurious insect indicates that by changes in our time of planting and method of work we can bring on the crop before or after, as the case may be, the pest is most active and hurtful. By this means, though the insects are not destroyed, we avoid the damage that might otherwise be great. One of the insects causing damage to corn in this state is commonly known as the "bud worm." This is the larval form of a beetle known scientifically as *Diabrotica 12-punctata.* This beetle is about one quarter inch in length, is yellowish-green in color, with the wing covers marked with twelve black spots. The head and the greater part of the legs is black. It is very fond of cucurbits and is frequently found in numbers on the blossoms of such plants as cucumbers and squashes. The larva ("bud worm") is white or yellowish in color, quite slender and soft bodied. It usually feeds upon the corn roots, though, as it grows older, it may eat directly into the stalk and destroy the plant. It is from this last form of attack that it has received the name, "bud worm." It has been noted that early planted corn is most likely to suffer from the attack of this pest. The method of farm practice suggested by this fact is obviously then *plant as late as possible* to avoid this injury by the "bud worm." In this connection it is as well to say that late planting will not entirely do away with this pest. A system of rotation of crops is highly desirable where this insect is present. This rotation should not include beans or cucurbits as both of these are acceptable food for the Diabrotica. Cotton may be used in the rotation with safety. There are undoubtedly many insect pests now present in our state whose damaging work would be much lessened by some such simple change in practice as that just noted. Where the method would be applicable, however, would be a matter to be determined by the study of individual cases.

Under this heading of "farm practice" we wish to call especial attention to an insect that will in the course of three or four years be of immense importance to the cotton growers of the state. Reference is here made to the Mexican Cotton Boll Weevil, an insect which has not yet made its appearance in Alabama, but whose arrival can be predicted with a fair degree of certainty. While the exact date of the introduction of this pest to this country is not known, yet it must have come here a short time before the year 1894, when the attention of the Bureau of Entomology of the U. S. Department of Agriculture was first called to it. It was then present and harmful to cotton in some seven or eight counties of Texas. Since that time, in spite of all control efforts, it has spread over a larger and larger territory until now the limit of its eastern dispersion is within thirty miles of the Mississippi river. Besides the enormous loss to the cotton crops in the states at present most affected by this pest, Texas and Louisiana, many thousands of dollars have been spent by these states and by the Bureau of Entomology in studies of the insect and in devising ways and means of control. These studies have developed, among other important items, the fact that the Mexican Cotton Boll Weevil hibernates as an adult. This means that a certain proportion of the full grown weevils live in the cotton fields, or in adjacent situations, through the winter and from these overwintering individuals are produced the first of the new series of weevils the following spring. A further important fact is that this weevil is confined to the cotton for its food. Based on these two facts is the method of control of this pest that has proved most satisfactory and it is one of "farm practice" purely. The method is in brief, as follows: First, plant as early as can be and avoid possible frost injury, using seed of some early maturing variety of cotton. Second, by thorough cultivation and the use of fertilizers force the cotton to early maturity. Third, as soon as the crop is made remove by cutting out, raking to windrows and burning, all cotton plants. While this procedure involves a change in practice in cotton growing in this state yet it is a change that would benefit the industry were the Boll Weevil never to get here.

By this method an excessively long period of time results in which no cotton is available as food for the weevils and the number successfully hibernating is much reduced. It is not in the intention of this bulletin to enter very deeply into the subject of the Mexican Cotton Boll Weevil. It is sufficient for our present purpose to merely call attention to the great importance of the method of "farm practice" as applied in this and similar cases of insect attack where other methods offer scanty or no relief.

Insects With Sucking Mouth Parts.

Our attention so far has been drawn to the insects that have biting mouth parts and that obtain their food by actually eating out portions of the attacked fruit or plant. There is, as was noted in our opening paragraphs, a series of insect pests whose method of eating is quite distinct and different from these so far spoken of. These insects have mouth parts so adapted, structurally, that they pierce through the outer covering of the plant or fruit attacked, and suck out the sap or juice. They do not use as food any of the outer part of the plant and as a consequence none of the poisoning methods heretofore spoken of are of any avail in their control. Another point of dissimilarity between these insects and the group designated as having biting mouth parts is that while the latter insects move about from place to place and do not, as a rule, gather together in fixed colonies, the series with sucking mouth parts have this bunching together, gregarious habit, strongly developed. Not only is the colonizing habit characteristic of these insects but in the most injurious representatives of the group we find that when the sucking mouth parts have been inserted in the plant tissue and feeding begun the individuals remain fixed in the chosen situation throughout the balance of their lives. This habit of restricted motility, as it may be termed, is especially evident among the so-called scale insects (*coccidae*) and in the nearly related group of insects, the plant lice, (*aphididae.*) The methods of control that are successful with these insects are based upon this life habit of restricted motility and in the main consist of the use of what are known as "contact insecticides." These insecticides depend for their killing power, not upon the introduction of some toxic agent to the digestive tract of the insect, but upon the effect that the agency used may have upon the insect when in contact with it externally. They may be caustic in their action, actually destroying the tissues of the insect, and so bringing about its death, or they may be oily in their nature and depend for their killing power upon entering the body of the insect through the breathing pores. These are situated upon the sides of the body, and through them and their connecting tubes, (*tracheae*), air is carried to all parts of the insect's body. While the exact action of the oily sprays upon the insect's respiratory system is problematical, still the value of these sprays depends upon their effect on this system. A third class of contact insecticides depend for their value upon their tendency to loosen the insect from its situation upon the plant and permit the action of the weather upon the thus exposed pest to cause its death. Each of the methods above outlined has its value in particular cases and under certain conditions.

Control of Scale Insects.

The two pests among the scale insects causing the greatest losses in this state are the so-called San Jose Scale (*Aspidiotus perniciosus* Comst.) and the New or West Indian Peach Scale (*Aulacaspis pentagona* Targ.) The San Jose Scale is well distributed throughout the whole state while the West Indian Peach Scale is not quite so widespread in its distribution. Both insects belong in the group known as the armored scales which means that the living creature is covered over with an armor like shell which is composed of the cast skins (*exuviae*) of the insect and of a waxy material secreted by it. In both cases the individuals are extremely small and it is only their great numbers that make them a dangerous pest. It is not our intention at the present time to enter into an extensive description of either of these insects. For a fuller discussion of the subject the reader is referred to Circular No. 1, issued from this department in October, 1906. It is enough to say here that the same means of control are applicable and recommended for both insects.

These consist solely of contact sprays and the one in most general use, and at present most satisfactory, is the so-called Lime-Sulfur-Salt spray. This may be made by the following formula:

Lime	30 pounds
Sulfur	20 pounds.
Salt	5 pounds.
Water	60 gallons.

*Preparation.**—"For preparing the wash two vats or boilers are necessary, and if the spraying is to be done on a large scale, one of these, at least, should hold a couple of hundred gallons. If a smaller number of trees are to be treated, iron kettles will answer the purpose. Of course the preferable way of cooking the wash is by means of live steam.

Many ways have been suggested for mixing the materials, but the results are the same in every case, so long as the mixture has been subjected to the required amount of boiling. It is largely a matter of convenience, then, that determines the particular method, and the one found to best answer this requirement is as follows:

First, place two or three inches of water in the boiler, and to this add the sulfur, which has previously been made into a paste by mixing with hot water in order to remove the lumps, or sift the dry sulfur through a mosquito wire netting and stir in thoroughly. Then add about one fourth of the lime, and when the violent boiling has ceased add another fourth, and so on until the required amount of lime has been added. Hot water should be added with the lime as needed, so as to make the mixture a creamy consistency. Too much water will "drown" the lime while

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*From Alabama Agric. Exper. Station, Circular No. 1, Oct. 1906.

on the other hand too little, will cause incomplete slaking of the lime. In this way the heat generated by the slaking lime is taken advantage of, and by adding the sulfur first, plenty of time is given for removing the lumps.

By the time the lime is thoroughly slaked the fire should continue the boiling, so that the time of boiling begins with the addition of the lime. The salt and about one-fourth of the water should now be added and the whole boiled from one to two hours, keeping it frequently stirred in the meantime. At the end of this period screen into the spray tank, add the necessary amount of *hot* water and apply to the trees hot.

The wash, when properly made, is a heavy reddish-brown liquid, very caustic and having a strong sulfur odor. The heavier materials settle upon standing, leaving a lighter liquid both in color and weight.

Application—On account of the heavier ingredients of the wash quickly settling to the bottom, means should be provided for agitating the mixture in the spray tank. This is best done, of course, by the power outfit. In the absence of this a gearing may be attached to the wheel of the wagon and the mixture agitated while going from one tree to another. A still simpler way is to stir frequently by means of a hoe or paddle.

The nozzle should be of the stopcock type, which will permit of ready cleaning. The type of spray should be a rather coarse one which will thoroughly wet the insects.

* * * * * * * *

Thoroughness in application cannot be too strongly urged, and *no part of the tree should escape treatment.*

Time of application.—The Lime-Sulfur-Salt wash is for winter use only. It must not be used when trees are growing for very grave injury will be the result if it is applied at that time. When the trees are dormant it can be safely used upon them. Such weather conditions in the winter as will permit work in the orchard will be satisfactory for applying the Lime-Sulfur-Salt wash."

The difficulty attendant upon the preparation of this wash has led to a large amount of experimentation with other washes. Among the many materials used in this experimental work, the so-called "soluble oils" seem to offer the most promise and where winter work with the Lime-Sulfur-Salt preparation has been impossible, then it is advisable to use this material. It is known under different trade names and under the designation, "Scalecide," a quite desirable contact insecticide is sold. The spray made with this material can be used with safety in the spring and its results, when so used, are fairly satisfactory.

The main point to be observed in the use of this and all other contact insecticides is thoroughness of application. To be effective the material must come in direct contact with the insect to be destroyed.

Plant Lice.

Another quite destructive series of insects with sucking mouth parts are the so-called "plant lice," the Aphids. These are soft bodied creatures, quite small, though generally larger than the scale insects, and are more easily destroyed than are the latter pests.

Certain species of aphids are well known to our truck gardeners, as for instance, the cabbage louse, (*Aphis brassicae*), while certain other series are quite destructive to orchard products and even to trees. When the attack of these insects is confined to the above ground parts of the tree or plant they can be quite readily destroyed by a spray made as follows: Dissolve one and one-half pounds of ordinary kitchen or laundry soap in one and one-half gallons of water. This can best be done by shaving the soap into boiling water and keeping the water boiling until the soap is fully dissolved. Remove from the fire and pour into the strong suds thus made one gallon of kerosene oil, stirring vigorously while pouring. Continue this vigorous stirring for fully ten minutes. The result should be a fairly stable creamy emulsion with no free oil. To the Kerosene Emulsion thus made add eighteen gallons of water and the spray is ready to be applied. It will be found quite effective as a destroyer of the majority of plant lice with which the grower will have to deal.

There are certain species of plant lice that attack not only the above ground portions but also feed upon the roots and root crowns of the trees. When our problem is the control of such insects as these, special methods of procedure are necessary. The best known of these pests is the Wooly Aphis of the apple—an insect that is familiar to all who are interested in the growth of this fruit. Very briefly we may say that the general method of procedure in such cases as these is to work in about the tree and root crown such materials as wood ashes or tobacco dust. These materials have a tendency to either destroy the insects or discourage their attack at the point where it is most damaging, the root crown. Special cases of this character, however, demand special study and treatment.

In the control of certain of the insects with sucking mouth parts no spraying or other method of ordinary procedure is of use and we are reduced to the practice of "hand picking" or jarring the insects off of the infested plants in our control efforts. This is true of the larger representatives of the series, as for example, the so-called "squash bug," (*Anasa tristis,*) where spraying is of little or no value and control is obtained only by the removal and destruction of the individual insects.

There are many other insects of the type with sucking mouth parts to which attention might be called but we believe the purpose of this paper is served in citing the instances above noted.

Whether the insect causing damage is of the biting or sucking type, a reasonable study of it and its activities allows us to apply remedial measures far more economically and with a greater hope of success than would be the case without this study. The purpose of this Bulletin will have been served if it brings about a closer study of the insect causes of loss in this state and a more intelligent application of remedial measures.

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Descriptions and Classification of Varieties of American Upland Cotton

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BY

J. F. DUGGAR, *Director*

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DESCRIPTIONS AND CLASSIFICATION OF VARIETIES OF AMERICAN UPLAND COTTON.

BY J. F. DUGGAR, *Director*.

REASONS FOR DESCRIBING AND CLASSIFYING VARIETIES.

The objects in view when this work was undertaken by the writer in 1899 were the following:

(1) To determine what qualities accompany large yield of lint, so that farmers might be able to choose more intelligently the best of existing varieties according to their qualities.

(2) To ascertain what characters are correlated, so as to lay a firmer foundation for rational schemes of breeding better varieties of cotton.

(3) To obtain a better understanding of the meaning of variety tests made by the southern experiment stations, by ascertaining what *qualities,* rather than what *proper names,* have usually been associated with high yield under variable conditions of soil and climate.

(4) To protect cotton farmers against the payment of exorbitant prices for seed of so-called new varieties in cases where the "novelty" was the same as some well-known old variety, seed of which could be obtained at a reasonable price.

The investigation is by no means completed and is being continued, especially to determine what characteristics may be combined in one plant and what qualities are antagonistic. The results of the first year's work in describing and classifying varieties was published in 1899 as Bulletin No. 107 of the Alabama Experiment Station. The present publication includes investigation of varieties made at Auburn, Alabama, in 1899, 1902, 1903, 1904, 1905, and 1906. During each of those years collections numbering 60 to 100 so-called varieties were grown, so that the data here published usually represent the average results of tests of the same variety extending through several years. Some of the recently introduced varieties, however, have been tested only one year.

BASIS OF THIS CLASSIFICATION OF VARIETIES.

The cotton plant is very unstable, changing easily in many of its characters according to the climate and soil where it is grown. This tendency to vary with its surroundings is especially strong as regards the form of the plant, the length of the lint, and the size of the crop. Even the percentage of lint in the seed cotton varies somewhat from year to year. Moreover, the pollen may be carried from one variety to another by insects, thus producing hybrids from which still further variations arise. Because of these and other natural causes, it is to be expected that there should be numerous agricultural varieties of cotton differing from each other in slight and not very permanent qualities or characters.

Hence any attempt to classify agricultural varieties of cotton is more or less unsatisfactory. The gradations between varieties in any one agricultural character, for example, in size of boll, are so slight and gradual that positive identification of a single plant is practically impossible. However, it is believed that the averages,—for example, the average size of boll of a number of typical plants within one variety, taken in connection with the average of other qualities,—may be made the basis of a system of classification, which, though not infallible, will be useful. The classification here proposed is based, as far as considered practicable, on *groups* of qualities, rather than on a single character. Unfortunately the characteristics that are important to the farmer are those that vary most widely with change of environment.

The tentative scheme of classification here presented is practically the same as that published by the writer in 1899, in Bulletin No. 107 of the Alabama Experiment Station. A new group has been added to include chiefly varieties intermediate between the semi-cluster and any other group.

UNIFORMITY NEEDED WITHIN A VARIETY.

Man has done quite as much as nature to increase the confusion as to the varieties of American upland cotton. The chief difficulty that has been encountered in the attempt to describe and classify cottons grown at Auburn under several hundred different names has been the absence of uniformity among the plants of a single variety. While this variability is partly due to natural agencies, it is also largely due to the failure of growers to avoid the mechanical admixture of the seed of other varieties, which so easily occurs at public gins. Worse still, in the case of many, perhaps most, of the so-called varieties, there has been no long period of selection through successive years with a view to fixing a uniform type.

A cotton ought to have a considerable degree of uniformity between the plants composing it before it is entitled to a name. If it is a selection from an old variety it may have this uniformity from the beginning, provided that undesirable qualities are cast out by careful selection. If the new cotton is a natural or artificial hybrid, or a mechanical mixture of two varieties, it will require at least several years of rigorous selection to secure any approach towards uniformity. Until this uniformity is secured it is neither just to the public nor advantageous of the exploiter to bestow a variety name.

It cannot be too strongly urged upon those who would originate new varieties of cotton that in selecting plants for seed they should select for the same quality or qualities every year. Stick to your ideal year after year. If you find plants that are strong in some other quality than that you have heretofore had in mind, but different from the plants selected in previous years, either discard them or propagate them as a separate strain in a different field. Secure uniformity and special merit; until this is attained do not inflict the public with a new name and additional confusion and financial loss.

The confusion among varieties is still further increased by the renaming of old varieties, innocently or for self interest, sometimes intentionally by growers or seedsmen, sometimes by one's neighbors. This practice cannot be too severely condemned, however innocently it is sometimes done. It is to be hoped that public sentiment will hold every exploiter of a new variety morally and financially responsible that what he sells at an advanced price under a new name shall be something more than a new name.

In the long run there is more profit to the grower in the legitimate business of selecting and selling improved seed of a good and well known variety under its true name than in selling it under a new name. Here right and self-interest are on the same side.

GROUPS OF VARIETIES.

The short staple or upland varieties of cotton may conveniently be divided into seven classes, and to these may be added the long staple upland varieties as an eighth. I would propose for each of these general classes a name, giving, when practicable, an idea of the manner of growth of the plant, and with each class name would associate the name of some distinct and well known variety as a type or standard. I shall designate these groups as—

(1) Cluster varieties, or Dickson type.
(2) Semi-cluster varieties, or Peerless type.
(3) Rio Grande varieties, or Peterkin type.
(4) The King-like varieties, or King type.
(5) Big Boll varieties, or Truitt types.
(6) Long Limb varieties, or Petit Gulf type.
(7) Intermediate varieties, or varying types.
(8) Long Staple Upland varieties, or Allen type.

The lines of demarkation between these groups are not always clear and distinct; one group often merges into another by almost imperceptible gradations, just as is the case with related varieties.

Below is given a list of the varieties which are included under these several groupings, and also a general description of the varieties composing each class. Some varieties are not classified, either because of insufficient data, or more frequently because badly mixed. In cases of a medium degree of impurity, or variation, description has been made of the predominant type.

GROUP I.—CLUSTER VARIETIES, OR DICKSON TYPE.

The most striking characters are (1) the extreme shortness of the fruit limbs, and (2) the tendency of the bolls to grow in clusters, often two and even three from the same node. The plants are often tall and always slender and normally erect,though often bent down by the weight of bolls growing near the upper end of the main stem. The few base limbs are often long, or there may be no wood limbs,especially when these varieties are closely crowded or grown on poor land. The bolls and seed are usually small, but may be of medium size;—the seed are thickly covered with fuzz, which is usually whitish, with little or no brownish or greenish tinge.

As to the time of maturity these varieties must be classed as early, even though they sometimes make a second growth of bolls in the top of the plant which may fail to mature. In earliness they are surpassed by the varieties of the King type (Class IV.)

In per centage of lint they are variable, some of them equalling in this respect the Rio Grande group.

Dickson, Jackson, (also called Limbless or African), U. S. Dept. Agr. No. 128, and Welborn, belong to this group. (See illustrations.)

GROUP II.—SEMI-CLUSTER VARIETIES, OR PEERLESS TYPE.

These varieties have in less marked degree some of the qualities which distinguish Class I, being erect and having bolls borne singly very near together. Along the main stem are short fruit limbs increasing in length towards the bottom of the stem. The two to five base or wood limbs are usually of medium length. In size of bolls and size of seed and percentage of lint there is considerable diversity among these varieties. The seed are usually well covered with fuzz of many shades, whitish, greenish, or brownish. Most of these varieties are early or medium, but some that belong in both the semi-cluster and big boll groups are late in maturing. The following varieties are included in the semi-cluster group: Barnett, Berryhill, Blue Ribbon (L. S.), Cummings, Defiance, Dongola (B. B.), Featherstone, Garrard, Haralson (B .B.), Hardin, Hawkins, Herndon, Hilliard, Lealand, McCall, Minor, Montclare (B. B.), Norris, Peerless, Pullnot, Rogers (B. B.), Sterling, Tyler, and Woodfin.

GROUP III.—RIO GRANDE VARIETIES, OR PETERKIN TYPE.

The characters which most distinctly mark this class are:

(1) The large proportion of lint, usually 35 per cent. or more, of the weight of seed cotton, and

(2) Seeds of which many are bare of fuzz, except at the tip end, or so scantily covered with fuzz that the dark seed coat shows through.

The plants are well branched, and usually, on upland soil, of medium size. On many plants the stems and branches are of a deep red color. The bolls are small to medium and the seed are quite small. In time of maturing these varieties are usually neither very early nor extremely late.

The varieties included in this group are conveniently divided into two sub-groups according to the presence or absence of naked, smooth seed. The following Rio Grande varieties have a considerable proportion of naked seed: Anson Cream, Bates, Braddy, Brannon, Cameron, Carolina Queen, Champion, Combination, Crossland, Dixie Wilt-Resistant, Gayosa(?), Mattis(?), Moss, Parker, Peterkin, Pinkerton, Ptomey, Shine Black Seed, Sistrunk, Texas Oak, Texas Wood, Victor, and Wise.

Rio Grande varieties having practically no naked seed, but having many seed so scantily clothed with fuzz that the dark seed coat shows through, giving a brown color, are the following:

Berryhill, Borden, Dearing, (probably) Eureka, Excelsior (?), Favorite, (probably) Gregg, Layton, Park's Own, Speight, and (probably) Toole.

GROUP IV.—KING-LIKE VARIETIES, OR KING TYPE.

The varieties of this group are the earliest of American cottons. The plants are usually small but may be of medium size. The limbs are numerous and the fruit limbs are rather long in proportion to the height of plant. The fruit limbs are often crooked at the joints, reminding one of the crooked twigs of a black jack oak (*Quercus Marylandica*). The base limbs are short and sometimes replaced by fruit limbs bearing a number of bolls on each. King is essentially a short jointed, compact plant with an abundance of slender, rather crooked limbs. The bolls of this group are small; the seed are usually small and thickly covered with fuzz which is usually brownish, with an occasional seed showing a greenish tint. The percentage of lint is usually 33 to 35, and sometimes higher. King and its synonyms have on many blooms a red spot near the base of the inner portion of each petal. The varieties of this group are: Dozier, Grier, Golddust, Hodge, King, Lowry, Mascot, Missionary, and probably Shine Early.

GROUP V. BIG BOLL VARIETIES OR TRUITT TYPES.

The character which especially distinguishes this class is the large size of bolls, of which only 45 to 68 are required to yield a pound of seed cotton. Other specially notable qualities are late maturity and vigorous growth of stalk. The seed are large or very large, and covered with a thick fuzz, generally brownish white or whitish, a part of the seed of many of these varieties being covered with a deep green fuzz. The per cent. of lint often runs rather low and is usually between 31 and 34. The bolls are not closely clustered; in some varieties the upper limbs are so short as to give the top of the plant the erect, slender appearance which is common among semi-cluster varieties. In typical plants the base limbs are of short or medium length, the number of fruit limbs and bolls relatively few, and the main stem is rather short. However, a number of varieties are included here that have all or many of their plants of the semi-cluster form.

The following varieties belong in this group: Alex. Allen, Anderson, Bancroft, Banks, Berry, Bohemian, Brown No. 1 (?), Cheise, Christopher, Cleveland, Cliett, Cook Improved (?), Coppedge, Culpepper, Diamond, Double Header, Dongola, Drake (Ala.), Duncan, Ellis, Grayson, Gunn, Haralson, Hunnicutt Big Boll, Hutchinson, Jones, Langford, Lee, Maddox, Montclare, Mortgage Lifter, Ozier Big Boll, Reliable, Rogers, Rowden, Ruralist, Russell, Scogin, Sewell, Schley, Smith Improved, Smith Standard, Southern Wonder, Spearman, Strickland, Tatum, Texas Bur, Texas Storm Proof, Thrash, Todd, Triumph, Truitt, Webber-Russell, Whitten, and Wyche.

GROUP VI.—LONG LIMB UPLAND VARIETIES, OR PETIT GULF TYPE.

The varieties in this class grow to large size and have long limbs and long joints, the plants presenting a straggling appearance or want of compactness. The bolls and seed are both of medium to large size, the latter covered with fuzz of various shades. The per cent. of lint is usually low. The long limb form is usually accompanied by unproductiveness on average upland soil.

The following varieties are included in this group: Hagaman, Louisiana, Peeler, Petit Gulf, and probably Red Leaf.

GROUP VII.—INTERMEDIATE VARIETIES OR VARIOUS TYPES.

This group is here added to the scheme of classification published by the writer in 1899, primarily to include varieties having limbs a little too long to bring them within the semi-cluster class. It is also made to include a few other varieties that are intermediate between any two of the other seven groups.

To this division are assigned, Breeden, Boyd, Edgeworth, Eureka, Excelsior, Gold Standard, Hunnicutt (J. B.), Lewis, Meredith, Roby, Rosser, (probably) Shine Early, Sprueill, (possibly) Toole, Tucker, and Webber-Russell.

GROUP VIII.—LONG STAPLE VARIETIES, OR ALLEN TYPE.

The length of staple is the distinguishing characteristic. The lint usually measures 1 1-4 to 1 1-2 inches in length, or 28 to 34 millimeters or more. An almost invariable accompaniment to great length of staple is a low proportion of lint.

The plants grow to large size, have limbs of great length, and usually present a straggling appearance, though in some varieties only the base limbs are long, the upper limbs bearing a number of bolls close to the main stem, and giving the upper portion of the plant the appearance of great prolificacy.

The bolls are not very large, but are long, usually slender, tapering to a sharp point. Most of these long staple varieties are late in maturing a crop.

The seed are mostly of medium to large size, usually densely covered with fuzz, from which all trace of green is absent, the color being almost pure white, or in some varieties of a brownish tint. In some varieties the seed are bare. In this group are included—

Allen Long Staple, Allen Hybrid Long Staple, Black Rattler, Blue Ribbon, Cobweb, Cook Long Staple, Colthorp, Davis, Doughty (?), Eclipse (?), Ferguson (?), Florodora, Gholson, Griffin, Keno, Laclede, Matthews (?), Moon (?), New Century (?), Ozier Long Staple, Simms, Southern Hope (?), Sunflower, and Wonderful.

The varieties followed by an interrogation point are on the dividing line as grown on dry sandy upland soil at Auburn. On moister soil they usually have fiber long enough to admit them into the long staple group, or into a subdivision of that class which may be called the medium staple group.

PRODUCTIVENESS OF VARIETIES.

Tests of the yields of lint per acre have been made at Auburn for 90 varieties, in addition to a much larger number grown on areas too small to indicate the yield. Their rank in the production of lint each year when a "plot" test was made is shown by the figures in the following table. To compare any two varieties let the reader use only the figures for those years when both varieties entered the test.

From this table it will be seen that among the varieties tested for a considerable number of years the following are frequently near the top of the list: **Peerless, Peterkin, Russell, and Truitt.**

Among the varieties that have been tested only a few years, the following have usually taken high rank in yield of lint: **Cleveland Cook Improved, Jackson, Layton, Pullnot, and Toole.**

(See detailed descriptions, of illustrations of plants, and outlines of bolls, of each variety, which are alphabetically arranged on subsequent pages of this bulletin.

The lists just given of course do not include all the productive varieties, but only those that have been notably productive at Auburn after being tested here long enough to get average results for several years. Each variety is separately described and illustrated in alphabetical order in the following pages.

TABLE I.—*Rank of varieties of cotton on the basis of yield of lint per acre.*

TABLE I.	'89	'90	'91	'91	'92	'93	'96	'97	'98	'99	'04	'05	'06
Alex. Allen	--	--	--	--	--	--	--	--	--	--	4	10	8
Allen Hybrid Long Staple	--	--	--	--	--	--	11	16	--	--	--	--	--
Allen Long Staple	2	--	8	--	21	--	--	14	--	--	14	--	--
Bailey	--	--	--	12	18	--	--	--	--	--	--	--	--
Bancroft	--	--	--	--	--	--	--	--	--	--	--	4	17
Barnett	4	--	3	--	--	--	--	--	--	--	--	--	--
Berry	--	--	--	--	--	--	--	--	--	--	--	21	--
Blue Ribbon	--	--	--	--	--	--	--	--	--	--	34	16	--
Cameron	--	--	--	--	--	--	--	--	--	--	7	14	--
Cherry Cluster	6	--	4	--	17	--	--	--	--	--	--	--	--
Christopher	--	--	--	--	--	--	--	--	--	--	--	5	12
Cleveland	--	--	--	--	--	--	--	--	--	--	--	3	3
Colthorp Eureka	--	--	--	--	14	4	--	--	--	--	--	--	--
Colthorp Pride	--	--	--	--	11	7	--	--	--	--	--	--	--
Common	--	--	--	10	--	--	--	--	--	--	--	--	--
Cook Improved	--	--	--	--	--	--	--	--	--	--	6	2	1
Cook, (W. A.) Long Staple	--	--	4	--	24	1	--	--	--	--	--	--	--
Cook, (J. C.	--	--	--	12	--	--	--	--	--	--	--	--	--
Crossland	--	--	--	--	9	--	--	--	--	--	--	8	--
Culpepper	--	--	--	--	--	--	--	--	--	--	11	16	9
Dalkeith Eureka	--	--	--	--	15	10	--	--	--	--	--	--	--
Dearing	--	--	--	--	--	--	--	4	2	14	--	--	--
Dickson	--	--	2	--	20	--	3	12	--	--	--	24	--
Dixie Wilt Resistant	--	--	--	--	--	--	--	--	--	--	--	20	18
Doughty	--	--	--	--	--	--	--	--	--	--	10	--	--
Drake ("Cluster?")	--	--	--	--	--	--	--	--	--	--	20	--	--
Duncan	--	--	--	--	--	--	9	6	--	13	--	--	--
Edgeworth	--	--	--	--	--	--	--	--	--	--	27	--	--
Ellsworth	12	--	--	--	--	--	--	--	--	--	--	--	--
Florodora	--	--	--	--	--	--	--	--	--	--	33	--	16
Garrard	--	--	--	--	--	--	--	--	--	--	27	--	--
Gold Dust	--	--	7	--	22	--	--	--	--	--	--	--	--
Grier's King	--	--	--	--	--	--	--	--	--	--	25	--	--
Griffin Drought Proof	--	--	--	--	--	--	--	2	--	--	--	--	--
Hagaman	--	--	--	--	--	--	--	--	--	--	--	12	--
Hawkins	9	--	9	--	16	--	8	3	--	3	15	8	7
Herlong	--	--	6	--	23	6	13	--	--	--	--	--	--
Hunnicutt, (J. B.)	--	--	1	--	14	--	12	13	--	--	--	--	--
Hutchinson	--	--	--	--	--	--	1	7	7	--	--	--	--
Jackson	--	--	--	--	--	--	--	--	--	1	3	17	--
Johnson Excelsior	--	--	--	--	--	--	--	--	--	--	28	--	--
Jones Improved	5	--	10	--	--	--	10	5	8	7	24	--	--
Jones No. 1	--	--	--	--	17	--	--	--	--	--	--	--	--
Jones Long Staple	--	--	11	--	19	5	14	--	--	--	--	--	--
Keith	--	--	5	--	11	--	--	--	--	--	--	--	--
King	10	--	--	6	8	--	5	--	--	10	17	18	5
Layton	--	--	--	--	--	--	--	--	--	--	2	5	2
Lealand	--	--	--	--	--	--	--	--	--	--	38	--	--
Lewis Prize	--	--	--	--	--	--	--	--	--	--	16	--	--
Lowry	--	--	--	--	--	--	--	--	--	12	--	--	--
Mascot	--	--	--	--	--	--	--	--	--	--	18	--	--
Matthews Long Staple	--	--	--	--	7	11	--	--	--	--	--	--	--
Meredith	--	--	--	--	--	--	--	--	--	--	30	--	--
Mortgage Lifter	--	--	--	--	--	--	--	--	--	--	31	--	--
Nancy Hanks	--	--	--	--	--	--	--	--	--	--	19	--	--
Okra	9	--	--	13	12	8	--	--	--	--	--	--	--
Parker	--	--	--	--	--	--	--	--	--	--	33	--	--
Peeler	--	--	--	7	8	--	--	--	--	--	--	--	--
Peerless	7	1	--	4	6	--	4	11	--	--	--	--	--

TABLE I.—(*Continued*)

	'89	'90	'91	'91	'92	'93	'96	'97	'98	'99	'04	'05	'06
Peterkin	--	2	--	5	1	--	7	8	3	4	1	12	6
Petit Gulf	--	--	--	3	3	--	17	--	--	--	--	--	--
Red Leaf	--	--	--	--	--	--	--	--	--	--	12	9	11
Pride of Georgia	--	--	--	--	--	--	--	--	--	--	29	--	10
Pullnut	--	--	--	--	--	--	--	--	--	--	8	5	4
Rameses	8	--	--	9	--	--	--	--	--	--	--	--	--
Russell	--	--	--	--	--	--	--	--	1	8	20	6	15
Rowden	--	--	--	--	--	--	--	--	--	--	5	--	--
Rogers	--	--	--	--	--	--	--	--	--	--	23	--	--
Schley	--	--	--	--	--	--	--	--	--	--	25	5	--
Shine	--	--	--	--	--	--	--	--	--	--	22	20	--
Simms Long Staple	--	--	--	--	--	--	--	--	--	--	9	--	--
Smith Improved	--	--	--	--	--	--	--	--	4	--	--	--	--
Southern Hope	--	5	--	8	5	--	--	--	--	--	--	--	--
Southern Wonder	--	--	--	--	--	--	--	--	--	--	--	15	--
Storm Proof	--	4	--	15	2	--	--	--	--	--	--	--	--
Strickland	--	--	--	--	--	--	--	--	--	11	--	7	--
Sunflower	--	--	--	--	--	--	--	--	--	--	34	--	15
Texas Bur	--	--	--	--	--	--	--	--	--	--	13	13	--
Texas Oak	--	--	--	--	--	--	--	1	6	6	--	--	--
Toole	--	--	--	--	--	--	--	--	--	--	--	1	3
Truitt	1	3	--	2	4	--	2	9	5	2	24	16	14
Tyler	--	--	--	--	--	--	6	15	--	9	--	--	--
Webber-Russell (U.S.D.A.)	--	--	--	--	--	--	--	--	--	--	--	--	13
Welborn Pet	3	--	--	11	13	2	15	--	--	5	--	22	--
Whatley Improved	--	--	--	--	--	9	16	10	--	--	--	--	--
Wise	--	--	--	--	--	--	--	--	--	--	5	--	--
Woodfin Prolific	--	--	--	--	--	--	--	--	--	--	23	19	--
Wonderful	--	--	--	14	16	1	--	--	--	--	--	--	--
Zellner	11	--	--	1	10	--	--	--	--	--	--	--	--
No. varieties in test	13	5	13	15	29	11	17	16	8	14	40	30	20

NO ONE BEST VARIETY.

There is no one variety of cotton that is best for all soils and for all climatic conditions. At no experiment station has any single variety maintained the first place in productiveness year after year. When fall frosts occur at an early date the earlier varieties may have the advantage. An unusually late frost may place the late varieties far in the lead.

In years when a long staple commands a premium of four to six cents, a long staple variety, in spite of its usual lower productiveness will be more profitable on suitable land than ordinary or short-staple varieties. In other years, in other markets, and on dryer land, the most productive short staple variety may be far more profitable than a long staple.

After the invasion of the boll weevil, the best cotton to grow may not be the one that now makes the largest yield, but the one that forms a large proportion of its bolls so early in the season as to insure a crop before the weevils become excessively numerous. Likewise many other conditions keep any one variety from taking a position of universal pre-eminence.

The quality that is most universally desirable in a variety of cotton is productiveness, or high yield of lint per acre. With productiveness the farmer would be glad to unite as many of the following characters as possible:

(1) Large size of boll, to facilitate picking.

(2) Length of lint, with a view to a higher price per pound.

(3) Earliness.

(4) Storm resistance or ability to hold in the burr in spite of rain and wind, provided this quality shall not be accompanied by difficulty of picking.

(5) Ease of picking, if not accompanied by excessive tendency for the seed cotton to be beaten or blown to the ground.

CORRELATION OF CHARACTERS.

Relation of size of bolls to size of seed and to production of lint.

An analysis of the tables that follow shows that generally varieties with big bolls have also large seed. Thus of the 49 varieties having bolls so large as to require only 65 bolls or fewer per pound of seed cotton, all but 9 have seed averaging above .13 of a gram, and all but three have seed heavier than .12 of a gram. Langford and Spearman are notable exceptions to this generalization, the large size of their bolls being due to the great number (respectively 46 and 49) of rather small seed.

Likewise the varieties with smallest bolls are those with smallest seed.

In the plot tests at Auburn the most productive varieties have been found a little more frequently among the varieties having small seed (usually varieties of the Peterkin type), than among the big boll group, which, however, has been well represented among the winners.

High per cent. of lint is favorable to large yield of lint per acre, but not a necessary indication of large yield of lint. Thus nearly half of the 16 varieties having highest per cent. of lint in Table III have proved to be especially productive. In further confirmation of this conclusion we may add that the 65 varieties having lowest percentages of lint (less than 32.9 per cent.), include not a single name that has given proof of unusual productiveness. Furthermore, the long staple varieties, generally recognized as considerably less productive of lint than the best short staple varieties, have a low or very low per cent. of lint, often below 30.

High per cent. of lint is usually, but not always, accompanied by small seed. However, Cook Improved, Haralson, Dongola and Montclare are among the exceptional examples showing that it is possible to combine high per cent. of lint with rather large seed (and also with large bolls and productiveness).

Great length of fiber seems antagonistic to high per cent. of lint, All the data for the long staple varieties constitute the foundation for this deduction.

Relation of earliness to other qualities. Taking the King-like varieties as representing extreme earliness of opening, we conclude that *the qualities usually associated with earliness are small size of boll, small size of seed, short length of fiber, and medium or below medium productiveness.* Since earliness, in the greater part of the cotton belt, is chiefly important as a means of lessening the injury from the boll weevil, when it shall have occupied the entire cotton growing area, we should mark Bennett's important distinction between early opening and early setting of bolls. He regards the latter as much the more important as a means of decreasing injury from boll weevils. We might reasonably expect early setting of bolls and early opening to occur together, but on this point additional data are needed. Bennett concludes that we may identify early plants by their having short "joints" and by their lowest fruit limbs being near the ground.

Definitions.	*Bolls.*	*Per cent lint.*	*Size of seed.*
Large (or high)	40-68 per lb.	36 or above	.13 gram or more
Medium	69-80 per lb.	33-36	.11-.13 gram
Small (or low)	80 or more per lb.	30-33	below .11 gram

TABLE II.—*Number of bolls required to make 1 pound of seed cotton*

	Years	Bolls per lb		Years	Bolls per lb
Triumph	1	46	Sprueill Green Seed	4	67
Double Header	1	47	Breeden	1	68
Anderson	1	49	Corput	2	68
Bohemian	1	49	Grayson	1	68
Hunnicutt Big Boll	1	49	Hutchinson	2	68
Texas Storm Proof	1	50	Edgeworth	5	69
Cheise Improved	1	50	Hilliard	3	69
Todd	3	51	Rich Man's Pride	1	69
Diamond	1	52	Sprueill Re-Improved	2	69
Southern Wonder	1	52	Alex. Allen (recently 60)	4	70
Sewell	1	54	Lealand	3	70
Banks	3	56	Wilson Matchless	1	70
Spearman	1	56	Gayosa Prize	1	71
Mortgage Lifter	3	58	McCall	1	71
Bancroft	3	58	Pullnot	3	71
Strickland	2	58	Simms Long Staple	3	71
Tatum	1	58	Brannon	2	72
Truitt	5	58	Cook Long Staple	5	72
Ellis	2	59	Meredith	2	72
Christopher	4	59	Sistrunk	1	72
Japan	1	59	Best	1	73
Wyche	1	59	Blue Ribbon (fuzzy seed)	4	73
Rowden	3	60	Parks Own	2	73
Smith Standard	1	60	Warren	1	73
Brown No. 1	1	61	Red Leaf	3	73
Haralson	3	61	Carolina Queen	1	74
Holloway Storm Proof	1	61	Minor	2	74
Reliable	1	61	Nancy Hanks	3	74
Thrash Select	1	61	Rosser No. 1	2	74
Berry	2	62	Big Boll	1	75
Jones Improved	4	62	Doughty Long Staple	5	75
Rogers	1	62	Little Improved	1	75
Russell	5	62	Parker	2	75
Webber-Russell	1	62	Braswell Cluster	1	76
Cliett Improved	2	62	Florodora	3	76
Culpepper	5	63	Garrard	3	76
Dongola	3	63	Gregg	1	76
Langford	1	63	Layton	3	76
Maddox	2	63	Dixie Wilt Resistant	3	76
Drake "Cluster"	5	64	Peterkin	5	76
Duncan	1	64	Branch Long Shank	1	77
Lee Improved	2	64	Gold Standard	3	77
Ruralist	2	64	Hardin	1	77
Whitten	1	64	Hawkins Jumbo	1	77
Cleveland	3	65	Hodge	1	77
Coppedge	1	65	Mattis	3	77
Doughty Big Boll	1	65	No. 145 (U. S. D. A. selection)	1	77
Gunn	3	65	Peerless	4	77
Montclare	3	65	Pride of Georgia	3	77
Texas Bur	4	65	Wise	5	77
Cook Improved	3	66	Cummings	3	78
Griffin	3	66	Favorite	1	78
Roby	1	66	King No. 3	1	78
Scogin	3	66	Lewis Prize	3	78
Spruiell Prolific	1	66	New Century	2	78
Matthews Long Staple	2	67	Texas Oak	2	78
Schley	3	67	Bur	1	79
Smith Improved	3	67			

Table II.—(*Continued*)

	Years	Bolls per lb		Years	per lb
Hawkins	5	79	Ferguson	2	
Lowry	2	79	King	4	
Missionary	1	79	Butler	1	
Mitchell	1	79	Borden Prolific	1	
Moss	2	79	Cobweb	3	
Norris	1	79	Excelsior	4	
Ozier	2	79	Herlong	1	
Pinkerton	3	79	Ptomey	1	
Speight	1	79	Victor	2	
Blue Ribbon (black seed)	4	80	Anson Cream	2	
Todd Early	1	80	Bates Little Brown	1	
Tucker	2	80	Shine Early	5	
Berryhill	4	81	Black Rattler	2	
Gholson Long Staple	2	81	Welborn	3	
Improved Long Staple	1	81	Cameron Early	4	
Johnson Excelsior	1	81	Toole	3	
No. 146 (U. S. D. A selection)	2	81	Eclipse	1	
Petit Gulf	2	81	Shine Black Seed	3	
Boyd Prolific	3	82	Sterling	2	
Jackson	5	82	Woodfin Prolific	1	
King No. 1	4	82	Eureka	1	
Bingham	1	83	Bates Poor Land	1	
Grier	3	83	Defiance (Drake)	1	
Dozier	1	83	Laclede	1	
Moon	1	83	Combination	1	
Ozier Long Staple	1	83	Colthorp	3	
Sunflower	3	83	Mascot	2	
Woodfin Non-Pariel	3	83	Braddy	2	
Allen Long Staple	4	84	Early Gayosa	1	
Crossland	3	84	Shine No. 2		
Extra Early	1	84	Dearing	2	
Hagaman	2	85	Dickson	3	
Herndon Select	3	85	Keno	1	
Texas Wood	4	85	Barnett	2	
Allen Hybrid Long Staple	1	86	Seabrook (Sea Island)	1	
Tyler Limb Cluster	1	86	Sea Island	3	

TABLE III.—*Varieties of cotton arranged according to per cent of lint*

	Years	per cent
Shine No. 2	1	41.5
Victor	2	40.5
Bates Little Brown	1	39.6
Wise	5	39.5
Layton	3	39.0
Cook Improved	3	38.9
Todd Early	1	38.9
Combination	1	38.8
Eureka	1	38.6
Triumph	1	38.6
Toole	3	38.5
Favorite	1	38.3
Moss	2	38.3
Haralson	3	38.2
Jackson	5	38.0
Peterkin	5	38.0
Roby	1	38.0
Berryhill	4	37.8
Braddy	2	37.8
Brown No. 1	1	37.7
Grier	3	37.7
Johnson Excelsior	1	37.7
Little	1	37.7
Bates Poor Land	1	37.6
Borden	1	37.5
Crossland	3	37.5
King No. 1	4	37.5
Whitten	1	37.4
Texas Wood	4	37.2
Blue Ribbon (wooly seed)	4	37.0
Sistrunk	1	36.9
Cameron Early	4	36.8
Montclare	3	36.8
Shine Black Seed	3	36.8
Red Leaf	3	36.8
Brannon	2	36.4
Gregg	1	36.4
Pullnot	3	36.3
King	4	36.3
Thrash	1	36.2
Rich Man's Pride	1	36.2
Pinkerton	3	36.2
Gold Standard	3	36.1
Rowden	3	36.0
Dongola	3	36.0
Carolina Queen	1	35.8
Lewis Prize	3	35.8
Mascot	2	35.8
Edgeworth	5	35.7
Rogers	1	35.7
Nancy Hanks	3	35.6
Welborn	3	35.6
Ptomy	1	35.5
Hodge	1	35.4
Extra Early	1	35.3
Anson Cream	2	35.2
Bingham	1	35.2
Cleveland	3	35.1
Langford	1	35.1
Garrard	3	35.0
Rosser No. 1	2	35.0
Maddox	2	34.9
Tucker	2	34.9
Cliett	2	34.8
Breeden	1	34.7
Culpepper	5	34.7
Pride of Georgia	3	34.7
Hawkins	5	34.6
Hilliard	3	33.6
No. 146 (U. S. D. A. selection)	2	34.5
Excelsior (Moore)	4	34.5
Hutchinson	2	34.4
McCall	1	34.4
Minor	2	34.4
Mortgage Lifter	4	34.4
No. 145 (U. S. D. A. selection)	1	34.4
Webber-Russell	1	34.4
Alex. Allen	4	34.3
Braswell Cluster	1	34.3
Christopher	4	34.3
Hagaman	2	34.3
Missionary	1	34.3
Sprueill Green Seed	4	34.3
Defiance (Drake)	1	34.2
Texas Oak	2	34.2
Double Header	1	34.1
Herlong	1	34.1
Schley	3	34.1
Smith Improved	3	34.0
Southern Hope	3	34.0
Woodfin Prolific	1	34.0
Parks Own	2	33.8
Warren	1	33.8
Boyd Prolific	3	33.7
Cheise Improved	1	33.7
Dozier	1	33.7
Speight	1	33.7
Banks	3	33.6
Colthorp	3	34.6
Branch Long Shank	1	33.6
Lealand	3	33.6
No. 149 (U. S. D. A. selection	1	33.6
Ozier	2	33.6
Holloway Storm Proof	1	33.5
King No. 3	1	33.5
New Century	2	33.5
Sterling	2	33.5
Peerless	4	33.4
Tatum Big Boll	1	33.2
Texas Bur	4	33.2
Tyler Limb Cluster	1	33.2
Herndon Select	3	33.1

TABLE III.—(*Continued.*)

	Years	per cent
Lowry	2	33.1
Dixie Wilt Resistant	1	33.1
Texas Storm Proof	1	33.1
Parker	2	33.1
Wyche Big Boll	1	33.1
Doughty Big Boll	1	33.0
Reliable	1	33.0
Todd Improved	3	33.0
Bancroft Herlong	3	32.9
Jones Improved	4	32.9
Russell	5	32.9
Truitt	4	32.9
Blue Ribbon (black seed)	4	32.8
Bohemian	1	32.8
Burr	1	32.8
Coppedge	1	32.8
Drake "Cluster"	5	32.8
Meredith	2	32.8
Moon Long Staple	1	32.7
Sprueill Re-Improved	2	32.6
Strickland	3	32.5
Berry	2	32.4
Keno	1	32.4
Mattis	3	32.4
Dickson	3	32.3
Lee	2	32.3
Barnet	2	32.2
Wilson	1	32.2
Big Boll	1	32.1
Cummings	3	32.1
Ellis	2	32.1
Gunn	3	32.1
Best	1	32.0
Shine Early	5	32.0
Woodfin	3	32.0
Spearman	1	31.9
Mitchell	1	31.8
Petit Gulf	2	31.8
Griffin	3	31.7
Early Gayosa	1	31.5
Corput	2	31.4
Matthews Long Staple	2	31.4
Florodora	3	31.3
Ozier Long Staple	1	31.3
Simms Long Staple	3	31.3
Gholson Long Staple	2	31.2
Norris	1	31.2
Ferguson	2	31.2
Hawkins Jumbo	1	31.1
Scogin	3	31.1
Black Rattler	2	31.0
Dearing	2	31.0
Laclede	1	31.0
Sewell	1	31.0
Anderson	1	30.9
Grayson	1	30.8
Hunnicutt Big Boll	1	30.8
Butler	1	30.4
Smith Improved	3	30.4
Hardin	1	30.3
Ruralist	2	30.3
Cook Long Staple	5	30.2
Eclipse	1	30.2
Doughty	5	30.1
Duncan	1	30.0
Japan	1	29.7
Sprueill Prolific	1	29.5
Davis Long Staple	2	29.2
Sunflower Long Staple	3	29.2
Diamond	1	29.1
Cobweb	3	28.8
Improved	1	28.3
Seabrook	1	28.1
Allen Long Staple	4	28.0
Allen Hybrid Long Staple	1	26.9
Sea Island	3	26.5
Gayosa Prize	1	24.9

TABLE IV. *Weight of 100 seed; varieties arranged according to size of seed.*

	Years	Grams		Years	Grams
Todd Improved	3	16.89	Cook Improved	3	12.6
Duncan	1	16.64	Improved Long Staple	1	12.6
Sewell	1	16.54	Triumph	1	12.6
Bancroft Herlong	3	16.40	Hutchinson	2	12.6
Banks	3	16.28	Norris	1	12.6
Gayosa Prize	1	16.03	Doughty Big Boll	1	12.5
Holloway's Storm Proof	1	16.03	Braswell	1	12.3
Texas Storm Proof	1	15.98	Scogin	3	12.4
Rowden	3	15.91	Big Boll	1	12.4
Anderson	1	15.58	Cook (W. A.) Long Staple	5	12.4
Spruiell Prolific	1	15.53	Hawkins Jumbo	1	12.4
Thrash	1	15.52	Sprueill Green Seed	4	12.4
Double Header	1	15.34	Cleveland	3	12.
Ellis	2	15.31	Cummings	3	12.
Mortgage Lifter	3	15.27	Rich Man's Pride	1	12.
Truitt	4	15.06	McCall	1	12.
Lealand	3	15.04	Webber-Russell	1	12.
Strickland	2	14.96	Alex. Allen	4	12.
Maddox	2	14.95	Parks	2	12.
Cheise Improved	1	14.82	Texas Bur	4	12.
Southern Wonder	1	14.74	Ruralist	2	12.
Lee Improved	2	14.46	Pullnot	3	12.
Russell	5	14.34	Bur	1	11.
Coppedge Improved	1	14.32	Hilliard	3	11.
Rogers	1	14.30	Lowry	2	11.
Diamond	1	14.28	Meredith	2	11.
Hunnicutt Big Boll	1	14.27	New Century	2	11.
Dongola	3	13.92	Floradora	3	11.
Cliett	2	13.87	Garrard	3	11.
Berry Big Boll	2	13.85	Cobweb	3	11.
Culpepper	5	13.65	Edgeworth	5	11.
Matthews Long Staple	2	13.62	Moon	1	11.
Best	1	13.55	Tatum	1	11.
Bohemian	1	13.54	Breeden	1	11.
Christopher	4	13.53	Allen Hybrid Long Staple	1	11.
Smith Standard	1	13.49	Griffin	3	11.
Gunn	3	13.46	Mitchell	1	11.
Grayson	1	13.44	Simms Long Staple	3	11.
Japan	1	13.44	Ferguson	2	11
Montclare	3	13.37	King No. 3	1	11.
Brown No. 1.	1	13.29	Schley	4	11
Smith Improved	3	13.27	Seabrook (Sea Island)	1	11
Wyche Big Boll	1	13.27	Blue Ribbon (black seed)	4	11
Peerless	4	13.24	Roby	1	11
Haralson	3	13.19	Hawkins	5	11
Jones Improved	4	13.19	Gholson Long Staple	2	11
Whitten	1	13.19	Minor	2	11
Drake "Cluster"	5	13.16	No. 145 (U. S. D. A.selection	1	10
Sea Island	3	13.15	Johnson Excelsior	1	10
Blue Ribbon (fuzzy seed)	1	13.10	Nancy Hanks	3	10
Branch Long Shank	1	13.06	Excelsior	4	10
Doughty Long Staple	5	13.06	No. 149 (U. S. D.A.selection)	1	10
Corput	2	12.99	Parker	2	10
Sprueill Re-Improved	2	12.82	Bingham	1	10
Ozier Big Boll	2	12.75	Warren	1	10
Reliable	1	12.70	Defiance (Drake)	1	10

TABLE IV.—(*Continued.*)

	Years	Grams		Years	Grams
Pride of Georgia	3	10.70	Early Gayosa	1	9.78
Pinkerton	3	10.69	Berryhill	4	9.77
Dixie Wilt Resistant	1	10.67	Colthorp	3	9.68
Ozier Long Staple	1	10.66	Hodge	1	9.69
Langford	1	10.63	King	4	9.66
Spearman	1	10.57	Texas Oak	2	9.66
Boyd Prolific	3	10.55	Wilson	1	9.62
Gregg	1	10.55	Crossland	3	9.60
Hardin	1	10.52	Dickson	3	9.59
Sunflower	3	10.52	Todd Early	1	9.58
Rosser No. 1.	2	10.44	Peterkin	5	9.52
Brannon	2	10.41	Jackson	5	9.51
Little	1	10.40	Keno	1	9.48
Petit Gulf	2	10.39	Ptomey	1	9.45
Allen Long Staple	4	10.38	Lewis Prize	3	9.43
Gold Standard	3	10.36	Black Rattler	2	9.39
Hagaman	2	10.36	Woodfin Prolific	1	9.38
Mattis	3	10.33	Dozier	1	9.33
Carolina Queen	1	10.31	Herndon Select	3	9.20
Grier	3	10.21	Mascot	2	9.13
No. 146 (U. S. D. A.)	2	10.21	Laclede	1	8.97
Texas Wood	4	10.17	Cameron Early	4	8.94
Shine Early	5	10.16	Layton	3	8.88
Red Leaf	3	10.15	Wise	5	8.72
Woodfin	3	10.11	Favorite	1	8.70
Borden	1	10.04	Toole	3	8.57
Moss	2	9.98	Barnett	2	8.56
Welborn	3	9.97	Shine Black Seed	3	8.38
Herlong	1	9.96	Tyler	1	8.36
Eclipse	1	9.94	Victor	2	8.33
Tucker Improved	2	9.92	Extra Early	1	8.26
Dearing	2	9.89	Butler	1	8.18
[illegible]nson Cream	2	9.88	Combination	1	8.17
Sistrunk	1	9.84	Bates Poor Land	1	8.16
Sterling	2	9.84	Eureka	1	8.05
King No. 2.	1	9.82	Shine No. 2.	1	8.03
Speight	1	9.82	Braddy	2	7.64
Missionary	1	9.80	Bates Little Brown	1	5.48

CONDITIONS UNDER WHICH THESE DESCRIPTIONS, PHOTOGRAPHS AND WEIGHINGS WERE MADE.

All descriptions and photographs herein published were made from typical plants grown at Auburn, Alabama, on upland fields. The soil here is sandy and dry and under these conditions the cotton plant makes relatively a small growth of stalk. The fiber of the long staple varieties is shorter here than when the same variety is grown in moister soil. Time and conditions have not thus far permitted careful and repeated measurements of fiber, and until this can be done by more accurate methods than are sometimes used, it is thought best to make no comments on the character of fiber except where the staple is distinctive. There has usually been an application of from 400 to 600 pounds of complete fertilizer per acre, and the average yield for different years has varied from about three-fourths to about one and one-eighth bales per acre. Photographs were taken about the time of first frost, and since the date of making the photographs necessarily varied, the pictures should not be taken as indicating relative earliness of varieties. Neither do the figures show the relative sizes of plants. The drawings of bolls are exactly the same size as the original boll, chosen as apparently typical of each variety.

Data as to size of bolls, weight of seed, per cent of lint, etc., are as a rule based on the average of three samples for each year that the given variety was tested, or fifteen separate samples in the case of a variety tested five years. The lint was removed by hand picking, and comparisons with percentages of lint from ginning some of the same varieties show but little difference, say 1-2 to 1 per cent higher for hand picking. The area available did not permit the growing of all varieties on plots large enough to determine the yield per acre. Where such yields were determined they are indicated in Table I.

The writer cheerfully records his obligations to those who have assisted in this work, especially to L. N. Duncan, Assistant Agriculturist, who has prepared most of the tables from our records, and has otherwise given most effective help. Among others to whom credit is due are C. M. Floyd, Superintendent of the Farm, and C. R. Hudson, formerly Assistant Agriculturist.

The writer is well aware that the plain statement of the undesirable qualities, or the failure to find conspicuous merit in a variety, may bring disappointment to the originator or exploiter and may perhaps bring censure upon the experimenter. However, conscious of entire impartiality, recognizing the possibility of errors of judgment and the limitations imposed by the small number of tests of certain recently introduced varieties, he can only present his findings with the hope that they will aid the farmer to choose the variety best for his conditions and to point out merits and defects, note of which may aid originators of new varieties still further to improve their creations.

DESCRIPTIONS OF VARIETIES.

Alex Allen.—This is a variety which A. W. Allen, Temple, Ga., states that he originated in 1898 from a single plant found in a field of mixed varieties. This is a compact, erect, big boll variety with semi-cluster form. Plants medium size, short jointed. Maturity early to medium. The bolls the last two years averaged 60 per pound of seed cotton, or larger than in our earlier tests. Storm resistance slight; per cent of lint medium or above, (34.3). Seed medium in size, fuzzy, mostly white, but some of them greenish white and some brownish white. Lint short. Rank in yield of lint in field tests at Auburn 4th, 10th and 8th. This is a promising prolific variety, useful on account of its yield, earliness, and large size of bolls.

Allen.—(Synonyms, Allen Long Staple, Allen Improved, Allen Silk, and Talbot). Originated by James B. Allen, Port Gibson, Miss., who reports it to be a cross between his Allen Hybrid and Yellow Bloom. The plants are tall with long base limbs and numerous rather short central and upper limbs. Maturity medium to late. Bolls small (84 per pound of seed cotton), or small to medium, and pointed; locks 4 or 5; storm resistance, slight. Per cent. of lint very low, (28 per cent.) Seed small to medium as judged by weight, (.104 gram), but appearing large because of abundant fuzz. Lint very long and fine. Rank in yield 2nd, 18th, 14th, and 21st. This is a well established, standard long staple variety, with excellent quality of lint and a well bolled plant.

Allen Hybrid Long Staple.—This is one of the earlier varieties originated by James B. Allen, Port Gibson, Miss., and is one of the parents of Allen Long Staple. As grown here it differed but slightly, if at all, from its descendant. The bolls are small (86 per pound of seed cotton); per cent of lint very low (26.9); seed small and fuzzy, mostly white. Maturity late. Rank in yield of lint 11th and 16th.

African.—(See Jackson).

Anderson.—Grown only in 1906. Seed received from J. F. Anderson, Williamson, Ga. This is a big boll variety with plant typical of that group, but better supplied with bolls than the average big boll variety. On type of plant this was regarded as one of the best of the big boll varieties grown at Auburn for the first time in 1906. However, the low per cent. of lint, (30.9), makes further test necessary before we can pronounce this variety a productive one. Plant medium in maturity and in height; limbs medium length; bolls very large (49 per pound), mostly five locks, opening wide. Seed very large and fuzzy, white and pale greenish white. Lint medium in length. Yield not determined.

Anson Cream.—(Synonym, probably Peterkin). Seed was obtained from North Carolina. This variety belongs in the Rio Grande group and is probably a local name for, or a selection from, Peterkin. Seed of some plants are naked, while seed of other plants, that are probably impurities, are densely covered with whitish brown fuzz. (See Peterkin.)

Bancroft.—(Synonym, Bancroft Herlong, Jones Herlong, and probably Russell.) Seed was obtained from E. Bancroft, Athens, Ga. This old variety belongs in the big boll group, and has a rather short-limbed plant. The bolls are large, 58 per pound, long, tapering gradually to a point. The seed are large, fuzzy, deep green and brownish green. Maturity late. The leaves have the large size and relatively shallow indentations between lobes that distinguish the leaves of Russell. This variety is probably the parent of the Russell, for in size and shape of leaves, in size and shape of boll, and in color and size of seed the two are practically identical. Lint medium in length. Rank in yield of lint at Auburn 4th and 17th.

Banks.—(Synonym, Banks Big Boll). This is a big boll variety with limbs of medium length. The bolls are large (56 per pound), roundish, either blunt or abruptly pointed. Locks mostly 4. Storm resistance medium. This variety very closely resembles Truitt in form of plant, size of bolls, size and appearance of seed, and in per cent of lint (33.6); seed very large, (.163 gram), fuzzy, whitish brown. Lint of medium length. Maturity medium.

Bailey.—This variety, which was grown at Auburn about 1890-1893, is now probably extinct. As described in Alabama Experiment Station Bulletins 33 and 56, Bailey cotton had a small prolific plant, with branches of medium length, long "joints," small roundish bolls; seed small, mostly naked and black; staple of medium length; maturity early; per cent of lint very low.

Barnes.—(Synonym, Baggarly). Grown only in 1903, using seed from J. R. Banks, Newnan, Ga. There are several types of plants, one similar to Russell, another to the long limb group, and some plants resembling Peterkin. The data given in tables are from the plants resembling Russell.

Barnett.—An old semi-cluster variety now almost or quite extinct. The plants are not very uniform, and are of medium maturity and fruitfulness. The bolls are small, roundish or ovate, some of them abruptly pointed, mostly 4 locks per boll. Per cent of lint below medium (32.2), although the seed as recently obtained were small and exactly similar in appearance to Peterkin.

Bate's Little Brown.—(See Peterkin.) Seed was obtained from R. Bates, Jackson, S. C. In all important qualities this cotton is similar to Peterkin.

Bates's Poor Land.—(Synonyms, Peterkin, Bates Little Brown). Seed was obtained from R. Bates, Jackson, S. C. In all important qualities similar to Peterkin and Bates's Little Brown.

Berryhill.—F. M. Berryhill, Aline, Amite County, Mississippi, states that he originated this variety in 1898 by selection from Brannon. This variety contains some plants resembling in form Peterkin and King, but more of the semi-cluster form. The seed are small, fuzzy, mostly brownish; per cent lint 38; bolls small (81 per pound). In maturity it is medium to early; moderately prolific.

Locks mostly 5. This variety is very similar to Lewis.

Berry.—(Synonym, Berry Big Boll). J. L. Berry, Griffin, Ga., states that he originated this in 1896, from unknown parentage. This is a big boll variety. The bolls are large, (averaging 62 per pound), abruptly pointed. The per cent of lint averaged low, (32.4). The seed are large, fuzzy, mostly white, greenish white, and brownish white. In all of the qualities mentioned above Berry is similar to Truitt, but differs from the latter in being earlier. Locks 4 to 5. Storm resistance fair. Rank in yield of lint at Auburn in 1905, 21st. The most promising characteristic of this variety is its earliness for a big boll variety.

Best.—Grown only in 1903. Plants of the King form, but per cent of lint lower and size of bolls larger than that type. Maturity early. Seed greenish white.

Big Boll.—Of doubtful classification, the bolls being of medium size and too small to admit it to the big boll class, to which in other qualities it would belong.

Bingham.—Grown only in 1895. This is apparently a mixed variety, having some long limb and some almost semi-cluster plants. Seed small to medium, brownish to greenish. Locks mostly 5. Per cent of lint medium or above. Bolls small (83 per pound of seed cotton).

Black Rattler.—Seed from W. E. Collins, Mayersville, Miss. This is a long staple variety, having plants similar to Allen Long Staple. The seed are naked and the per cent of lint averaged 31. The bolls are small (91 per pound), ovate and abruptly pointed, and most of them containing 4 locks. Lint fine and long.

Blue Ribbon.—This variety was originated in 1900 by the South Carolina Experiment Station as a result of a cross between Allen Long Staple and Dickson. It is distinctly a semi-cluster variety of the long staple group, but the lint is not quite so long as the standard long staple varieties. The bolls are small to medium in size (averaging 80 per pound), ovate, and pointed, with 5 or 4 locks. The plant is medium to tall, abundantly fruited, compact, erect with short joints, the upper limbs short, the base limbs medium to long. Maturity, early to medium, and the earliest of the long staple group. Per cent of lint 32.8, or one of the highest of the long staples. Seed are medium size. There are two strains of Blue Ribbon differing chiefly in the fact that one has nearly naked black seed; the other seed covered with white, or brownish white fuzz. Rank in yield of lint at Auburn 24th and 16th. The earliness, compact shape, number of bolls and length of lint make this a promising variety, and the staple should command sufficient premium to make this a competitor in point of profit with the best short staple varieties.

Bohemian.—This is a big boll variety from Texas with the characteristic shape of plants of that group. The bolls are very large, 49 making a pound of seed cotton; the per cent of lint is low (32.8) the seed are large, fuzzy, and mostly white. The lint is unusually long for this class of cotton. The plant is large and of pyramidal shape with rather long limbs. Maturity, late. Bolls ovate and abruptly pointed.

Borden.—The high per cent of lint (37.5), small size of bolls (89 per pound), and small size of seed suggest that this may be a member of the Peterkin group. The seed are fuzzy and brownish. Seed were obtained from A. Borden, Goldsboro, N. C.

Boyd.—Seed of this old variety were obtained from H. C. Prevost, New Orleans, La. The plant is of medium size, somewhat variable, sometimes approaching the semi-cluster form, and assignable to the intermediate group. The seed are scantily covered with brownish fuzz and resemble Peterkin. Bolls small (82 per pound), 4 or 5 locks, short and roundish, sometimes abruptly pointed and sometimes blunt. Per cent of lint 33.7. Maturity early to medium. Lint, short. This variety is interesting only as being the reputed parent of a number of better varieties.

Braddy. (Synonym, Peterkin). This strain was selected by L. C. Braddy, Dillon, S. C., from a variety known locally as Simpson, which was probably Peterkin. The plant has the typical shape of the Peterkin group and has numerous, medium to long, rather slender limbs. In per cent of lint (37.8), small seed, naked or brownish fuzzy seed, this variety appears to be identical with Peterkin, though bolls were smaller (99 per pound) and a somewhat larger proportion of seed was naked in tests made at Auburn. In maturity it is medium. The plant is prolific, the type well fixed. In a publication of the United States Department of Agriculture, the statement is made that the seed are gray, and tufted, and the lint very curly.

Branch Long Shank.—M. L. Branch, Bishop, Ga., states that this has also been known under the name of Shank-High. But a comparison of the seed as grown under the first name at Auburn with seed distributed in 1907 by the United States Department of Agriculture suggests that either this cotton is wanting in uniformity or that the two names are not synonyms. The Branch seed are mostly brownish white, while the seed from the Department are mostly white with some greenish seed. The plant is tall, rather poorly supplied with limbs and bolls. The bolls have 4 and 5 locks, and are of medium size (77 per pound). The seed are large and the per cent of lint 33.6. Maturity medium. Lint short to medium.

Brannon.—(Synonym, Little Brannon and probably Peterkin). This is apparently a synonym of Peterkin, as indicated by the high per cent of lint, 36.4, small seed, most of them naked, or scantily covered with brownish fuzz. The points in which it differs from Peterkin are the larger size of bolls (72 bolls making one pound of seed cotton), and longer limbs or more straggling form of plant. It might even be placed in the long limb group.

Braswell.—(Synonym, Braswell Cluster). Seed was obtained from J. R. Pitt, Racy Mount, N. C. The plants were very variable, there being a few of a semi-cluster type and some long limbed or straggling. The semi-cluster plants had bolls of medium size, medium per cent of lint; seed mostly white, and of medium size, fuzzy. In maturity the plant ranks as medium, and it is rather prolific.

Breeden.—Seed were obtained from T. C. Breeden, Lester, S. C. This is a rather tall plant, and seems to have fruit limbs a little longer than in the semi-cluster group; hence it is classed in the intermediate group. The bolls are above medium size (68 per pound), usually with five locks, oval with abrupt point. Storm resistance, good. The seeds are medium size and brownish and whitish brown colors, being of a lighter shade of brown than seed of Gold Standard.

Brown No. 1.—Seed was obtained from M. L. Brown, Bremen, Ga. In high per cent of lint (37.7), large size of boll (61 per pound), and in form of plant, which varies between typical big boll shape and tall, short limbed form, this cotton is practically identical with Cook Improved. The seed are a little larger and contain a larger proportion of dark greenish brown seed, the seed from some plants resembling Bancroft. This is a prolific variety of medium maturity.

Bur.—Bolls, medium to small, classification uncertain.

Butler.—This cotton, from North Carolina, embraced plants of several types. In maturity it ranked as medium. Per cent of lint only 30.4.

Cameron.—(Synonym, Cameron Improved). This was originated about 1895 by R. R. Cameron, West Greene, Ala. The parent varieties were Drake "Cluster" and Peterkin. The characteristics of both parent plants are plainly shown in the form of plant, some plants being of characteristic Peterkin shape, others tall with short upper limbs, and still others resembling the big boll type. At present this cotton more nearly resembles the Peterkin than the Drake "Cluster." Its high per cent of lint (36.8), small bolls (92 per pound), and small seeds, which are either naked or covered with brown fuzz, are identical with Peterkin. The bolls are mostly oval or ovate, abruptly pointed, with 5 or 4 locks. Maturity medium, storm resistance medium to poor; rank in yield of lint at Auburn, 7th and 14th. We are justified in assigning this to the Rio Grande group except a minority of the plants which show traces of other ancestry.

Carolina Queen.—(Synonym, Peterkin). Seed were obtained from J. C. Fowke, Blalock, S. C., who has selected seed of unknown origin, but which evidently must have been Peterkin. In high per cent of lint (35.8), form of plant, small seed, and the brown fuzzy covering of most seed, this plant resembles Peterkin, but differs from Peterkin only in having nearly all of its seed fuzzy, and in the slightly larger bolls (74 per pound). This may be considered as a fuzzy-seed form of Peterkin, promising because of its larger bolls.

Champion.—(See Ptoney and Peterkin.)

Cheise.—This unusual name is probably a local designation for a variety of the big boll class from Texas. Bolls are large, seed large and brownish white.

Cherry Cluster.—This variety from South Carolina is probably now extinct. From Alabama Experiment Station Bulletins Nos. 33 and 56 we learn that the plant was of medium size, compact, well limbed and prolific, resembling Peerless, but having longer limbs and joints; bolls small and roundish; seed small, fuzzy; maturity early.

Christopher.—This is said to have been originated by R. H. Christopher, LaGrange, Ga., about 1880. In form of plant, size of bolls (only 59 per pound of seed cotton), large size of seed (.135 gram), medium per cent of lint (34.3), and characteristic form of plant, this variety belongs to the big boll group. Most of the plants have the rather low, symmetrical, diffuse growth characteristic of that group. Some of them have rather short upper limbs, forming what may be called the erect type of big boll. The bolls are large (59 per pound), roundish, often blunt, and more frequently contain 5 than 4 locks. Maturity medium. The seed are large, fuzzy, and mostly brownish white, with an occasional greenish white seed. Rank in yield of lint at Auburn, 5th and 12th. This is a prolific big boll cotton, resembling Truitt in most points, but differing from the latter in having a larger proportion of roundish blunt bolls.

Cleveland.—J. R. Cleveland, Decatur, Miss., states that he originated this variety about 1885 by selecting seed from a cotton bearing no known name. The plant is tall and is well supplied with bolls and with limbs of medium or short length, tending toward the erect type of big boll plant. The bolls are large, (65 per pound) usually having five locks and falling out easily, this being the chief shortcoming of this variety. The seed are of medium size, fuzzy, brownish white, with some greenish seed .Bolls large, roundish, and pointed or bluntish. This is one of the earliest of the big boll group, ranking as early to medium. At Auburn, it has been one of the most productive of the big boll group, ranking in yield of lint, 3d in 1905, and 3d in 1906, or a little below Cook Improved.

Cliett.—Seed were obtained from R. A. Cliett, Harlem, Ga. The plants are mostly of characteristic big boll form, or in some cases of erect big boll form. The bolls are large, (63 to the pound of seed cotton), and roundish. The per cent. of lint averaged 34.8. Maturity medium. The seed are large, fuzzy, brownish white and greenish white.

Cobweb.—W. E. Collins, Mayersville, Miss., states that he originated this variety about 1878, using Sea Island and Peeler as parents. It resembles Colthorp and Black Rattler. The plant is tall, open of pyramidal form and is a long staple upland variety. The bolls are small (89 per pound), slender, long pointed, and usually having four locks. This variety has naked seed, of medium size, (.117 gram), the naked seed doubtless coming from the Sea Island parent. The per cent. of lint is 28.8. The lint is long and fine.

Cook Long Staple.—(Synonym, W. A. Cook.)

This variety is said to have been originated by W. A. Cook, Newman, Miss. The plant is medium to tall, of rather straggling or limby form, with long internodes, the plants with best fiber resembling in form Allen Long Staple. Maturity, medium to late. The bolls are of medium size and larger than those of any other long staple tested, except Griffin, 72 bolls averaging one pound of seed cotton. The bolls are ovate, either long pointed or abruptly pointed; per cent. of lint 30.2; seed of medium size, mostly white or brownish white. The fiber is abundant and of long staple, but neither so long nor so fine as that of Allen Long Staple, and Griffin. The seed obtained in recent years has been badly mixed with some short staple variety. This is apparently one of the most productive varieties of the long staple group, having ranked in the tests at Auburn as 1st, 4th, and 24th, in different years.

J. C. Cook.—A variety of purple leaf cotton, probably now extinct or represented by some improved descendant, (See Red Leaf.) The writer, who has been unable to obtain any seed under this name, puts on record here data taken from earlier publications of the Alabama Experiment Station. In 1891 this variety was the least productive of 12 varieties tested. Its staple was very short; per cent. of lint 34.5. "Stalk, medium, pyramidal, purple. Leaves purple underneath, presenting a singular appearance. Devoid of wood limbs. Bolls round; staple very short; not prolific; very late."

Cook.—(Synonym, Cook Improved.) This variety was originated by J. R. Cook, Ellaville, Ga., in 1895. He believes it to be a natural cross between some early variety and one known locally as Beat All. In form of plant Cook cotton is somewhat variable. About 60 per cent of the plants are tall with short fruit limbs, and few medium length base limbs. The remaining plants are mostly of the diffuse big boll type with fruit limbs medium to long. The bolls are large, (66 making a pound of seed cotton), roundish, often blunt, with usually five locks. The seed cotton falls out easily, which is the point of greatest weakness in the variety. In maturity, Cook is early to medium, ranking with Cleveland and Berry Big Boll as the earliest varieties having large bolls. The bolls open well and are easily picked. The per cent of lint is very high, the average at Auburn being 38.9 per cent. This has been one of the most prolific varieties both at Auburn and at other stations. Its rank in yield of lint at Auburn during the past three years has been 6th, 2nd, and 1st. Its productiveness, large size of bolls and extremely high per cent of lint have brought this variety recently into deserved popularity.

Colthorp.—(Synonyms, Colthorp Pride, Laclede, Colthorp Black Rattler.)

Seed was obtained from Colthorp & Co., Talla Bena, La., who state that this cotton originated about 1902 from a few locks of cotton of unknown origin, having black seed and good length of staple. This is a long staple variety but as grown at Auburn the staple was not quite as long as Griffin and Allen. This cotton very closely resembles Black Rattler and Cobweb in form of plant, small size of bolls (98 per pound), naked black seed. and in character of lint. Per cent. of lint averaged for three years 33.6.

Colthorp Eureka.—(See Keno.)

Combination.—R. Bates, Jackson, S. C., states that he originated this variety. It has a high per cent of lint (38.8) , small, fuzzy, brownish seed, and a plant similar to Peterkin. Although the plant bears many bolls, their small size, (97 to the pound of seed cotton), makes this variety worthless. This is believed to be a strain of fuzzy seed Peterkin.

Coppedge.—Seed were obtained in 1899 from C. S. Coppedge, Nyson, Ga. This is a big boll variety (65 bolls per pound) with large, fuzzy, brownish white seed. The storm resistance is fair; maturity medium.

Corput.—(Synonym, Corput Find.) This cotton as grown at Auburn for two years was too badly mixed to be described. It contained plants that could not be distinguished from Jackson, and others similar to Peterkin.

Crossland.—(Synonyms, Peterkin, Carolina Queen, Moss, Texas Wood, etc.)

In form of plant, size and shape of boll, in small seed, and in appearance of seed, which are partly naked and partly covered with a scant brown fuzz, we have not been able to find any difference between this cotton and the Peterkin variety. When tested in field plots at Auburn, its average rank in yield of lint was about the same as that of Peterkin.

Crawford Peerless.—(See Peerless).

Culpepper.—(Synonym, probably Wyche.) J. E. Culpepper, Luthersville, Ga., states that he originated this variety about 1892, using Wyche and Dickson as parents. It is now exactly similar to Wyche and shows no trace of its alleged Dickson parentage, and should probably be regarded as a selection from Wyche. In form of plant this variety is typical of the big boll group, being rather low, spreading, and having limbs of medium length. The bolls are large, (63 making one pound of seed cotton), ovate, rather blunt pointed, opening well and having very poor storm resistance. There are variously five and four locks. The per cent. of lint averaged 34.7. The seed are large and covered with a dense fuzz. Most seed are brownish white, or white, with a small proportion that have a greenish tinge. Maturity, medium, or earlier than most big boll varieties. Lint, short to medium. The plants are prolific for a big boll variety. In plot tests at Auburn Culpepper ranked about midway from top to bottom of list.

Cummings.—This is a local name in the eastern part of Alabama for a variety once quite popular and regarded as productive. It is now little grown or entirely extinct in its pure form. It is said to have been especially subject to boll rot, which is assigned as the cause of its disappearance. As grown at Auburn the plant was of medium height, and of semi-cluster or nearly semi-cluster type. The bolls are of medium size, (78 per pound), ovate, abruptly pointed; maturity, early to medium; storm resistance poor; seed fuzzy, medium size, mostly brownish white.

Davis Long Staple.—This is a long staple, rather short jointed variety. The plants are rather prolific; the staple long and fine; maturity, almost as early as any of the long staples; bolls small and tapering.

Dearing.—(Synonyms, Dearing Prolific and Dearing Small Seed.) A variety apparently but little grown now. As grown at Auburn this was rather an unpromising variety of uncertain classification. Some plants were of the sem-cluster form and other were somewhat similar to Peterkin. Seed, small, fuzzy, brownish. Per cent. of lint only 31.5, although it is stated that once this variety had a high per cent of lint. Lint, short to medium. Maturity, medium.

Defiance.—(Synonym, Drake Defiance, and probably World's Wonder.)

Seed obtained from Drake Brothers, Philomath, Ga., who introduced the variety within the past few years. This is a prolific, semi-cluster, well fruited cotton, with small bolls. The plant is tall, well shaped, with short upper limbs and medium to long base limbs, resembling Woodfin and Hardin. The bolls are small, 92 average bolls being required in our test to yield one pound of seed cotton. The bolls are ovate, abruptly pointed and more frequently containing five than four locks. The per cent of lint is 34.2; seed small to medium, fuzzy, and mostly brownish white and greenish white. In maturity Defiance is early but not equal to King. The Drake cotton from Alabama has the first right to the name Drake, by reason of priority of use.

Diamond.—(Synonym, Diamond Six Lock). This is a big boll variety with low per cent of lint. Large, brownish, fuzzy seed. The lint is above medium in length; the large, roundish bolls contain mostly five locks and occasionally six locks; maturity, medium to late.

Dickson.—(Synonyms, Dickson Cluster, Dickson Improved, Dixon and Simpson). David Dickson, of Oxford, Ga., whose agricultural writings have so strongly influenced Southern agriculture, originated this variety about 1857 or 1858, by continuous selection from Boyd Prolific. This typical cluster variety was once very popular, but is no longer a general favorite. The plant is slender, erect, with numerous very short fruit limbs and several medium to long base limbs. The bolls are numerous and closely clustered. The small size of bolls (104 per pound of seed cotton) constitutes its greatest fault. The seed are small, fuzzy, mostly brownish white, and occasionally greenish white. The lint is short to medium. Most plants mature early, though not so early as King. The small bolls are ovate to roundish, and often blunt. The per cent of lint is low (32.3.) In 1905, in our variety test, boll rot destroyed more than half the bolls of Dickson, while adjacent varieties suffered only to a medium extent. It was not then possible to determine whether this was due to the use of badly infected seed or to an inherent weakness in the variety. In three field tests at Auburn it ranked near the bottom of the list, and in two tests near the top of the list.

Dixie Wilt Resistant.—(Synonyms, U. S. Dept. Agriculture No. 148 and Orton No. 148). This variety is the result of successful attempts to develop a variety of cotton that should be resistant to cotton wilt, also called "black heart" and "black root." Credit for originating it is due W. A. Orton, of the Bureau of Plant Industry, Department of Agriculture, Washington, D. C., who in 1901 saved seed of plants growing on the farm of M. C. Scott, near Montgomery, Alabama, that were resistant to this disease. The name of the variety from which selections were first made is unknown. Mr. Orton thinks that the Dixie is the result of accidental hybridization between this original selection and other cottons grown with it the following year. Each year it has been grown by him on infested land and seed has been saved from plants that resisted cotton wilt. While more immune than any other variety tested in comparison with it, it is not yet entirely proof against wilt, especially on land badly infested with both wilt and nematodes, or root knot worms. The plants are of medium size, having numerous medium length branches and resembling Peterkin, from which, however, it differs in having a very low per cent of lint. The bolls are small, ovate or roundish, and pointed. There are more frequently five than four locks; storm resistance is medium to good. The per cent of lint averaged 33.1. The seed are small (averaging .107 gram). The seed are variable, the fuzzy brownish seed being those preferred by the originator. Some plants have seed many of which are partially or entirely naked and exactly like Peterkin. Small green or greenish seed also occur. Lint is of medium length. In maturity this plant is medium to late. There is need for improvement in yield of lint, per cent of lint, size of bolls, uniformity of seed, and lower position of first limbs.

Double Header.—Seed were obtained in 1906 from R. H. Smith, Monticello, Ga. This is a promising big boll variety unusually well supplied with limbs and bolls. The leaves resemble Russell in size and shape. The seed also are similar to Russell and Bancroft Herlong, being very large, fuzzy, deep green and brownish green. The bolls are very large,(only 47 being required to make a pound of seed cotton as compared with 62 in the Russell variety). This evidently belongs in the Russell or Bancroft sub-division of the big boll group, but is apparently an improvement on both. The bolls are ovate, tapering and usually contain five locks; the bolls turned down, the seed cotton hanging together and showing medium storm resistance. The parts of the bur curl up. The per cent of lint is medium, 34.1; lint medium length; maturity, medium or medium to late. This variety has not yet been tested by us in such a way as to determine the yield of lint per acre.

Dongola.—(Synonyms, probably Haraldson, Montclare, Rogers and perhaps Lealand). Seed were obtained from B. F. Malabar, Waynesboro, Ga. This is a big boll variety approaching a semi-cluster, and very similar to Montclare and Rogers. The plant is tall with base limbs of medium length and short fruit limbs well supplied with bolls. It is short jointed and rather slender. The bolls are large (63 per pound), roundish, and often blunt. The seed are large, fuzzy, and mostly brownish white. The per cent. of lint is high for a big boll variety (36). In maturity, Dongola ranks as late. The lint is of medium length.

Doughty.—(Synonym, Doughty Long Staple). We have grown this variety for five years, and have found it badly mixed. Some of the plants have the characteristic long staple form, and others more nearly resemble the big boll and straggling plants. The best type of plants have fiber scarcely long enough to admit this cotton to the long staple class, and on most plants it is plainly short staple fiber. The bolls are medium size (75 per pound), ovate, and long pointed, containing four or five locks. The seed are large, fuzzy, mostly browish white. The plant is well supplied with bolls, and in maturity ranks as medium to late. In one plot test at Auburn, Doughty ranked tenth in yield of lint.

Doughty Big Boll—This name has apparently been used incorrectly as a synonym for Doughty.

Dozier.—(Synonyms, Dozier Improved and King). This cotton from North Carolina has plants that resemble the larger specimens of King. In size and character of bolls, seed and lint, and even in the red spots on the petals, we were unable to see any difference between this and King, ercept that the Dozier cotton was less uniform.

Drake.—(Synonyms, Drake Improved and Drake "Cluster.") This variety is the result of selections made by R. W. Drake, Laneville, Alabama, probably from the Peerless variety. In form of plant most plants clearly belong in the big boll group, while others approach the semi-cluster type. However, the word "cluster" is misleading, for this variety is not even a semi-cluster, though well supplied with bolls. The bolls are large (64 per pound), oval, abruptly pointed and only occasionally bluntish. The seed are large, fuzzy, mostly brownish white and greenish white. Lint of medium length. This variety is entirely different from Drake Defiance.

Drake Defiance.—(See Defiance).

Duncan.—This old variety from Georgia is now nearly or quite extinct. In shape it resembles Jones and other typical big boll varieties. The bolls are large (64 per pound), ovate, or oval, and abruptly pointed or blunt; usually with 5 locks. The per cent of lint is low; the seed are very large, fuzzy, mostly whitish brown and greenish white. In plot tests at Auburn it ranked one year at the bottom of the list and two years about midway of the list in yield per acre. In maturity it is medium to late. Lint medium in length.

Early Gayosa.—(See Gayosa).

Eclipse.—(Synonym, Eclipse Long Staple). This variety grown here in 1902 had all the characteristics of a long staple cotton, except that it was deficient in the length of lint. This may have been due to the very dry summer which that year reduced the length of staple of most long staple varieties. The bolls and seed are small (93 bolls per pound), the seed fuzzy, and mostly brownish white.

Edgeworth.—(Synonyms, Little and Little Improved). This cotton was introduced by J. C. Little, Louisville, Ga. This variety is difficult of classification, and is probably best assigned to the intermediate group. The plant is tall and limbs are short to medium. The bolls average medium size (69 per pound), and usually have 5 locks. The seed are fuzzy, small, mostly brownish white and greenish white, resembling King. The per cent of lint is 35.7. This is a well bolled plant of early to medium maturity. In the only plot test at Auburn it took low rank in yield of lint per acre.

Ellis.—(Synonym, Ellis Big Boll). Seed were obtained from G. B. Ellis, Palmetto, Ga. This is apparently a big boll variety with some plants approaching the long limbed type. The bolls are large (59 per pound), ovate, and abruptly pointed. The seed are large, fuzzy, mostly brownish white and greenish white. The per cent of lint is 32.1.

Eureka.—Seed were obtained from S. L. Thornton, Hartwell, Ga. Apparently this name has been applied to several different kinds of cotton. The per cent of lint of this short staple variety is high (38.6); bolls small (95 per pound), roundish; seed small and fuzzy, mostly brownish white. The variety seems to be intermediate between King and Peterkin.

Excelsior.—The cotton grown at Auburn under this name is the one originated by C. F. Moore, Bennettsville, S. C. The same name according to S. M. Tracy, has been applied to a selection from New Era, made in Georgia. The plant is similar to Peterkin, as also are most of the qualities of seed, except that there are no naked seed. The seed are small, fuzzy, densely covered with a brownish fuzz, but averaging a lighter shade of brown than the seed of Gold Standard. The per cent of lint, which in our first test was 32.8, has steadily risen to 38.1, probably due to careful selection by Mr. Moore. The bolls are small (95 per pound), oval, short, pointed. This is a prolific early to medium variety of the Rio Grande group.

Extra Early.—Seed were obtained from J. B. Crouch, Wedgefield, S. C. The plants were variable, the best being of semi-cluster type, and resembling Woodfin. The bolls are small, oval, mostly blunt. The per cent of lint is above medium. Seed small, fuzzy, brownish white.

Favorite.—Seed were obtained from S. G. Mayfield, Denmark, S. C. The form of plant, high per cent of lint, small size of bolls (78 per pound), small size of seed, and appearance of seed of many plants suggests that that is a strain of Peterkin with practicaly all the seed fuzzy, and mostly brown. The admixtures somewhat resemble King.

Ferguson.—This was received as a long staple variety, but as grown at Auburn the lint was not long enough to admit this to the long staple class. Occasionally plants were found that were practically lintless, the seed being naked and the boll almost entirely devoid of lint. The bolls are small and pointed (87 per pound). Per cent of lint 31.1; seed brownish white.

Featherstone.—Seed were obtained from J. A. Collins, Jackson, Ga. This is a variety having some plants that are quite or nearly of the semi-cluster type, and others with longer upper limbs. The base limbs are long and too far from the ground. The bolls are of medium size, ovate, mostly with sharp points. This variety showed considerable storm resistance. Seed of medium size, mostly whitish.

Florodora.—L. A. Stoney, Allendale, S. C., states that this variety was originated by him in 1900, and that the parent varieties were Sea Island and a prolific upland cotton of unknown name. This variety has been very popular in the eastern section of the cotton belt within the past few years. The plant is tall, usually well shaped, and having the characteristic size and shape of the long staple group. The bolls are ovate and pointed and of medium size (averaging 76 per pound), and have either four or five locks. The seed are of medium size, fuzzy, white or brownish white. The per cent of lint, as usual with long staple varieties, is low (31.3). In maturity Floradora is late. The staple is long and fine on most plants, and usually commands a considerable premium over ordinary upland. Growers of this variety in this county in 1906 received a premium of 4 to 5 cents per pound, and still higher premiums have been obtained elsewhere. Where the local markets offer no premium, long staple cotton must be shipped to the seaport markets. In our field tests at Auburn, Florodora, like other long staple varieties, ranked near the bottom of the list in yield of lint per acre.

Garrard.—(Synonym, probably Hawkins). Seed were obtained from P. R. & W. T. Garrard, Nona, Ga. This is a semi-cluster cotton which in appearance of plant, per cent of lint, medium size of boll, medium size of seed, and appearance of seed was indistinguishable from Hawkins. Seed are mostly brownish white with occasionally a shade of green. The variety is early to medium, and prolific.

Gayosa.—(Synonyms, Early Gayosa and Gayosa Prize). This cotton of uncertain classification—a part of the plants probably belonging in the Rio Grande, and part in the short limbed groups—was notable in our tests for its low per cent of lint. Bolls are small (71 per pound.) Some of the plants had naked seed like Peterkin.

Gholson.—(Synonym, Allen Long Staple). This is a selection from Allen Long Staple made by L. K. Gholson, Fort Deposit, Alabama. This cotton is similar in all respects to Allen Long Staple, which see.

Gold Dust.—(See King.)

Gold Standard.—Seed were obtained from Excelsior Seed Farm, Bennettsville, S. C. This variety is of doubtful classification, for it contains plants that in turn suggest the semi-cluster, the Rio Grande and the King group. Generally it is a rather compact, erect, almost semi-cluster plant with base limbs of medium length. The bolls are small to medium (77 per pound), mostly roundish. The per cent of lint is high (36.1); maturity, medium. This is a rather prolific variety, the most distinctive feature of which is the deep brown or yellowish brown color of fuzz, which densely covers the seeds of many plants.

Grayson.—(Synonyms, Grayson Big Boll, Grayson Early Prolific). Classification doubtful; bolls medium to large; low per cent of lint. Seed are large, mostly brownish white.

Gregg.—This variety is stated to have been originated about 1900 by S. A. Gregg, Florence, S. C., from a single plant found in a garden. The plant somewhat resembles Peterkin, but the fuzzy seed, mostly brownish white and greenish white, make the classification of this variety doubtful. The bolls are of medium size, mostly ovate and pointed. The per cent of lint is high.

Grier.—(Synonyms, Grier's King and King). Seed were obtained from L. F. Grier, Oxford, Alabama. This cotton was identical with King in all respects, including the red spot at the base of each petal.

Griffin.—(Synonym, Griffin Long Stajle.) This long staple variety was originated by the late John Griffin, Greenville, Miss., about 1867 as the result of repeated crossing between Sea Island and the Old Green Seed. Selection has been continued each year since then by the originator or by his son. At present selection is being made with a view to fixing the 5-lock quality, while maintaining the length and fineness of fiber. As grown at Auburn, the Griffin plant was not prolific. The lint is longer and finer than that of any other upland variety tested by the writer, but the fiber lacks uniformity of length; even the shortest fibers are full long for the long staple class. The staple is weak, and the outer part of the lock has often a characteristic glossy sheen. Maturity, late; bolls medium to large, and larger than any other long staple (66 being required to make one pound of seed cotton). Locks 4 and 5; per cent of lint, 31.7. Seed mostly brownish white or whitish brown; medium size.

Griffin Drought Proof.—This short staple variety from Georgia, is different from Griffin Long Staple. Per cent of lint low.

Gunn.—Seed were received from C. L. Gunn, Temple, Miss. This is a large plant of the Petit Gulf or long limbed type, though it might equally well be ranked as a large spreading form of the big boll group. The bolls are large (65 per pound), oval, abruptly pointed. The seed are fuzzy, mostly white, but with some mixture of deep green seed. Per cent of lint 32.1.

Hagaman.—Prof. H. J. Webber states that this variety originated near Jackson, La., and was probably a selection from one grown under the name of Dean, though Peeler, which it resembles, was the kind grown almost exclusively on the owner's plantation at the time. The form of plant varies somewhat, and is nearer to the long limbed than to any other group. Bolls small (85 per pound), ovate, pointed; seed small and on some plants brownish white and on others partly naked. Per cent of lint 34.3.

Haralson.—(Synonym, Dongola, which see.)

Hardin.—Originated by B. B. Hardin, Washington, Ga., who exhibited at the Macon Fair in 1906 single limbs almost completely hidden by the thickly clustered open bolls. Receiving no reply to letters addressed to the originator, we secured our seed through a firm in Montgomery, Alabama. As grown here in 1906, Hardin was a semi-cluster variety very similar to Woodfin and Sterling, but not bearing bolls in dense masses. The bolls were numerous and from medium to small in size (77 per pound of seed cotton), and the per cent of lint 30.3. The small seed are partly white and partly greenish white.

Hawkins.—(Synonyms, Hawkins Improved and Hawkins Jumbo). Originated by W. B. Hawkins, Nona, Ga. This is a standard semi-cluster variety, and the plant is usually prolific and of good shape. The medium to small bolls (79 per pound) are often roundish. The per cent of lint is 34.6. The seed are fuzzy, mostly brownish white and greenish white. Maturity, early to medium; lint, short to medium in length. In plot tests at Auburn it ranked in yield of lint 9th, 16th, 8th, 3rd, 3d, 15th, 8th, and 7th.

Hawkins Jumbo.—(See Hawkins.)

Herlong.—A variety entirely different from Bancroft was tested once. It had small bolls and small seed. (See also Bancroft.)

Herndon.—(Synonym, Herndon Select). This is a selection made by J. A. Herndon, Elberton, Ga., from an accidental stalk resembling the Dickson. The Herndon is almost a semi-cluster variety, with small bolls (85 per pound); small brownish white seed; and early to medium maturity. Per cent of lint 33.1.

Hodge.—(Synonyms, King and probably Dozier). This cotton from North Carolina has medium to small bolls; early maturity; small greenish white and brownish white seed. In form, the plant somewhat resembles the larger plants of King.

Hilliard.—This is a semi-cluster variety very near to the big boll class, with medium to large bolls (69 per pound); per cent of lint, 34.6; rather broad semi-cluster form of plant; medium size of seed, fuzzy, and chiefly brownish white. Maturity early to medium.

Holloway Storm Proof.—(Synonyms, Storm Proof and probably Rowden). A big boll large seed variety.

Hunnicutt.—(Synonym, Hunnicutt Choice). This is a variety originated by the late Dr. J. B. Hunnicutt, of Georgia, who several years ago wrote me that he believed the variety then to be extinct. This was a variety with medium to long limbs; bolls medium size, fuzzy, roundish, brownish white seed.

Hunnicutt Big Boll.—(Synonyms, probably Russell and Bancroft). The plants are similar to Russell. This cotton has recently been selected by J. A. Hunnicutt, Warsaw, Alabama. The bolls are very large, the seed large, fuzzy, brownish green and deep green, exactly resembling Russell, from which it is probably a selection. The per cent of lint is low and maturity late.

Hutchinson.—This big boll variety was obtained from J. N. Hutchinson, Salem, Ala. The bolls are large, ovate, abruptly pointed, showing considerable storm resistance. The seed are fuzzy, medium size, mostly brownish white with some greenish white.

Improved Long Staple.—This is in the long staple group with small bolls, fuzzy, brownish white medium sized seed.

Jumbo.—(Synonym, Hawkins.)

Jackson.—(Synonyms, African and Limbless.)

This variety, which a few years ago was largely exploited, is a tall, cluster cotton, resembling Welborn Pet, but having larger bolls, and lint adhering to the burs more firmly. The bolls are mostly borne in clusters near the main stem. There are usually one or two medium to long base limbs, but these are sometimes wanting and sometimes more numerous. The bolls are small, (82 per pound), ovate, tapering. Per cent of lint high, (38); seed fuzzy, small, mostly brownish white. At Auburn it ranked in yield of lint 1st, 3rd and 17th. This is a productive variety but with serious faults of form, height, tendency to shed and difficult of picking.

Jackson Wilt Resistant.—(Synonym, U. S. Dept. of Agriculture, No. 128.)

This is the result of selections made since 1900 by W. A. Orton, of the U. S. Department of Agriculture, from plants of the Jackson variety that withstood cotton wilt. It is resistant but not entirely immune.

Japan.—This big boll variety with large, fuzzy, white seed was obtained from a Texas seed firm and is probably a local name for some better known Texas variety.

Johnson.—(Synonym, Johnson Excelsior.)

This cotton is wanting in uniformity of type, containing plants resembling Peterkin, others like the big boll group, and some of semi-cluster form. The bolls are small, 81 per pound; the per cent. of lint high, (37.7); the seed small, fuzzy, and varying in color from pure white to a yellowish brown.

Jones.—(Synonyms, Jones Improved, Jones Re-Improved, and Schley.)

This is a standard big boll variety originated by J. F. Jones, Hogansville, Ga., probably from Duncan. The bolls are large, requiring 62 bolls per pound of lint. The bolls are pointed; the large seed are mostly white, also brownish and greenish white. Per cent. of lint, low. Maturity late. In seven years' tests at Auburn it was usually below the middle of the list and never higher than fifth in yield of lint.

Jones Long Staple.—This long staple is described as having a large, straggling, non-prolific, late plant, with large tapering bolls, large, fuzzy, brownish white seed. Staple long; per cent of lint very low.

Keith.—Tested at Auburn prior to 1894 and reported in Bulletins Nos. 33 and 56 as a prolific, short limbed, and apparently semi-cluster variety, with roundish bolls of medium size; seed of medium size, fuzzy, white or brownish white; maturity early; per cent. of lint, low; staple short.

Keno.—This is a selection made from Colthorp Eureka about 1895 by Colthorp & Co., Talla Bena, La. In form of plant and silkiness of staple it probably belongs in the long staple group, but as grown at Auburn the lint was of scant length for long staple. Bolls are very small, (104 per pound); per cent. of lint, (32.4); seed fuzzy, small, mostly brownish white.

King.—(Synonyms, King Improved, Gold Dust, Tennessee Gold Dust, King No. 2, King No. 3, Grier, Mascot, Hodge, Dozier, etc.)

This very distinct variety was originated in Louisburg, N. C., by T. J. King, about 1882-4, from several plants selected by him as superior to the parent varieties, which latter he declines to name. The King in form of plant is taken as a distinct group, with plants characterized by small size, short base limbs, numerous medium length upper limbs, the longest of which are sometimes crooked, the growth reminding one of the limbs of a black jack oak (*Quercus Marylandica.*) On part of the blooms there is a red spot inside the flower and near the base of each petal. The most valuable quality of this variety is its extremely early maturity. We have found no other so early. This makes it a favorite in regions where the boll weevil is present. Its popularity on this account is somewhat offset by the small size of bolls and by the shortness of staple. The per cent. of lint is high, almost equalling the Peterkin group. The seed are small, fuzzy, mostly greenish white and brownish green. The bolls are roundish or ovate, sometimes blunt. The seed cotton falls out easily. Occasional plants are found of large size, but in other respects these retain the characteristics of the King variety. In 8 years' plot tests at Auburn it was usually about the middle of the list and never above fifth in yield of lint per acre.

Layton.—A selection made by R. D. Layton, St. Matthews, S. C., from a mixed cotton. In form of plant, high per cent. of lint, (39), medium to small size of bolls, (76 per pound), and small size of seed, this variety belongs in the Rio Grande group, but it differs from Peterkin in that practically all of the seed are fuzzy. Most of them are brown or brownish white, some greenish white, the darker seed resembling the fuzzy seed occuring in the Peterkin variety. Like Peterkin, Layton has but slight storm resistance. There are usually five locks. Layton is medium in maturity and has proved at Auburn one of the most productive of the Rio Grande group, ranking in yield of lint per acre, second, fifth and second, among all varieties tested in plots in 1904, 1905, and 1906, respectively.

Langford.—Seed from S. J. Langford, Albin, Ga. This is a big boll variety. The plants are short jointed and approach the semi-cluster form, and are medium in maturity. The seed are fuzzy and small to medium; per cent. of lint 35.1. Bolls, 63 per pound.

Lealand.—Seed from H. P. Jones, Herndon, Ga.

This is a semi-cluster variety with roundish, mostly blunt bolls, above medium size, (70 per pound.) The seed are large, fuzzy, mostly brownish white and greenish white, but in some plants resembling Bancroft. In maturity Lealand is medium; per cent. of lint, 33.6. Although the plants are of pleasing shape and fairly well bolled, yet in a single test here Lealand ranked at the bottom of the list in yield of lint per acre.

Lee.—Seed from E. E. Lee, Wildwood, Alabama. This is probably a local name. It represents a big boll variety with ovate, pointed bolls; large, fuzzy, brownish white and greenish white seed.

Lewis.—(Synonyms, Prize, Lewis Prize.)

W. B. F. Lewis, Lewiston, La., states that he originated this variety. This is a plant of the erect, short-limbed type, with few short base limbs, or none, and characterized by some plants having near the base crooked fruit limbs, curving downward and bearing four, five, or more bolls. The photograph represents a plant of this type without base limbs. The bolls are medium to small, (78 per pound), ovate or roundish, pointed. The seed are fuzzy, small, mostly brownish white, and greenish white, the brownish seed resembling those of Layton. The per cent. of lint is 35.8. The fibre is rather short. In a single plot test at Auburn it stood just above the middle of the list in yield of lint per acre.

Limbless.—(See Jackson.)

Little.—(See Edgeworth.)

Laclede.—(See Colthorp.)

Louisiana.—This cotton from Louisiana is a large, straggling, long limbed plant with small bolls. It is a late variety and probably belongs in the Petit Gulf group.

Lowry.—Seed originally from J. G. Lowry, Cartersville, Ga. This is an early variety similar to King. The bolls are small, (79 per pound); the seed are medium size, mostly greenish white and brownish white. Per cent. of lint 33.1.

Maddox.—Seed obtained from J. S. Maddox, Orchard Hill, Ga. This is a big boll variety with fuzzy seed, some of which are greenish white and some brownish, the latter with only a scant covering of fuzz. It has large, ovate, pointed bolls, (63 per pound), large seed, per cent. of lint 34.9; maturity medium.

Mascot.—In all respects this proved identical with King, which see.

Matthews.—(Synonym, Matthews Long Staple.) This Mississippi variety, now nearly or quite extinct, is nearer to the big boll than to the long staple class. The lint is too short and the bolls too large for the long staple group. The bolls average 67 to one pound of seed cotton. The seed are large, fuzzy, white; maturity medium. Per cent. of lint 31.4.

Mattis.—Seed from C. F. Mattis, Learned, Miss. The plant was similar to Peterkin, but perhaps larger. The bolls are medium in size, (77 per pound), oval, pointed, with slight storm resistance; maturity medium; seed are small, black and naked. This seems to be a rank growing form of Peterkin with lower per cent. of lint, (32.4.)

Parker.—This cotton was originated by John M. Parker, Sr., in Bolivar County, Miss., about 1868. This belongs in the Rio Grande group as judged by form of plant, size of boll and size of seed. It differs from Peterkin in having somewhat more fuzz on the dark brown to brownish white seed, and in having a lower per cent of lint, 33.1. The bolls are small to medium, (75 per pound), ovate, and slightly pointed. The seed are small to medium; maturity medium.

At Auburn, Parker was less productice than Peterkin and had slightly longer limbs.

Mebane.—(Synonyms, Mebane's Triumph; Triumph, which see.)

Meredith.—(Synonym, Meredith Big Boll.)

Seed from J. C. Meredith, Jenkins, Ga. This variety can probably be classed as belonging to the intermediate group. The plant has one to three short base limbs, is medium to tall, and has ovate, pointed, medium sized bolls, (72 per pound). The seed are medium sized, mostly brownish white and greenish white. The per cent. of lint is 32.8; maturity medium. In a single plot test at Auburn it stood near the bottom of the list in yield.

McCall.—This is a semi-cluster variety of no conspicuous merit from South Carolina. The bolls are of medium size, (71 making a pound of seed cotton), ovate or roundish, and pointed. The per cent. of lint is 34.4; the seed are of medium size, fuzzy, mostly brownish white.

Minor.—Seed from J. J. Minor, Toomsboro, Ga. This is a semi-cluster variety, with rather long upper limbs for this group. The bolls are of medium size, (74 per pound of seed cotton), the per cent. of lint 34.4; seed of medium size, fuzzy, brownish white, brownish, and greenish. Maturity medium to late.

Missionary.—(Synonym, probably King, which see.)

The plants, though lacking in uniformity, resemble the larger plants of King and other qualities also accord with those of King.

Mitchell.—(Synonyms, Mitchell Twin Boll and Clark Prolific.)

H. B. Mitchell, Athens, Ga., states that he originated this variety about 1895. The classification of this variety is uncertain. Bolls are medium to small, (79 per pound); the seed medium in size, fuzzy, brownish white and brown.

Montclare.—E. M. Williamson, Montclare, S. C., states that this variety was originated by him about 1891, probably as a selection from Jones Big Boll. This rather promising variety belongs both in the big boll and in the semi-cluster groups, and closely resembles Dongola and Rodgers. The bolls are large, (65 per pound); roundish, often blunt, and usually contain five locks. The per cent. of lint is high for a big boll variety, averaging 36.8. Maturity, late.

Moon.—(Synonym, Moon Long Staple.) In form of plant this variety from Arkansas resembles most long staple varieties. In our test the length of lint was not quite sufficient to place this in the long staple group. The bolls are small, (83 per pound), the seed small to medium, fuzzy and white. Per cent. of lint 32.7.

Moss.—(Synonyms, Moss Improved, Peterkin, etc.)

This is a selection from Peterkin made since 1887 by B. D. Moss, Norway, S. C. This cotton could not be distinguished from Peterkin in size and appearance of seed, bolls and plants.

Mortgage Lifter.—It required 58 bolls of this big boll variety to make one pound of seed cotton. The bolls are ovate to roundish, and pointed. The seed are large, fuzzy, mostly white, with some brownish white and some greenish white. The per cent. of lint is 34.4; maturity, late; lint, medium to long.

Nancy Hanks.—This cotton, which lacks uniformity, is of doubtful classification. Some plants resemble the short limbed group, others the big boll group. The bolls are small; seed mostly fuzzy, and brownish white; per cent. of lint, 35.6.

New Century.—The form of plant resembles the long staple group, but the lint, though long for a short staple, was on our dry soil, too short for a long staple. The bolls are small to medium, ovate pointed, with usually 4 locks. The seed are medium to large, white and brownish white. Per cent. of lint medium; maturity medium to late.

Nonpariel.—(Synonyms, Woodfin, Woodfin Nonpariel, Sam Woodfin Prolific. See Woodfin.)

Norris.—Seed from H. H. Steiner, Grove Town, Ga. This is a semi-cluster variety with small bolls and a very low per cent. of lint. Seed are large and mostly brown and greenish brown. Maturity, medium to late.

Okra.—(Synonyms, Okra Leaf, Forked Leaf.) Now probably extinct. It is characterized by leaves having very narrow lobes, thus making the foliage surface relatively small. Limbs, long; length, between joints, medium; bolls small and tapering; seed of medium size, fuzzy, white; staple short; "Prolific for a long limbed variety."

Orton.—Nos. 128, 145, 149. (See U. S. Department of Agriculture.)

Orton.—No. 148. (See Dixie Wilt-Resistant.)

Ozier Long Staple.—(Synonyms, Ozier, Ozier Silk, Ozier Starnes, Tennessess Silk, Bob Silk, Bob White, Bob.)

Seed from J. D. Ozier, Corinth, Miss. This is a rather prolific variety of the long staple class. The bolls are small, ovate, and long pointed, with 4 locks. The staple is long and fine, but shorter than that of Allen Long Staple. Seed small to medium, fuzzy, white and brownish white; per cent lint low. Maturity medium.

Ozier Big Boll.—Seed from J. D. Ozier, Corinth, Miss. The seed received under this name produced somewhat variable offsprings, most plants belonging in the big boll group, with roundish bolls, often blunt, and usually five locks. Seed fuzzy, large, mostly white, brownish white and green. Per cent. of lint medium; maturity, late.

Parks Own.—Seed from G. F. Parks, Alexander City, Alabama. A local name given to a strain of fuzzy seeded Peterkin, that is no longer kept distinct.

Peeler.—Described in Alabama Experiment Station Bulletins Nos. 33 and 56 as a large, straggling, non-prolific, late variety, with long, drooping, long jointed limbs; medium to large, tapering bolls; seed large, fuzzy, brownish; per cent of lint, low.

Peerless.—(Synonyms, Crawford Premium, Crawford, etc.) This variety, once popular, is now rarely grown. This variety belongs in the semi-cluster group. The bolls are of medium size, ovate, abruptly pointed, with slight storm resistance. Seed are fuzzy, large, and variable in color, mostly a brownish white. Per cent of lint, 33.4; maturity, medium.

Petit Gulf.—This very old variety, now probably almost or quite extinct, belongs in the long limbed group. The plant is large, strag gling, long jointed, with slender limbs, often turning downward from the weight of bolls. As we grew it in 1899 and 1903, probably in mixed condition, the variety was practically worthless. The bolls are small, mostly ovate, and either abruptly pointed or obtuse, having both 4 and 5 locks. The seeds are of medium size, mostly fuzzy, greenish and whitish brown. Some of the small fuzzy seed are green. Maturity, late; lint, long for a short staple; per cent lint, 31.8.

Peterkin.—(Synonyms, Audrey Peterkin, Brazier Peterkin, Crossland, Carolina Queen, Moss Peterkin Limb Cluster, Texas Wood, Wise, etc.) This widely grown variety was originated by J. A. Peterkin Fort Motte, S. C., about 1870. As the result of continued selection by the originator, it is now one of the most uniform of all varieties. Plants are of medium to large size, abundantly supplied with branches, which are usually straight; base limbs numerous, and short to medium in length; upper limbs medium to long. The bolls are of medium size (averaging 76 per pound of seed cotton), ovate, pointed, opening wide, usually with five locks, which rather easily fall out. Maturity medium. The seed are small, more than half of them naked and black, except for a tuft of fuzz at the smaller end. The other seed are scantily covered with brownish fuzz. This variety is characterized by a rather high per cent of lint. Lint is above medium in length. In ten years in plot tests at Auburn it occupied respectively the following positions in yield of lint per acre: 2nd, 5th, 1st, 7th, 8th, 3d, 4th, 1st, 12th and 6th. No variety tested for so long a period has proved more productive, though some newer varieties tested only a few years are slightly ahead for those few years.

Pinkerton.—Seed from H. R. Pinkerton, Eatonton, Ga. This variety was lacking in uniformity of seed, but seems nearest to the Rio Grande group. Maturity, medium. Bolls, small, (79 per pound); seed small; per cent of lint, 36.2.

Pride of Georgia.—(Synonym, Malier Prolific). Seed from J. H. Malier, Sunny South, Ga. This Georgia variety is said to have originated about 1895. It is of doubtful classification, the plants lacking uniformity, some having the semi-cluster form. The bolls, which are ovate, and pointed, vary from large to medium. The seed are small to medium, fuzzy and mostly brownish white and greenish white. Maturity, medium. Per cent lint, 34.7.

Prize.—(See Lewis.)

Ptomey.—(Synonyms, Champion, Peterkin, etc.) This is doubtless a local name in one neighborhood in Alabama for Peterkin, which it resembles in all respects.

Pullnot.—Seed from J. E. Bradberry, Athens, Ga. This is a semicluster variety. The bolls are of medium size, or above, (71 per pound of seed cotton), ovate or roundish, and often blunt, with either 4 or 5 locks. It has but slight storm resistance. The seed are of medium size, averaging .12 of a gram, fuzzy, brownish white and brown, with a few deep green seed. This is a very promising prolific variety of medium to late maturity. In three plot tests at Auburn it ranked 8th, 5th, and 4th, or always in the upper quarter of the list in yield of lint per acre. The per cent of lint is high, (36.3).

Purple Leaf.—(See Red Leaf and J. C. Cook).

Rameses.—An old variety no longer grown. Apparently it was a semi-cluster variety, resembling Peerless. It is described in Bulletins Nos. 33 and 56 of this Station as having long base limbs; upper limbs long but short jointed; plant prolific and early; bolls roundish and of medium size; seed medium, brownish white; staple short.

Red Leaf.—(Synonyms, Willett Red Leaf, Willett Purple Leaf). Seed from N. L. Willett Seed Co., Augusta, Ga. This is a unique variety, leaves, stems, squares and bolls being a deep purple. The new blooms are pink instead of white. The plant is large and very ornamental. In shape it is somewhat like a large, long-limbed, long staple variety. The base limbs are numerous, usually 3 to 5, long and growing more nearly upright than in most varieties. It has been claimed that this variety is exempt from cotton rust and some other diseases. At Auburn it has been slightly attacked by rust, but is apparently somewhat more resistant to this disease than most varieties, and retains the leaves better under adverse conditions. In maturity it is late to very late. Storm resistance, slight. The bolls are of medium size (73 per pound of seed cotton), roundish, short pointed, with either 4 or 5 locks. Per cent of lint high (36.8); lint medium or above medium in length. The seed are small, fuzzy, brownish white, due to the black color of seed coat showing faintly through the rather scanty covering of white fuzz. The plant is rather long jointed and not very prolific in proportion to size. In three plot tests at Auburn it ranked in yield of lint per acre, 12th, 9th, and 11th. In color of foliage this plant resembles a cotton grown at the Alabama Experiment Station in the early '90's, under the name of J. C. Cook, (which see).

Reliable.—Seed from E. S. Rakestraw, LaGrange, Ga. This is a big boll cotton, resembling Truitt in size of bolls, which are large and pointed, in form of plant, which varies between typical big boll and the semi-cluster form; and in appearance of seed, which are whitish brown and greenish brown. In a single test, the seed were medium to large or a little smaller than seed of Truitt. Maturity late. Per cent lint, 33.

Rich Man's Pride.—Seed from E. W. Bond, Athens, Ga. Classification uncertain, plants having few base limbs of medium length, few short upper limbs; bolls above medium size, ovate, pointed; medium maturity, fuzzy seed, mostly brownish and greenish. Per cent of lint, high.

Roby.—Seed from J. E. Roby, Goodman, Miss. This variety seems to be intermediate between the big boll and the long limbed group. In a single test at Auburn it was considered promising on account of prolificacy, high per cent of lint, and rather large bolls, (66 per pound of seed cotton). The plants are large, abundantly supplied with limbs and bolls; both lower and upper limbs are long. Seed fuzzy, medium size, very variable in color, from brownish white to deep brown, with an occasional deep green seed.

Rogers.—Originated about 1890 by R. H. Rogers, Darlington, S. C., as the result of crosses between (1) Jones Improved, (2) a small bolled, storm-resistant, "cluster" form of Herlong, and (3) Jowers, the latter a small round boll, very prolific cotton. This variety belongs both in the big boll and the semi-cluster groups, and resembles Dongola and Montclare. The bolls are large (62 per pound of seed cotton), decidedly storm resistant, and have 5 and 4 locks, not opening wide. The bolls are roundish, pointed or blunt. The seed are large, brownish white, and greenish. Per cent of lint above medium; maturity, medium to late.

Rosser No. 1.—This variety of uncertain classification is apparently intermediate between the King and the big boll group. It has medium sized, ovate, pointed, bolls; seed mostly brownish, fuzzy, and small. In prolificacy, maturity, and storm resistance, it is medium. Per cent of lint is above medium.

Rowden.—This variety, which originated in Texas, belongs in the big boll group (60 bolls making one pound of seed cotton). The bolls are ovate, pointed, relatively storm resistant, the locks, mostly 5, hanging together in a compact mass, making picking easy. Per cent of lint above medium; maturity medium; lint, medium length. This variety has many valuable qualities, but has the weakness of having a small number of bolls, and an insufficient number of limbs. In a single field test at Auburn it stood 5th in yield of lint among 40 varieties tested. It is one of the favorite varieties in the boll weevil region of Texas.

Ruralist.—This variety was originated a few years ago by J. F. Merriam, Battle Creek, Ga. This is a big boll variety averaging in two years' tests 64 bolls per pound of seed cotton. The bolls are ovate, pointed, opening well; the per cent of lint is low; the seed are of medium size, mostly brownish white, brown and green. Maturity, medium.

Russell.—(Synonym, probably Bancroft.) This variety was originated about 1897 by J. L. Russell, Alexander City, Alabama, from a single chance plant of unusually thrifty growth and having very large bolls, found in his field. It has become a wide favorite, and probably divides the honors with Peterkin and Truitt of being the variety most extensively grown in Alabama at present. The plants are of medium size, having two to four base limbs of medium length, upper limbs of short to medium length. The leaves are characterized by large size and shallow indentations between the lobes. The bolls are large (averaging 62 per pound of seed cotton), long, ovate, tapering gradually to a point, opening well, and easily picked. The per cent of lint is below medium (32.9). The seed are large, densely covered with fuzz, either green or greenish brown. In maturity, Russell is late. In field tests at Auburn its rank in yield of lint per acre was 1st, 8th, 20th, 6th, and 15th, averaging about midway of the list for the years when it was tested. It stood ahead of Truitt three years and was beaten by Truitt two years. In all points, including characters of plants, foliage, seed, and yield, Russell and Bancroft Herlong have been practically identical. While no historical or documentary evidence has been found bearing on the point, my opinion is that Russell and Bancroft are identical, the Russell probably being a selection from a chance plant of Bancroft, found in Mr. Russell's field. This view is supported by the similarity in all points and by the further fact that, excepting a few strains exploited within the past few years, no other varieties have been found having the unique seed characters common to Bancroft Herlong and Russell.

Rust Proof.—Noted in Alabama Experiment Station Bulletin No. 56 as having large bolls, low per cent of lint. No longer obtainable under this name.

Sam Woodfin Prolific.—A selection from Woodfin and identical with the parent variety.

Seabrook.—This is a variety of Sea Island cotton (see above) originated by F. P. Seabrook, James Island, S. C. Among Sea Island cottons it is classed as a medium grade of staple and hard to gin on the gins commonly employed for that class of cotton, on account of some green fuzz on the seed. It is regarded as productive for this class of cotton, and better suited than most Sea Island strains for cultivation in the interior. The seed, averaging .11 gram and 26 per boll, are mostly naked and black, ercept for a tuft of greenish brown fuzz at each end of the seed. The per cent of lint was 28.1; bolls per pound of seed cotton 112. It did not mature its entire crop at Auburn.

Sea Island.—This belongs in a different species from the short staple and long staple upland varieties, being classed by botanists as *Gossypium barbadense.* The plants are very large and have long slender limbs; stems and leaves are free from hairiness. The bolls are very small and slender, tapering gradually to a sharp point; surface of bolls pitted. The leaves are entirely unlike those of short staple and long staple upland varieties, the lobes (usually 5) being separated by deep indentations. At Auburn the Sea Island matures only a small portion of its forms. The young bloom is cream colored instead of white, and has a red spot inside the flower, near the base of each petal. The per cent of lint is very low, averaging at Auburn 26.5; it required 127 bolls to make one pound of seed cotton. The seed, which are naked and black, were of large size (.13 gram), and the average was only 21 seed per boll. Lint very long, fine and silky.

Scogin.—(Synonym, Culpepper, which see). A selection made by

J. F. Scogin, Luthersville, Ga., from Culpepper, from which it cannot be distinguished.

Sewell.—A local name for a big boll, unprolific, large-seed variety with low per cent of lint. Seed mostly brownish white.

Shine.—(Synonyms, Shine Early, Shine No. 1, etc.) Originated by J. A. Shine, Faison, N. C., about 1875, who states that it is descended from Sea Island and from a little known variety called Micasucie. This is an early variety, but not quite so early nor so uniform as King. Some of the plants are of the short limbed type and some of them resemble King. This variety is inferior to King in per cent of lint (averaging only 32 per cent), and in two tests at Auburn, in which it was compared with King, the yield of lint was lower. Storm resistance, poor; bolls small (90 per pound); seed small, fuzzy, brownish white and greenish.

Shine No. 2.—This cotton, of variable type and uncertain classification, was originated by J. A. Shine about 1900, who states that its parent was Texas Bur.

Shine Black Seed.—(Synonyms, Hood and probably Peterkin.) This cotton is evidently a selection from Peterkin, which it resembles in all points.

Schley.—This is a selection from Jones Improved made by the Georgia Experiment Station. In one of our tests it exceeded and in another test fell below its parent in yield of lint per acre. It belongs to the big boll class, and is perhaps a little more erect and compact than its parent. The selection has increased the per cent of lint (34.1) and slightly decreased the size of seed, has made maturity earlier, and the form of plant more compact.

Simms.—(Synonym, Simms Long Staple). Seed obtained from J. F. Weekley, Wheeler, S. C. This long staple variety had bolls of medium sized, medium sized seed, mostly fuzzy and brownish. The plants were not productive. Maturity, medium to late.

Sistrunk.—This is a selection made by W. E. Sistrunk, Tallassee, Ala., beginning at a time when he was growing both Crossland and Hawkins varieties. As grown in 1905 it had not become entirely uniform, but the majority of plants had the Rio Grande characteristics, being evidently mostly selections from Crossland. The bolls are of medium size (72 per pound); per cent of lint high (36.7); seed small (.098 gram), mostly with a scant covering of a brownish fuzz. Plants prolific, and of medium to late maturity.

Smith Improved.—Seed from A. J. Smith, Conyers, Ga. This is a big boll variety with large fuzzy seed, which are brownish white and greenish white.

Smith Standard.—(Synonyms, Ben Smith, and Smith Choice, Bush). A big boll variety with large fuzzy seed and medium per cent of lint, medium maturity.

Southern Hope.—Seed from Marx Schaefer, Yazoo City, Miss. In shape of plant this is a typical long staple. The bolls are medium size, ovate, pointed. The staple is short for the long staple group. Per cent of lint is 30.6. Bolls medium size, 78 making a pound of seed cotton; seed small to medium, fuzzy, white and brownish white; maturity medium.

Southern Wonder.—Seed from L. F. Grier, Oxford, Alabama. This is a big boll variety (52 bolls per pound), with medium per cent of lint, large, fuzzy ,brownish white, brown, and green seed. If is moderately prolific and of medium to late maturity.

Spearman.—(Synonym, Spearman's Choice). Seed from W. B. Spearman, Social Circle, Ga. This is a big boll variety of medium maturity; plants compact and moderately prolific, approaching the semi-cluster form. The bolls are large (56 per pound), roundish, often blunt pointed. The seed are smaller than those of most big boll varieties, averaging .106 gram. The seed are fuzzy, mostly brownish white. The per cent of lint is low (31.7).

Speight.—Seed from J. B. Speight, Winterville, N. C. Classification uncertain, but probably it represents a form of the Rio Grande group; plants prolific, well shaped and suggesting Peterkin; bolls small, ovate; seed small, variable, either fuzzy, brownish white, greenish, or brown or nearly naked. Per cent of lint 33.7, or very low for the Rio Grande group.

Spruiell.—(Synonyms, Spruiell Re-Improved, Spruiell Green Seed, Spruiell Prolific). Originated by A. M. Spruiell, Leeds, Alabama, as a selection from Hutchinson. We have grown this cotton from the originator for several years under each of the above names, and have found the strains to be practically the same, the differences between the different strains being less than the differences between the individual plants of the same strain. This seems to be an intermediate between the big boll group and the King group. The bolls are above medium size (61 to 72 per pound, averaging 67 for the three strains), ovate, pointed. In maturity it is early to medium, or earlier than most varieties with bolls of this size. Further improvement in the matter of uniformity is needed. Seed, medium to large, fuzzy, whitish brown, greenish brown, brown and green.

Sterling.—Seed from L. W. Dance, Eatonton, Ga. This is a prolific semi-cluster cotton of early to medium maturity. It resembles Woodfin and the more compact, erect, plants of Hawkins. Bolls small (93 per pound), ovate, sometimes obtuse, seed small, mostly brownish white. Lint short to medium in length; per cent of lint, medium.

Storm Proof.—(See Texas Storm Proof.)

Strickland.—Originated by J. R. Strickland, Gordo, Ala. This is a big boll variety, with plants typical of that group. The bolls are large, (58 per pound), ovate, usually blunt-pointed. The per cent. of lint is low, (32.5). The seed are large, fuzzy, mostly brownish white. Lint above medium. In two plot tests at Auburn, Strickland ranked 7th and 11th in yield of lint per acre. This variety very closely resembles Truitt.

Sunflower.—Seed from Marx Schaefer, Yazoo City, Miss. This is a long staple variety with plants, bolls and fibres typical of that group. The bolls are small, (83 per pound of seed cotton), slender, tapering to a sharp point and having either 4 or 5 locks. The plant is prolific for a long staple variety. Storm resistance medium. Seed small to medium, white and brownish white. Maturity medium to late. Fiber long; per cent. of lint, low, (29.2).

Like the other long staple varieties it has stood near the bottom of the list in yield per acre of lint at Auburn, about equalling Florodora.

Tatum.—(Synonym, Tatum Big Boll.) Seed from R. D. Tatum, Palmetto, Ga. The plants are well shaped and characteristic of the big boll group. Bolls large, (58 per pound), abruptly pointed. Per cent. of lint, 33.2; seed, large, fuzzy, brownish white and greenish white. Maturity, late. This variety resembles Strickland, but has a larger per cent of greenish seed, which average smaller.

Texas Bur.—Originated by C. E. Smith, Locust, Grove, Ga., by selections since 1895 from an unknown variety originally from Texas. This is a big boll variety, with rather few medium length limbs, and medium maturity. Per cent. of lint, low. Seed of medium size, fuzzy, mostly brownish white, but with some greenish seed. In two plot tests at Auburn it ranked in yield of lint per acre about one-third the distance from the top of the list. On account of its apparent earliness for a big boll variety this cotton is worthy of preservation and improvement through an increase in the number of limbs and bolls.

Texas Oak.—(See Peterkin.) A variety of the Rio Grande class and identical with Peterkin, but having a lower per cent of lint, (34.2.)

Texas Storm Proof.—(Synonyms, Bahama, Drought Proof, Storm Proof). A big boll variety with medium per cent of lint; very large, fuzzy seed, (.16 gram), mostly brownish white. Some of the seed obtained under this name contained nearly or quite naked, black seed like Peterkin. Bolls very large, pointed; storm resistance considerable; maturity, late.

Texas Wood.—This is similar in all respects to Peterkin, which see.

Thrash.—See Wyche.

Todd.—(Synonym, Todd Improved). Seed from P. W. Todd, Grantville, Ga., who states that it originated about 1892 by selection from a field where "storm proof" and two other varieties were planted. This is a typical big boll variety with very large bolls, (51 per pound), bolls ovate, pointed, and usually with five locks. The per cent of lint is medium (33). Seed very large, (.169 gram), fuzzy, mostly whitish brown, but with some greenish seed. Maturity late; fairly prolific.

Todd Early.—Distinct from above; small bolls; classification uncertain.

Toole.—Originated by W. W. Toole, Augusta, Ga., in 1894 as a selection from Peterkin. It is probably an intermediate form between the Rio Grande group, and the King group, being much closer to the former. In a few plants were found red spots on petals, pointing to kinship to King. This is a very prolific variety. The plants are of medium size, symmetrical and abundantly supplied with bolls and limbs. The bolls are small (88 averaging in our tests one pound of seed cotton). The bolls are ovate, abruptly pointed, with five or four locks, opening wide and allowing seed cotton to fall out rather easily. The seed are small (only .086 gram), a part of them quite fuzzy and pale brown, but most of them appearing dark brown by reason of the very scant covering of white or brownish fuzz, through which the dark seed coat can be seen indistinctly. The per cent of lint is very high, (averaging 38.5). In maturity Toole is early or early to medium, being later than King and a little earlier than Cook. It has proved more productive than King or Peterkin, standing 1st and 3rd in two field tests at Auburn, or about equal to Cook. Its principal defect is the small size of bolls. Its earliness and productiveness should make it a favorite, especially after the appearance of the boll weevil.

Triumph.—(Synonyms, Mebane, Mebane Triumph). This variety was originated by Mr. ——— Mebane in the southern part of Texas, but our seed were obtained from J. L. & W. B. Myrick, Lott, N. C. This is a big boll variety, with immense bolls, only 46 bolls being required to make a pound of seed cotton. Other conspicuous merits of this variety are the facts that it is earlier than most big boll cottons, ranking as medium in maturity, and that it has a very high per cent of lint, (38.6 in our test). The seed are numerous, of medium size, (averaging .127 of a gram), fuzzy, brownish white and greenish. This cotton is somewhat resistant to storms; lint, of medium length or above. The yield of lint was not determined at Auburn, only a small area of this variety being grown. While not especially well bolled here, this variety has enough merit to make it a favorite in case its yield of lint in our 1907 test shall equal that of other leading varieties. This variety has been especially satsfactory in regions infested with the boll weevil.

Truitt.—(Synonyms, Truitt Big Boll, Truitt Premium). This is a popular and widely grown big boll variety, originated by George W. Truitt, LaGrange, Ga., by selection from the so-called "Old Georgia White Seed." The bolls are large (averaging in four years' tests, 58 per pound of seed cotton). The plants are well shaped and more prolific and more nearly approaching the semi-cluster type than do many of the big boll varieties. Bolls are large, ovate, pointed, opening wide, and not storm resistant. Seed large, fuzzy, mostly brownish white to white. Maturity, late, but not quite so late as Russell. This variety has been tested in plot experiments at Auburn for eleven years and ranked in yield of lint in the respective years 1st, 3rd, 2nd, 4th, 2nd, 9th, 5th, 2nd, 24th, 16th, and 14th.

Tucker.—(Synonym, Boyd.) Seed from W. B. Tucker, Opelika, Ala., who selected it from Boyd Prolific. Plants variable, mostly short-limbed; per cent of lint 34.9; bolls small; seed small, fuzzy, brownish white, brown and greenish; maturity, early to medium.

Tyler.—(Synonym, Tyler Limb Cluster). This is a semi-cluster variety from South Carolina, which is now probably extinct. Bolls small; seed like Peterkin; but per cent of lint only medium.

U. S. Department of Agriculture Nos. 145, 149.—These are selections made on account of wilt resistance by W. A. Orton. They have all been discarded because inferior in this point to Dixie and to U. S. D. A. No. 128, below.

U. S. Department of Agriculture, No. 128.—(Synonym, Jackson Wilt Resistant). A selection from Jackson Limbless made by W. A. Orton since 1890, with a view to increase its resistance to cotton wilt.

Victor.—(Synonyms, Combination, Peterkin, etc., which see). A strain of Peterkin from South Carolina that is abundantly supplied with bolls, the small size of which (89 per pound), makes it inferior to the parent. The seed are very small, brown, mostly fuzzy.

Warren.—Seed received from J. B. Warren, Moscow, Miss. Classification uncertain; not especially promising.

Webb.—This cotton from North Carolina includes two types, one is semi-cluster and one resembles the larger plants of King. Early but otherwise unpromising.

Webber-Russell.—A hybrid made by Dr. H. J. Webber, between Russell and some long staple variety. As tested in 1906 it had most of the characteristics of Russell, but smaller leaves, large, slenderer, and more pointed bolls, many white seed as well as the usual large green seed; fibers of unequal length on the same seed. It would not yet take rank among the long staple varieties. In a single test the yield of lint was slightly above that of Russell.

Welborn.—(Synonym, Welborn Pet.). A cluster variety now difficult to obtain, originated by the late Jeff Welborn, of Texas. Plants of medium height, consisting of a central stem with very short fruit limbs and one to four base limbs of medium length. Plant resembles Jackson, but the bolls are slightly smaller, (91 per pound) and less tapering; bolls ovate, thickly clustered, abruptly pointed. Maturity, early, but later than King. A peculiarity of this variety was the opening of most of its bolls about the same time. Per cent of lint above medium.

Whatley.—A local name in Lee County, Alabama, for a strain that is no longer maintained.

Whitten.—(Synonym, Whitten "Cluster.") A local name in the eastern part of Alabama for a big boll variety that seems to be a selection from Cummings or Peerless. Bolls, large, pointed; seed large, fuzzy; per cent lint, high; the plant resembles the so-called Drake "cluster" from Alabama.

Wilson.—(Synonym, Wilson Matchless). Seed from F. D. Wilson, Littleton, N. C. Classification uncertain. Bolls medium size, ovate, pointed, usually 5 locks; wood or base limbs one to five, of medium length. Per cent of lint low, (32.2). Seed small, fuzzy, brownish white and greenish white. Maturity, medium.

Wise.—(Synonym, Peterkin, etc., which see.)

Seed from H. P. Jones, Herndon, Ga. The plant in all qualities is not distinguishable from Peterkin, though in five years' tests it averaged 1 1-2 per cent higher in per cent of lint (39.5) and the seed averaged slightly smaller (.087 gram). It is possibly a few days later than Peterkin.

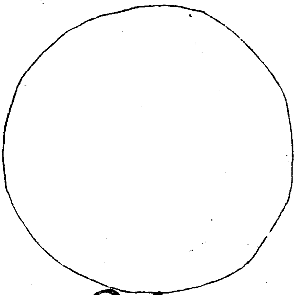
Wonderful.—An old long staple variety no longer obtainable. Described in earlier bulletins of this Station as having a large plant, with long, drooping, long-jointed limbs; bolls large, and pointed, maturity late; staple long; seed large, fuzzy, brownish white.

Woodfin.—(Synonym, Nonpariel.) Originated by S. V. Woodfin, Marion, Alabama, about 1898, who states that the parent varieties were Peerless, Peterkin, and one that he calls Senegambia. This is a well shaped plant of the semi-cluster type. The bolls are small, ovate, pointed, with either five or four locks. Maturity medium, to late; per cent of lint low to medium; seed small, fuzzy, mostly brownish white and greenish. This cotton is identical with Sam Woodfin Prolific and closely resembles Sterling and the most compact plants of Hawkins.

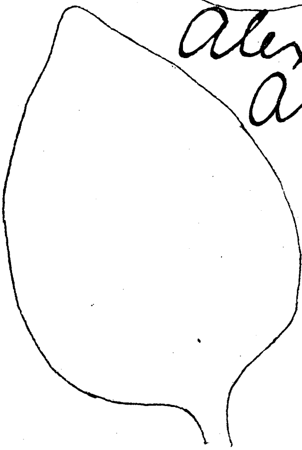
World's Wonder.—(Synonyms, Probably Defiance and Drake's Defiance; see Defiance.)

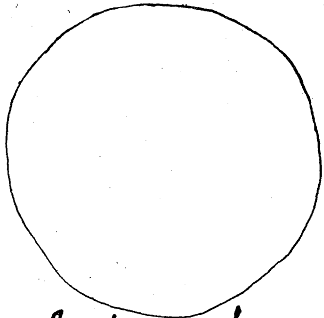
Wyche.—(Synonyms, Wyche Big Boll, Thrash). Seed received from J. S. Wyche, Wooster, Ga. who states that this variety originated there about 1873. This is a typical big boll variety, 59 bolls making a pound of seed cotton. Per cent of lint medium; bolls ovate, pointed, and with either five or four locks. The seed are large, mostly white or brownish white. Wyche resembles Jones Improved.

Zellner.—Extinct. Described in Alabama Experiment Station Bulletins Nos. 33 and 56 as having a plant of medium size; bolls roundish, of medium size; early; per cent of lint very low; staple short. This was apparently a semi-cluster variety.

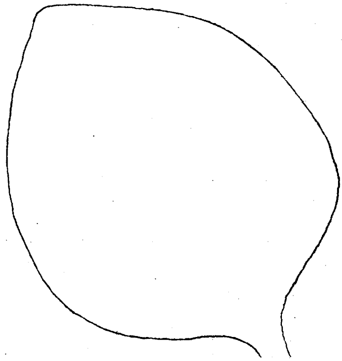


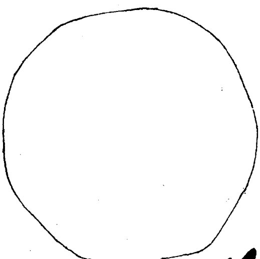
Alex. Allen



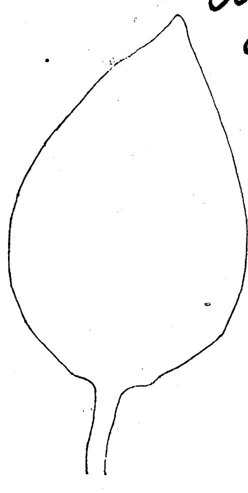


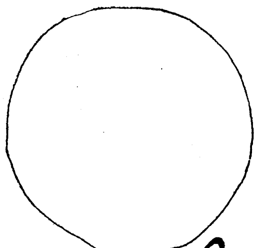
Anderson's Prolific



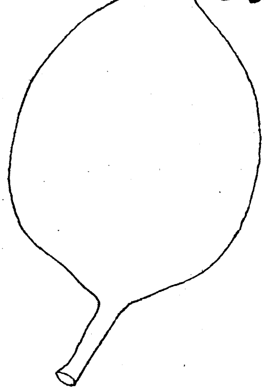


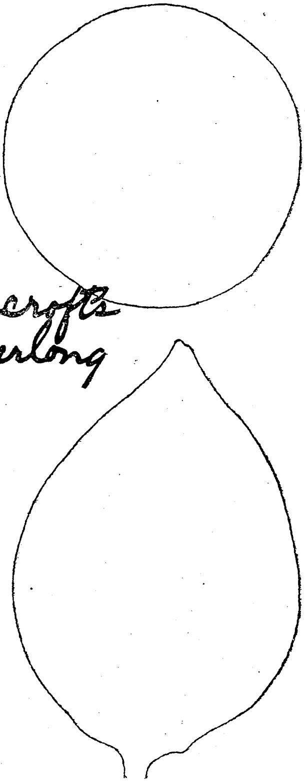
Allen's L.S.





Anson's Cream





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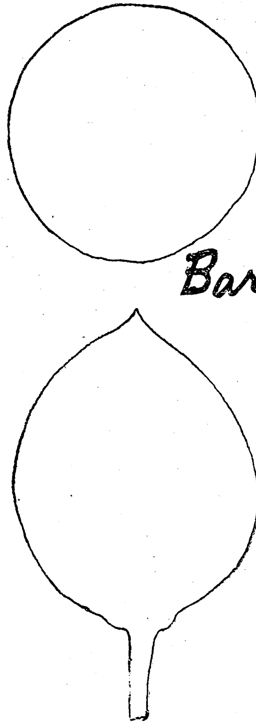

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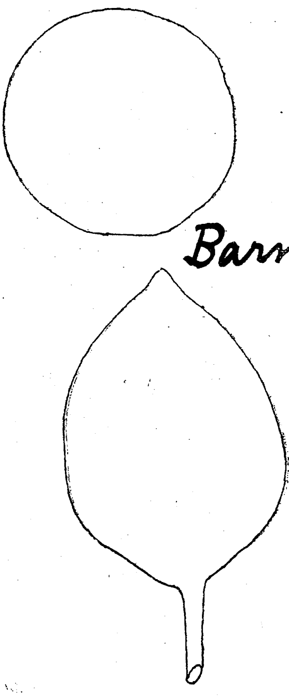

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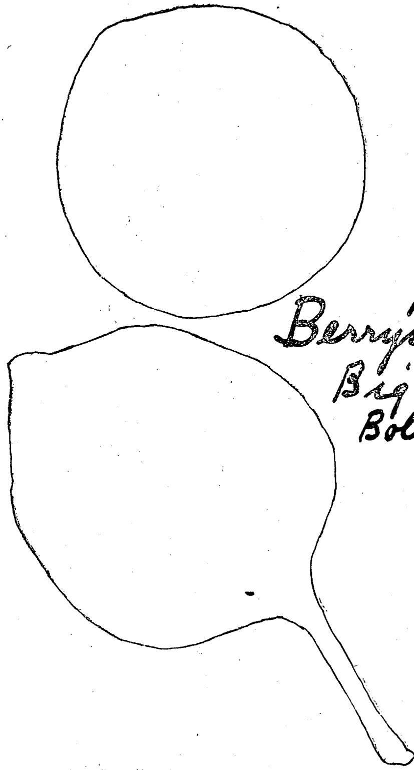
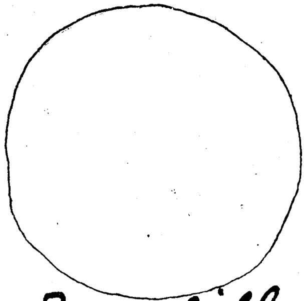


Berry's Big Boll



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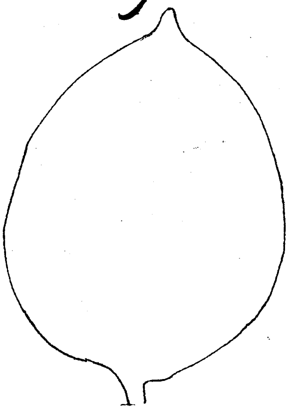

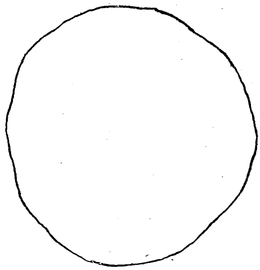

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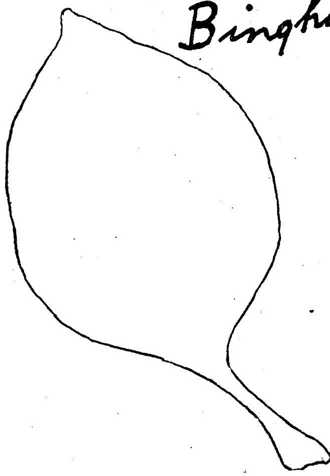

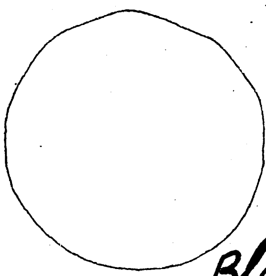

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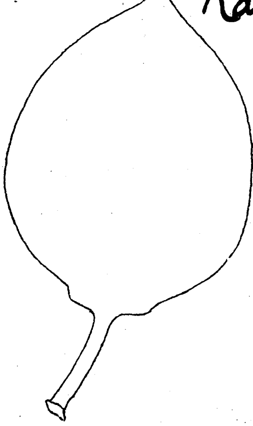

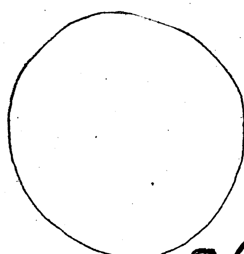

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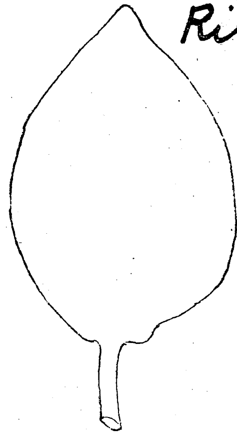

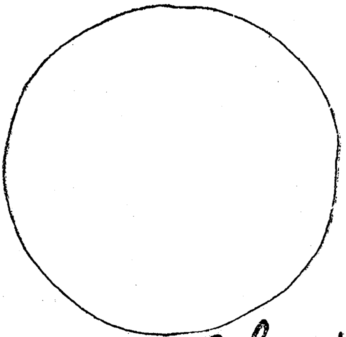

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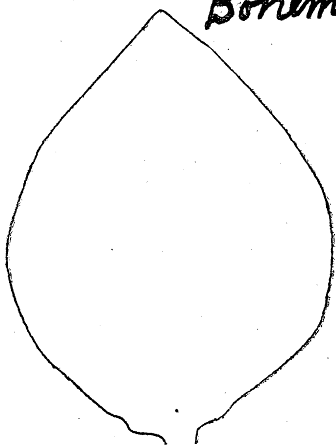

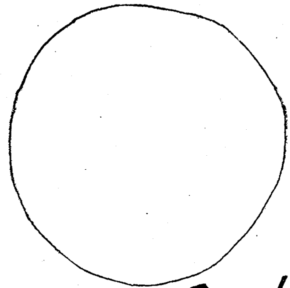

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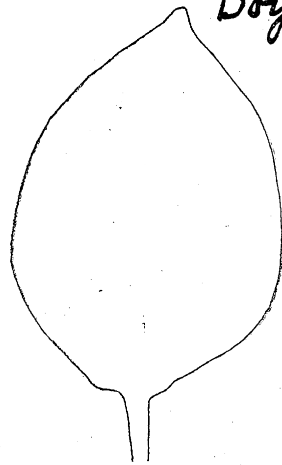

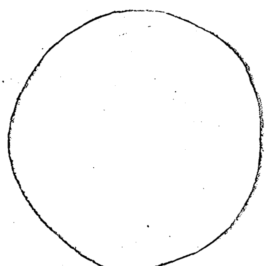

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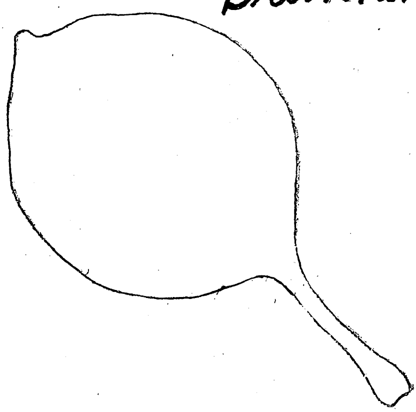

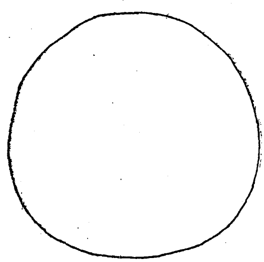

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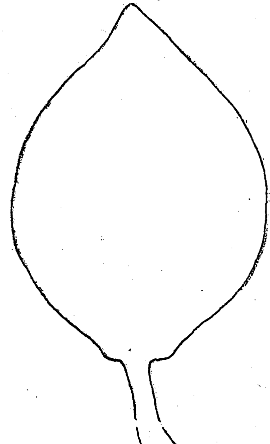

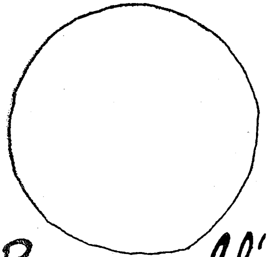

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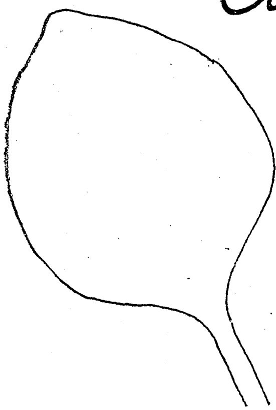

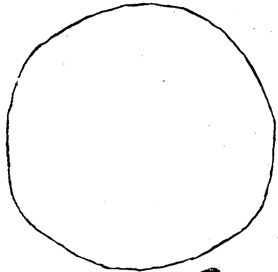

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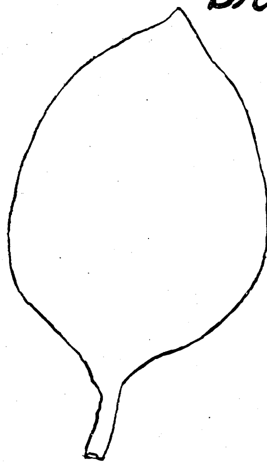

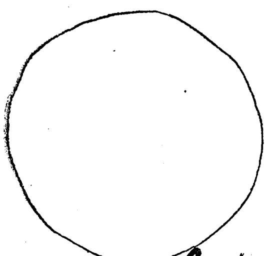

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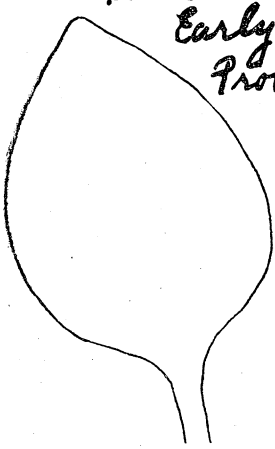

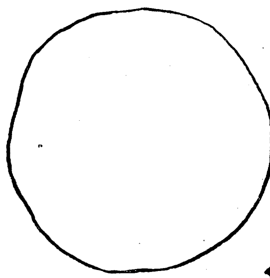

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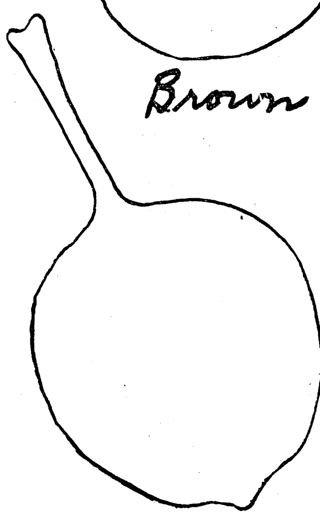

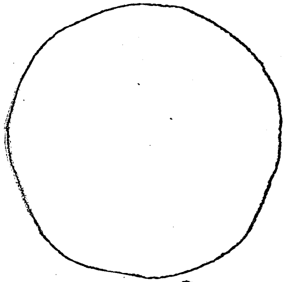

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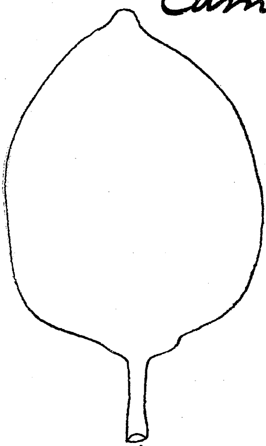

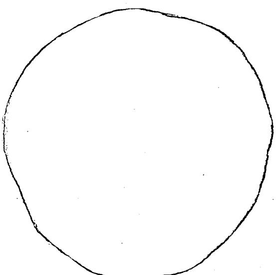

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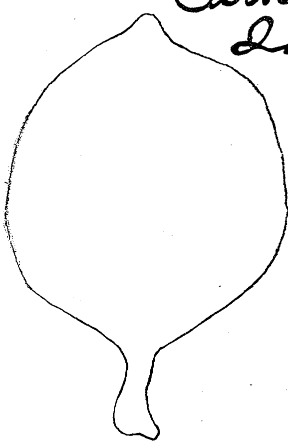

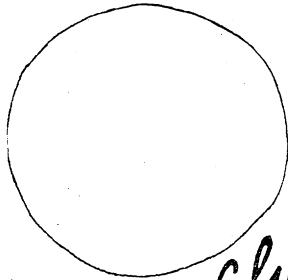

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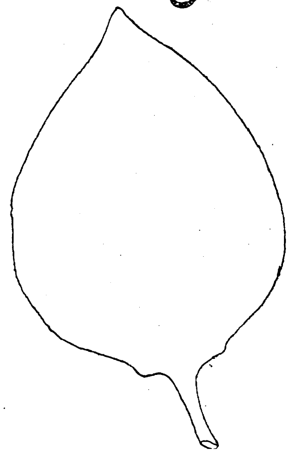

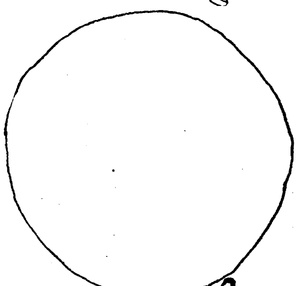

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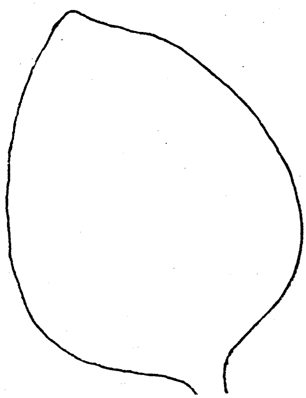

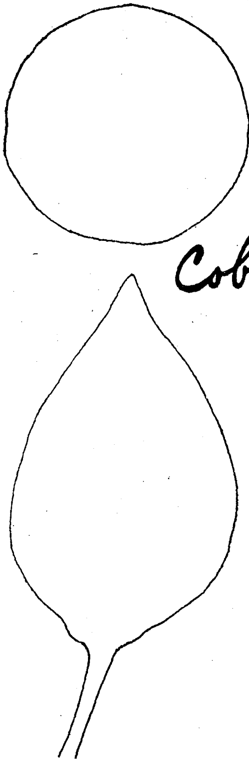

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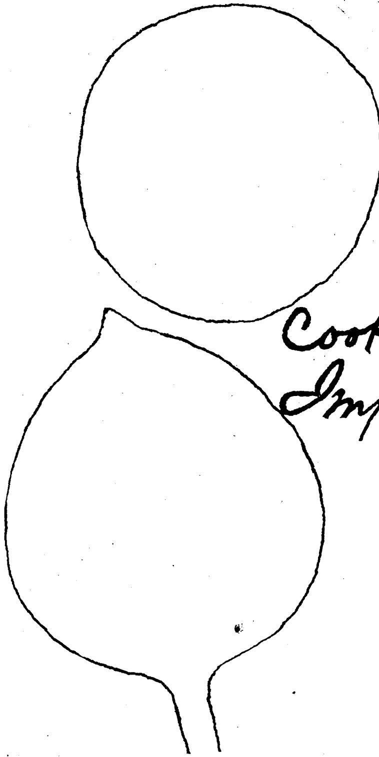
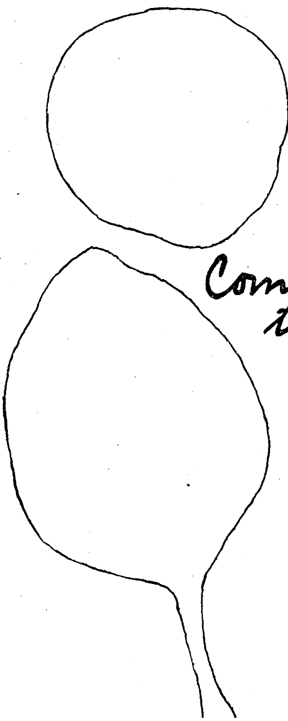


Cook's Impd.



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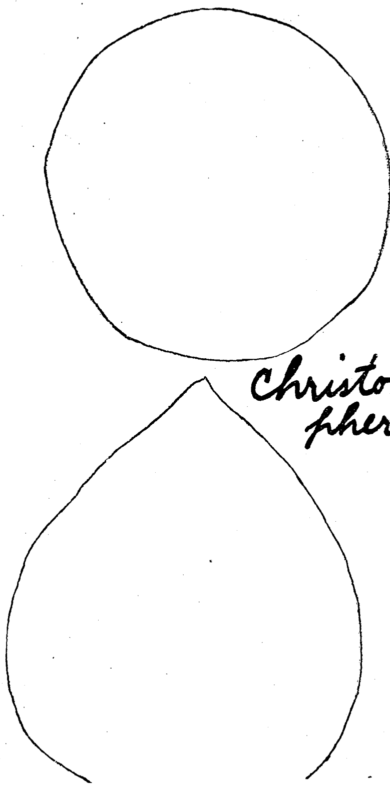

Christopher

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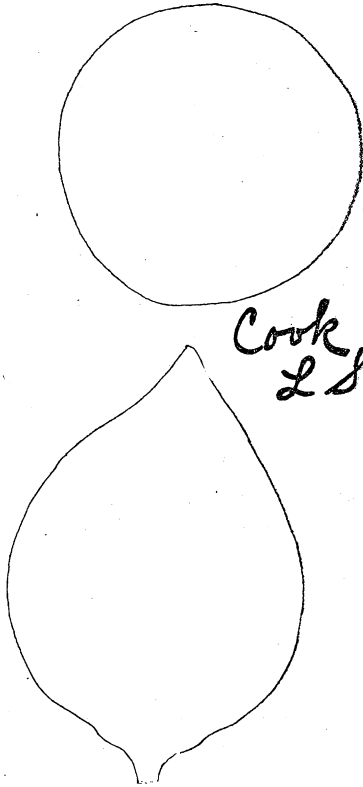
Laclede



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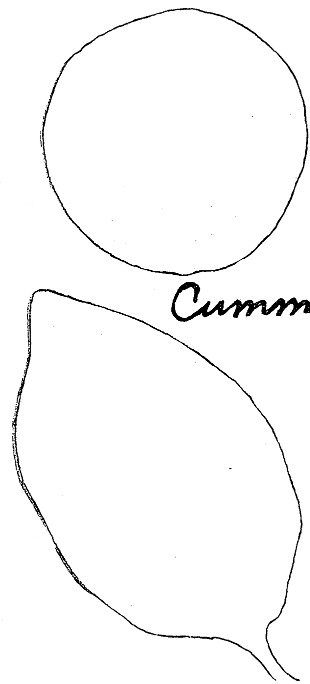

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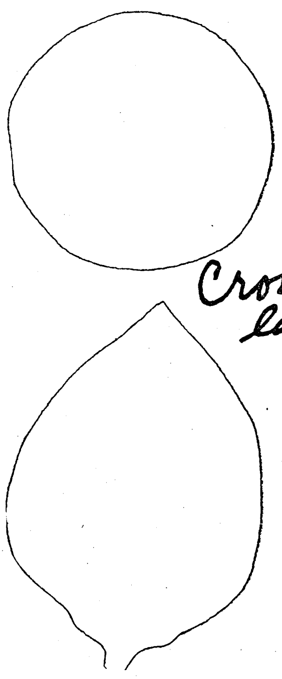

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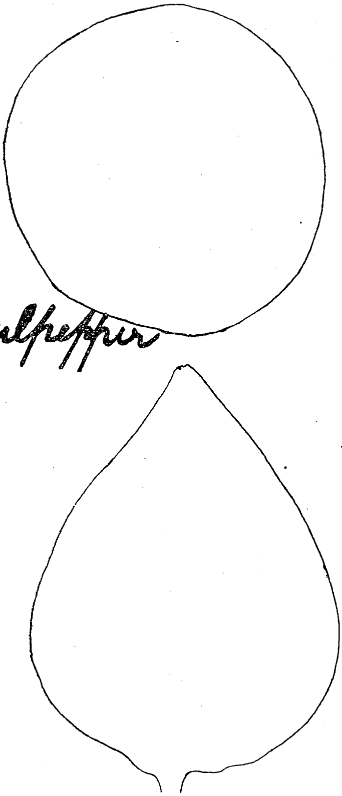

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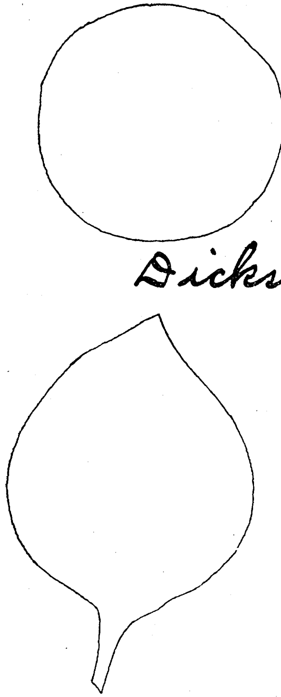

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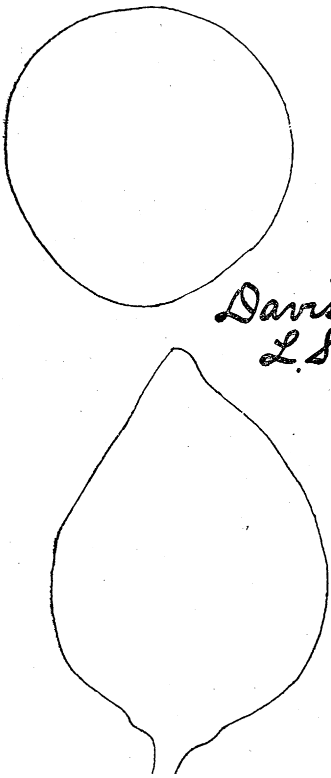

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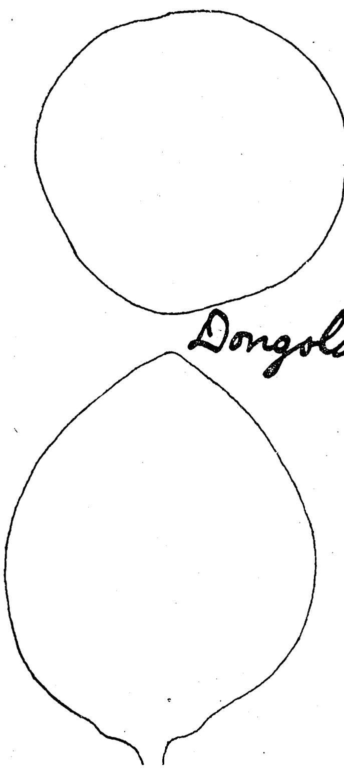

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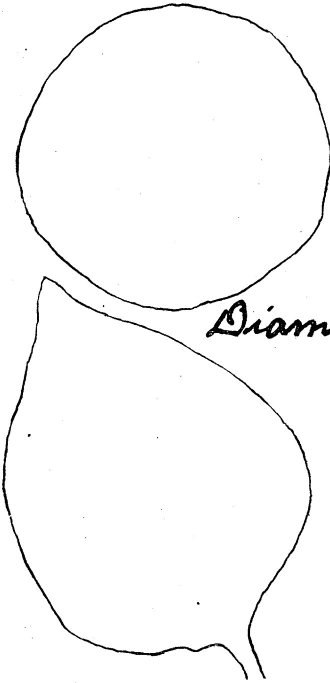

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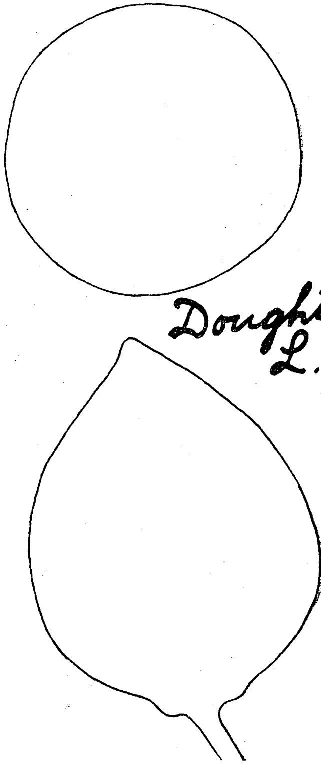

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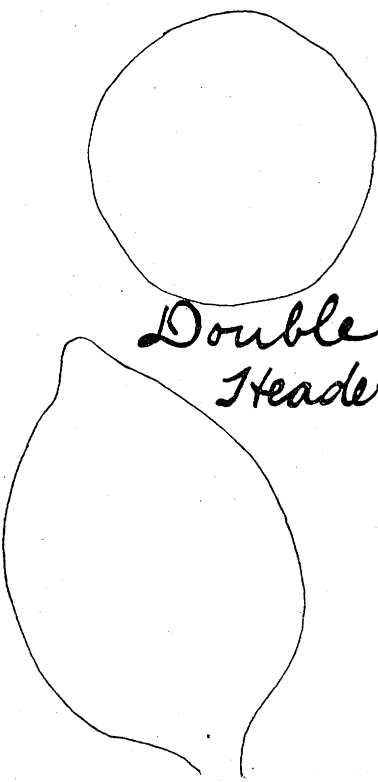
L.S



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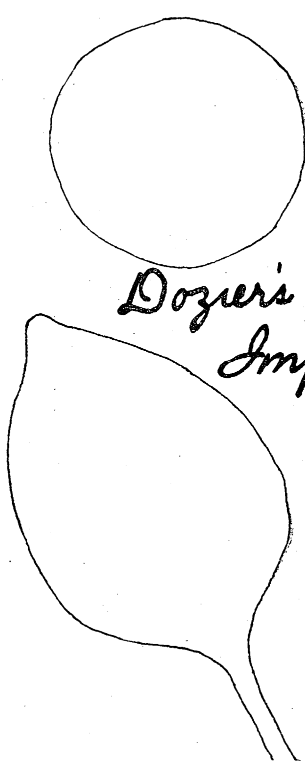

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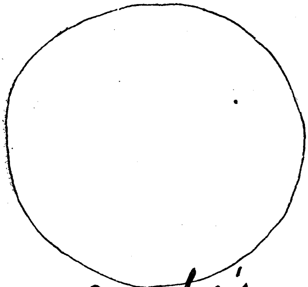
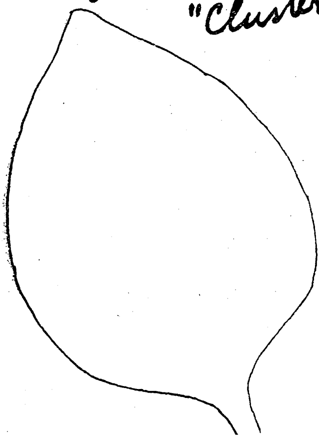
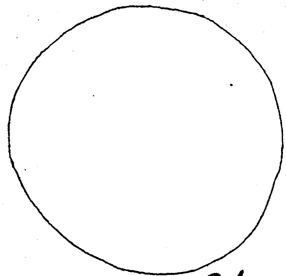


Drake's "Cluster".





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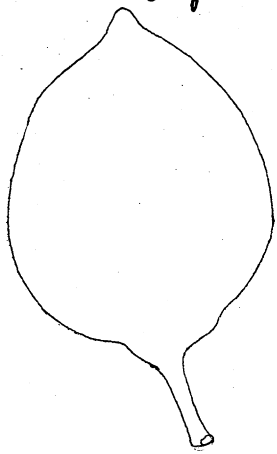
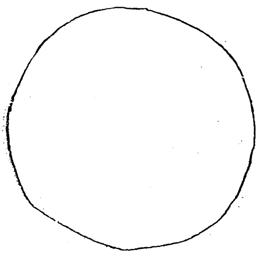
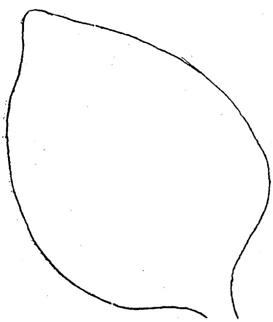
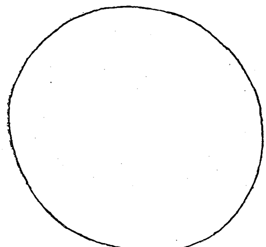




Drake's Defiance





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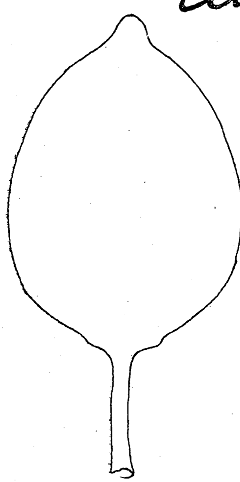
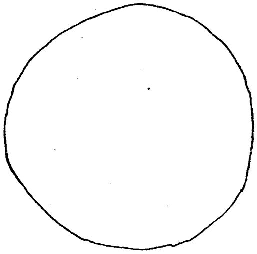
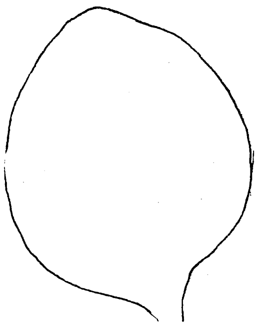
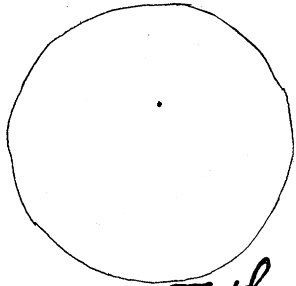




Extra Early





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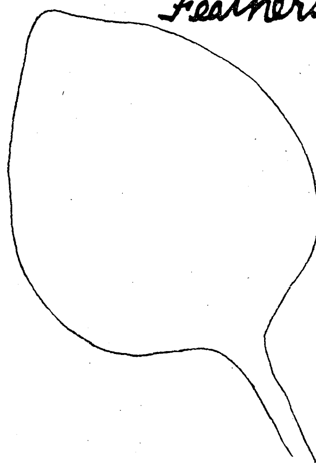

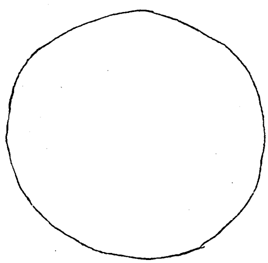

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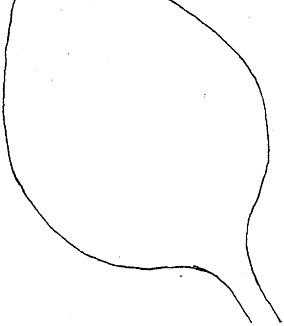

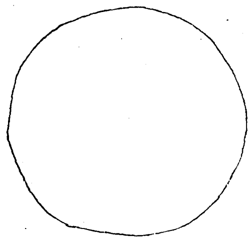

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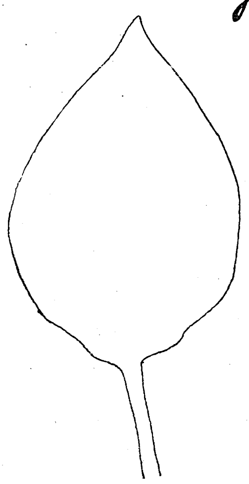

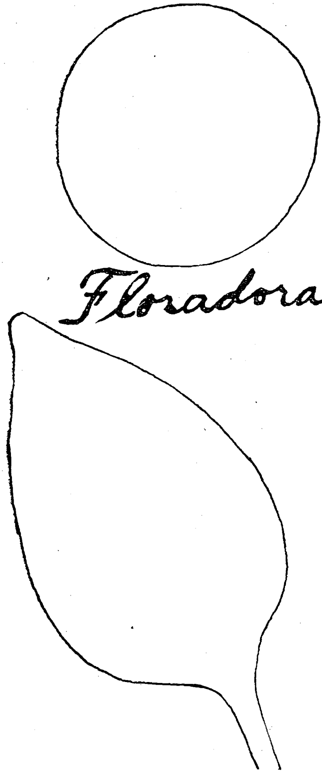

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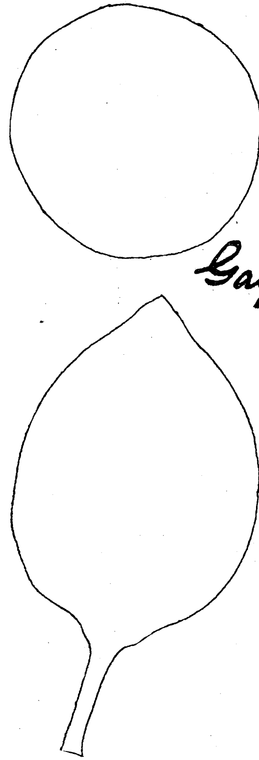

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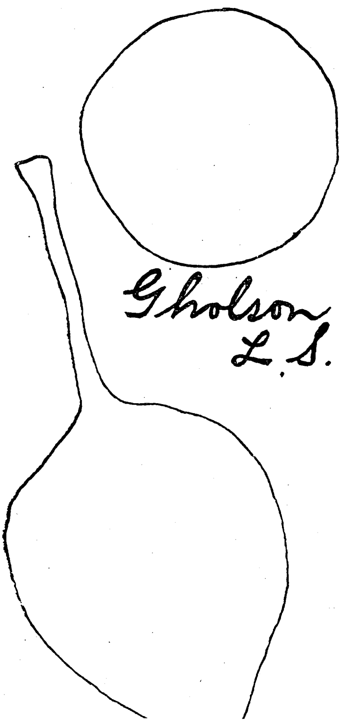

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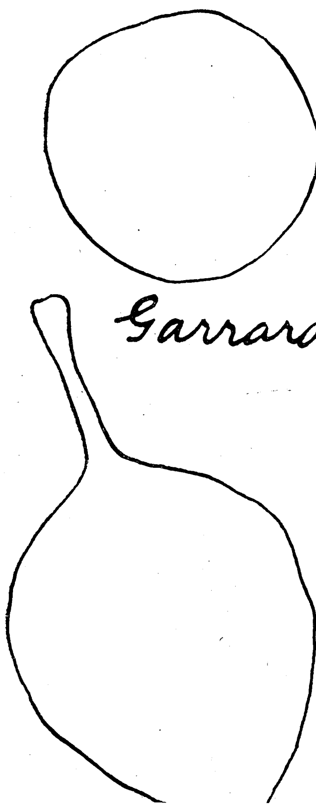

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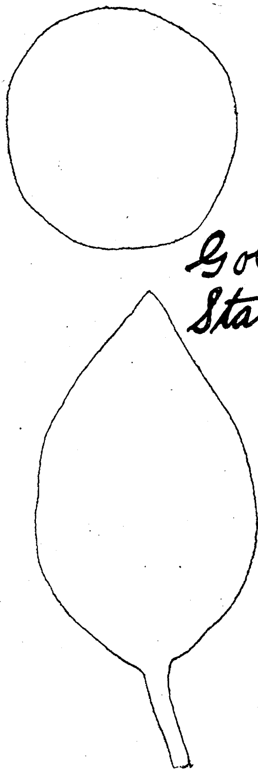

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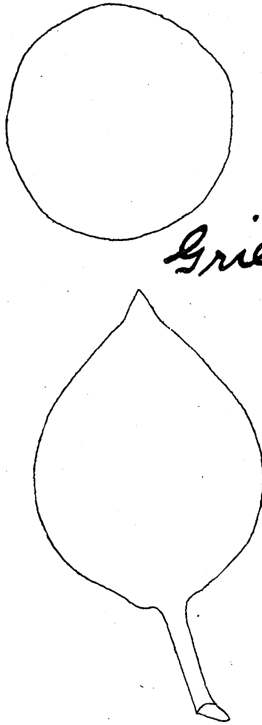

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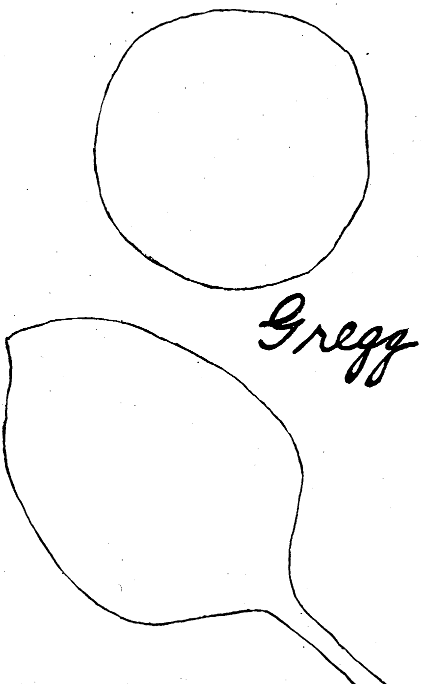

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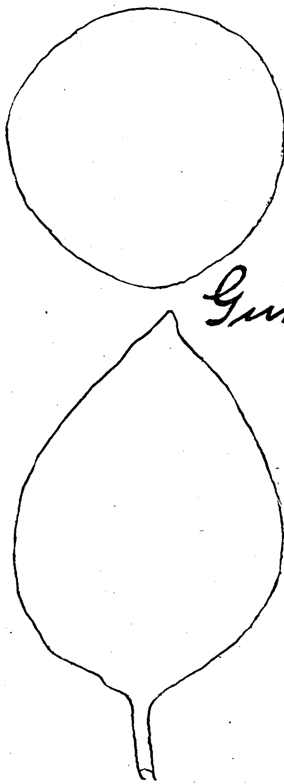

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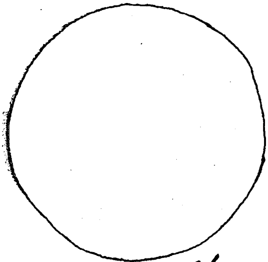

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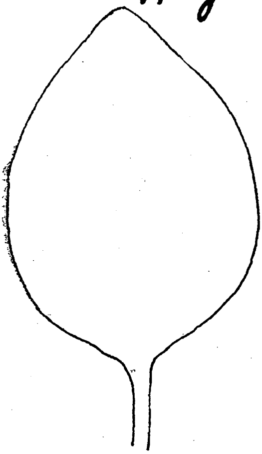

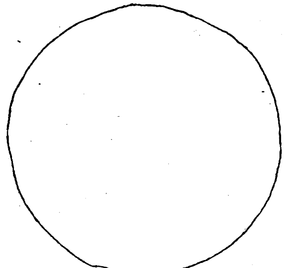

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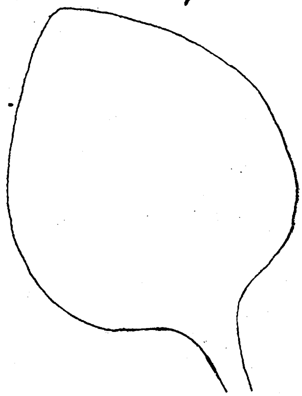

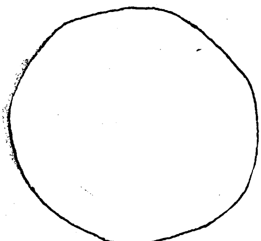

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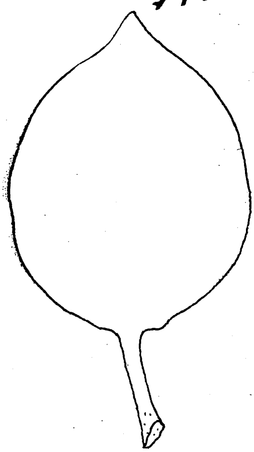

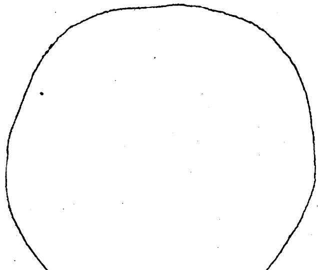

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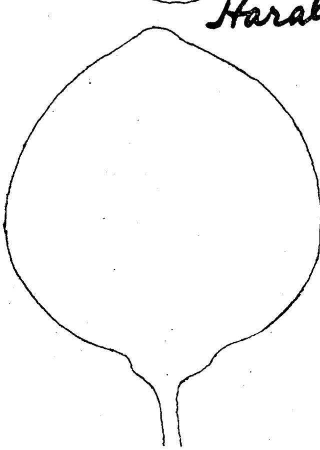

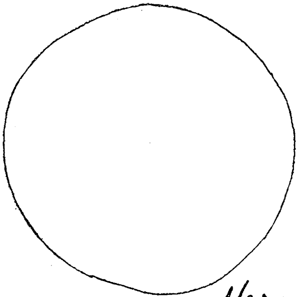

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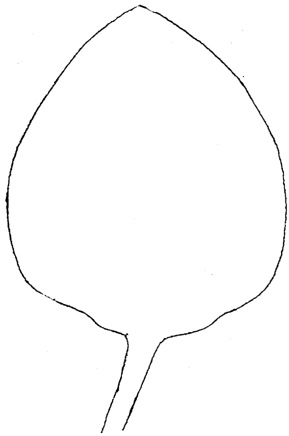

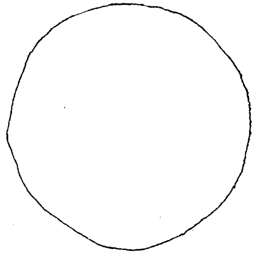

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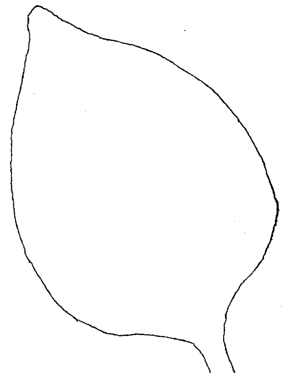

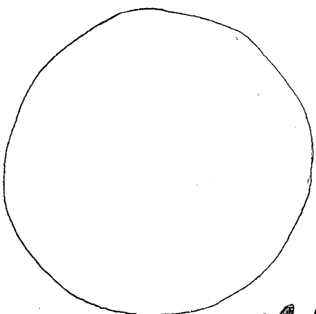

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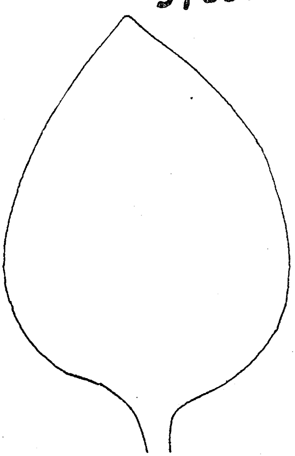

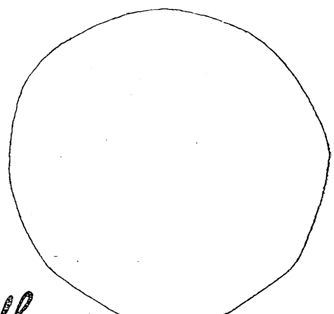

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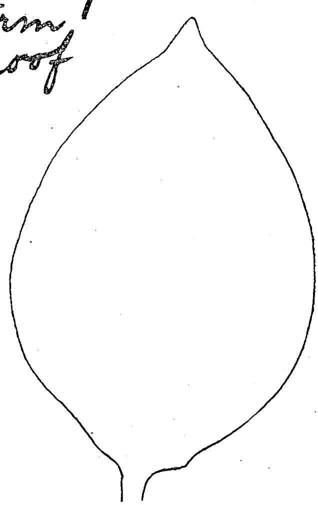

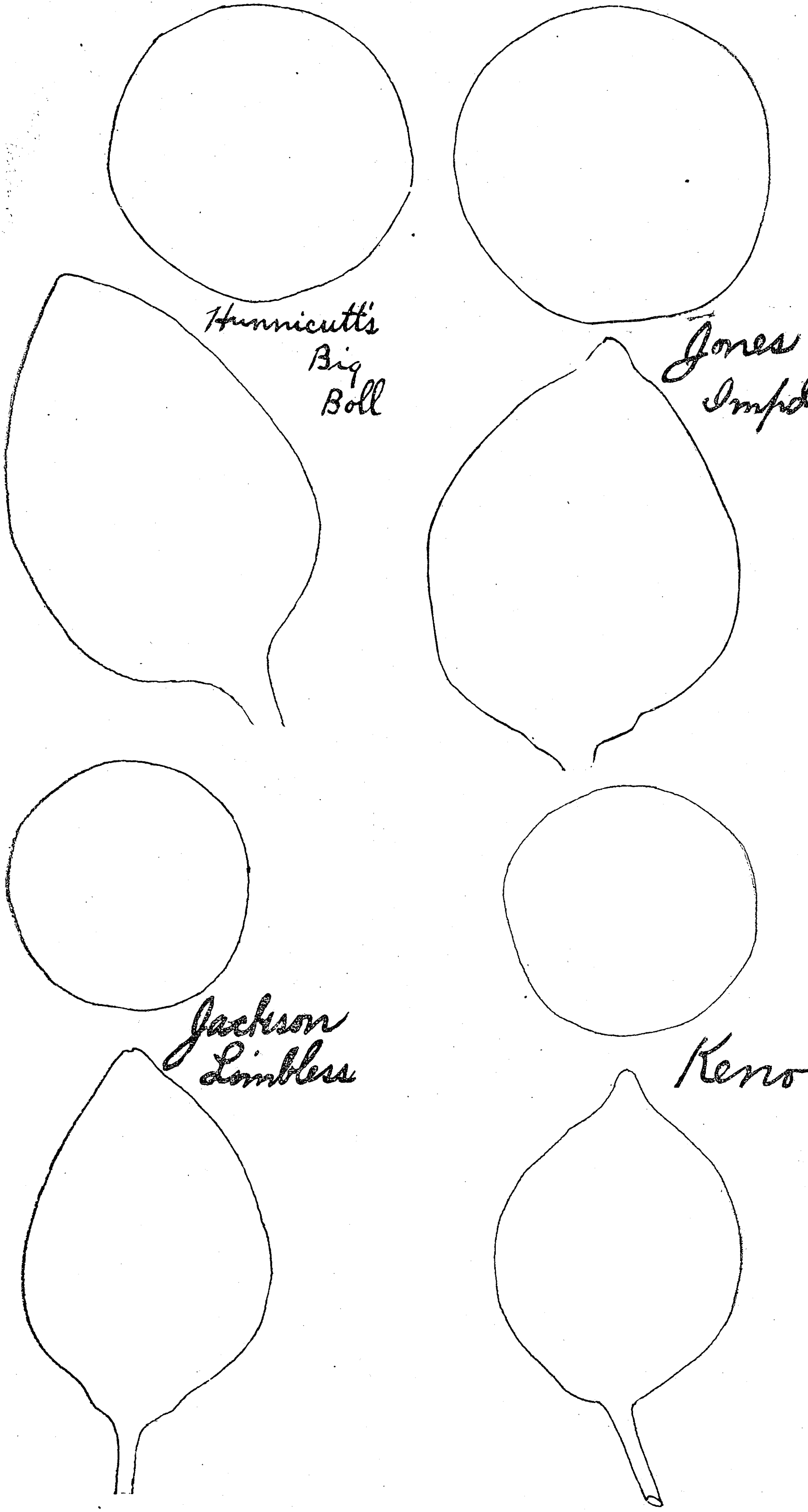
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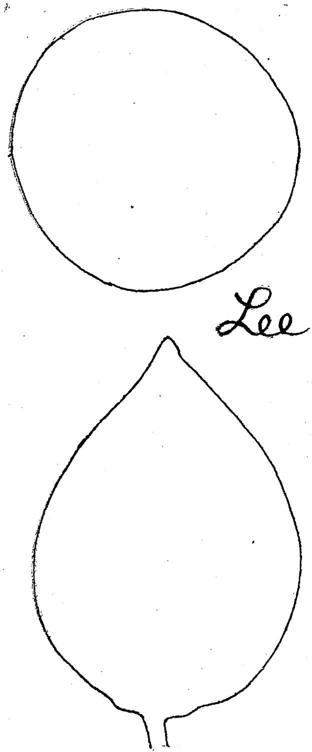
Jones Impd
Jackson Limbless
Keno



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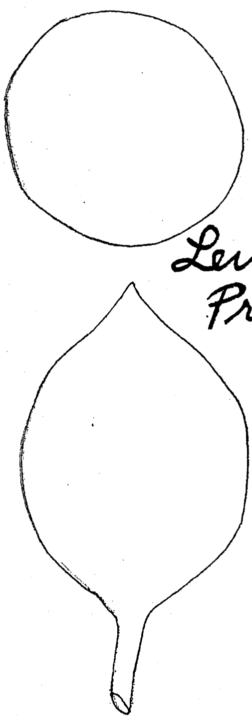

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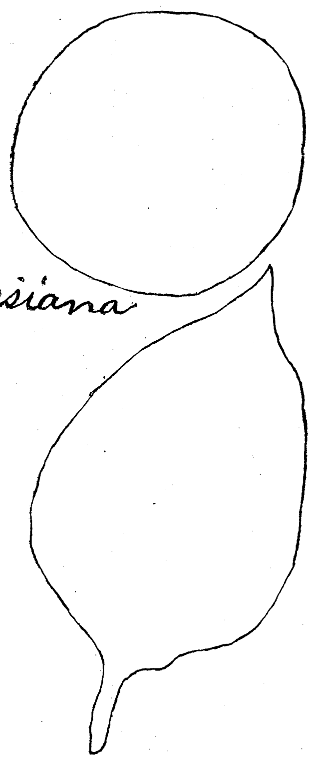

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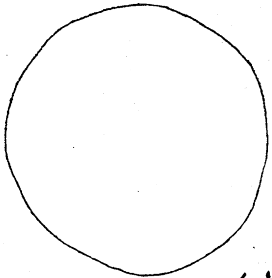

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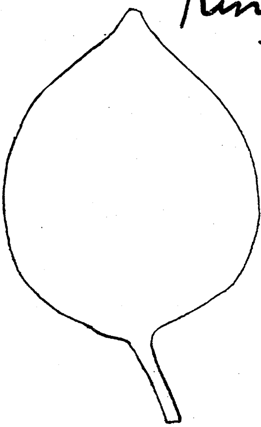

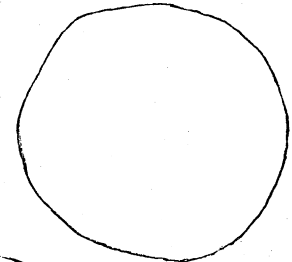

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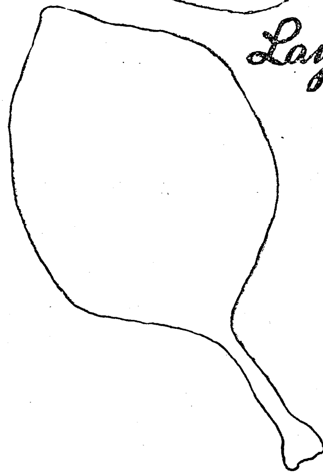
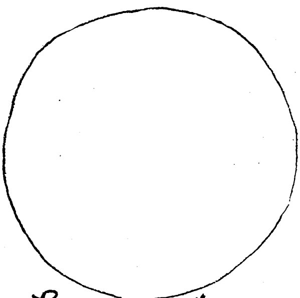
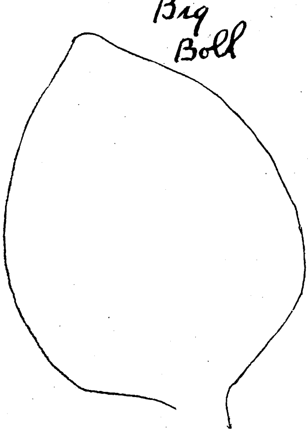
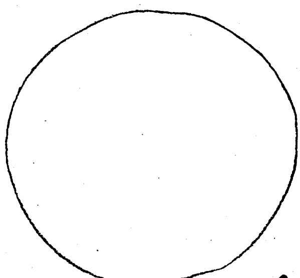




Langford's Big Boll





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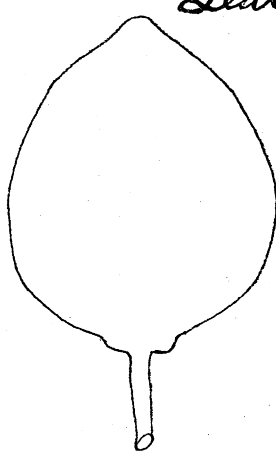

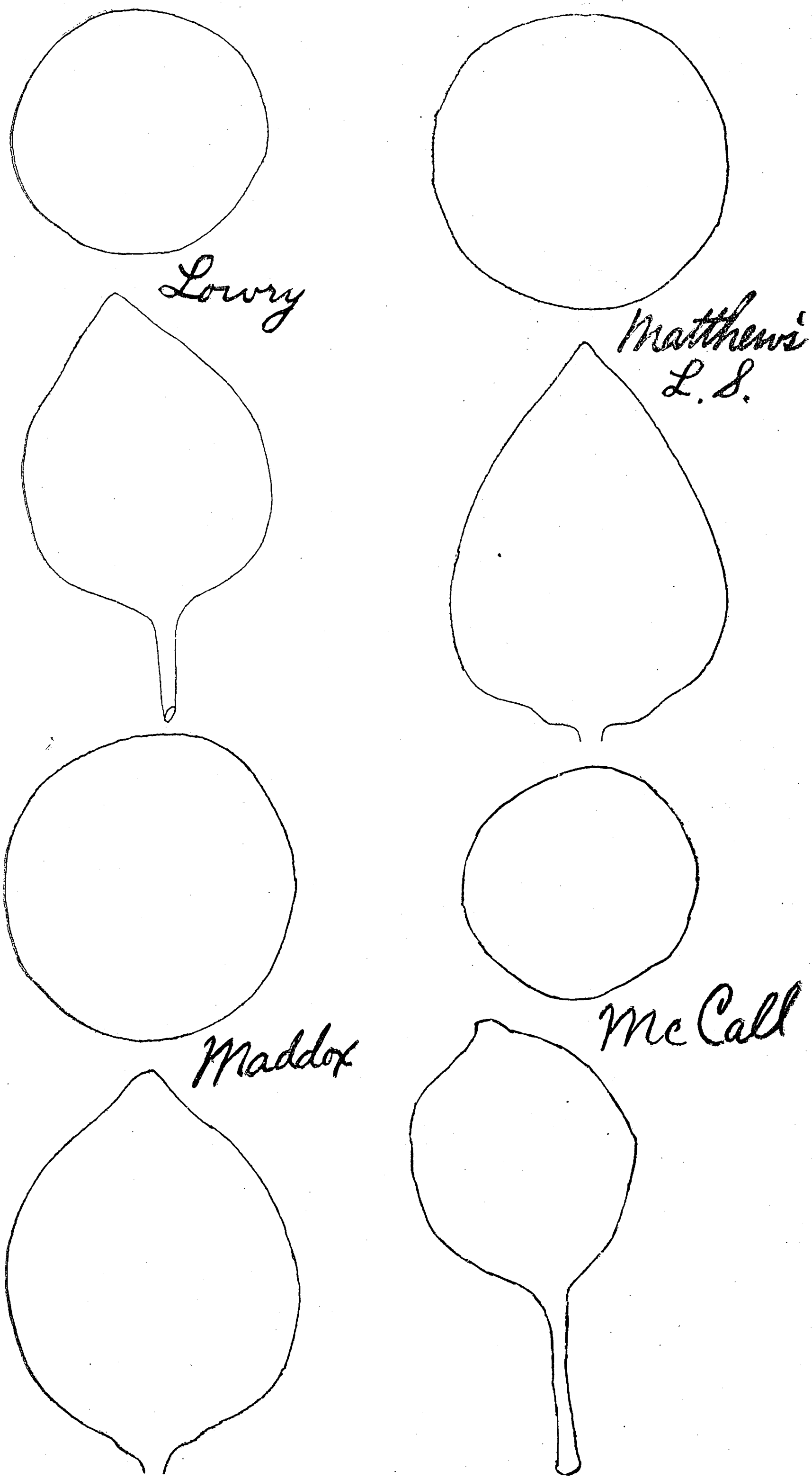
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Maddox
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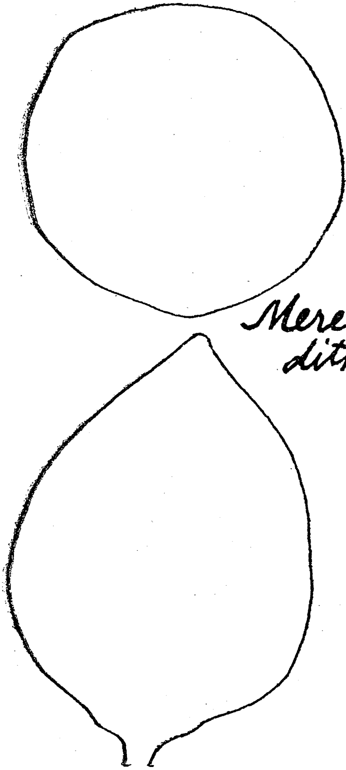

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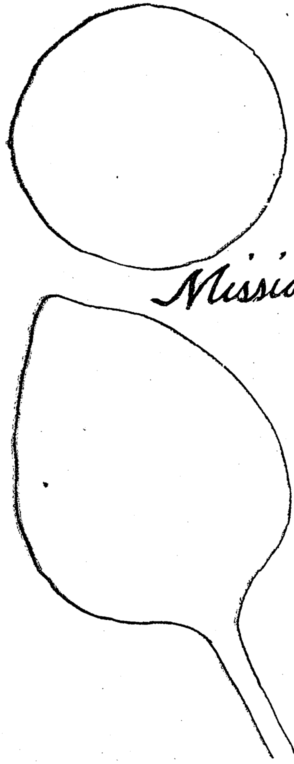

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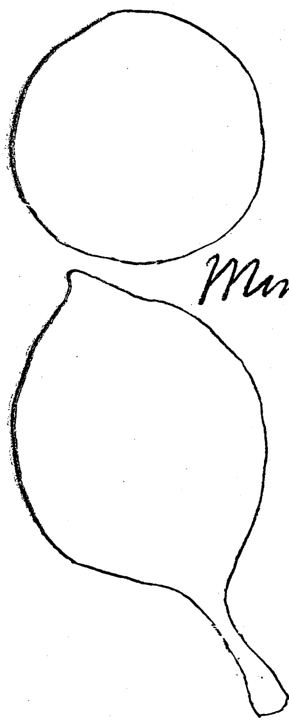

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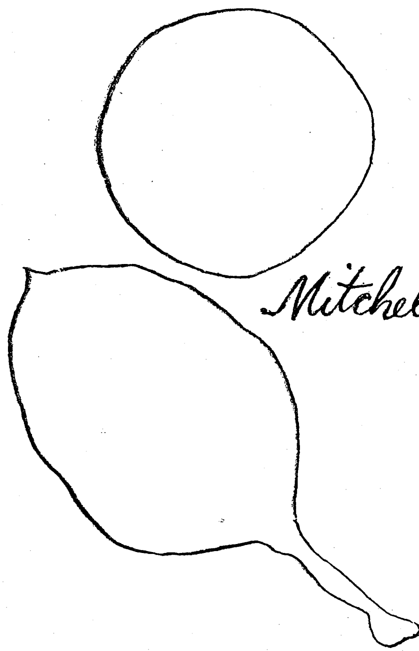

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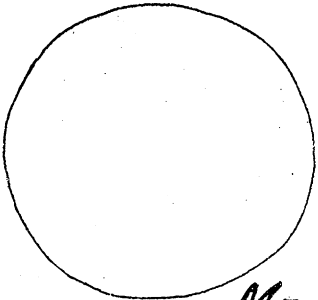

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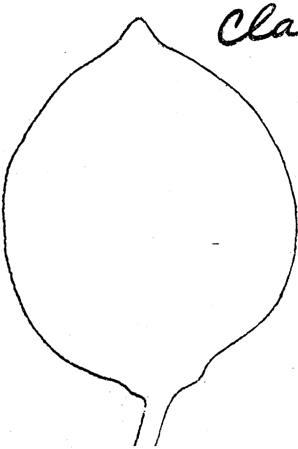

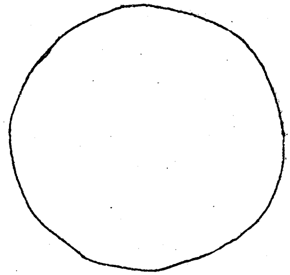

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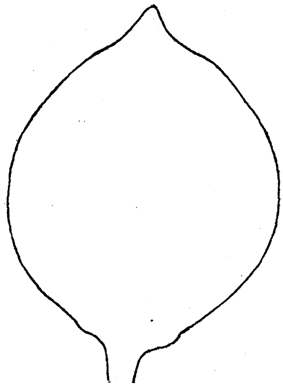

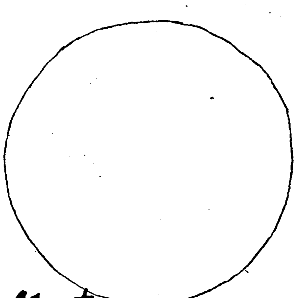

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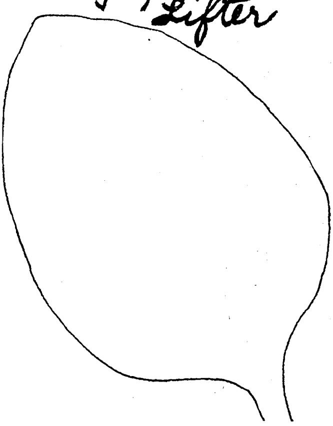

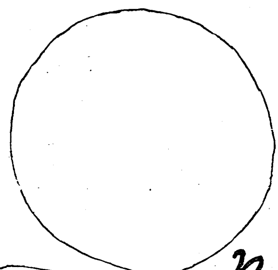

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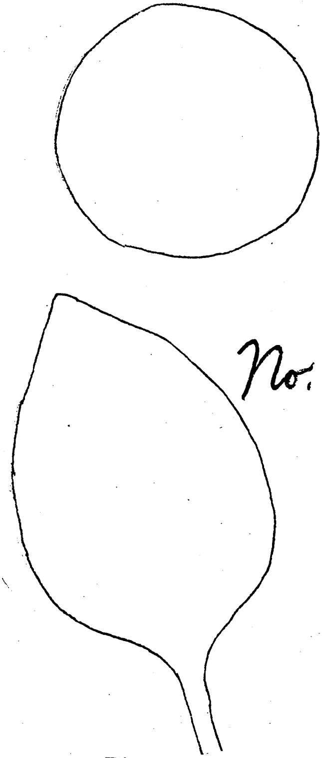
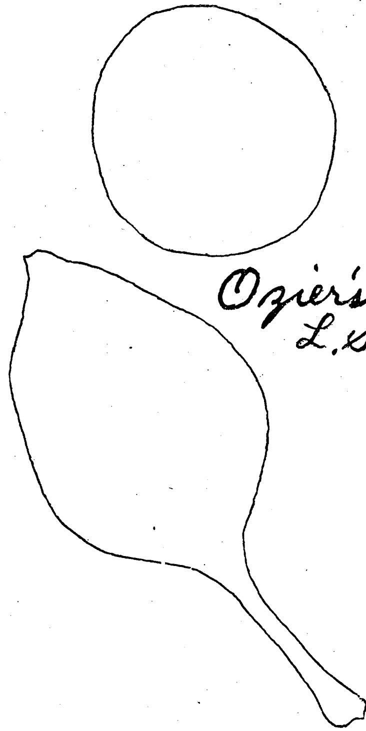


No. 148

Dixie Wilt-Resistant.



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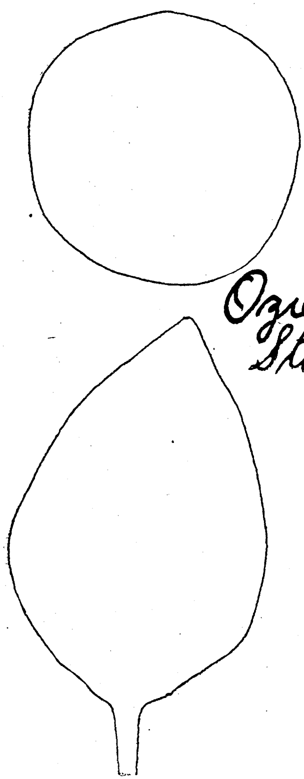

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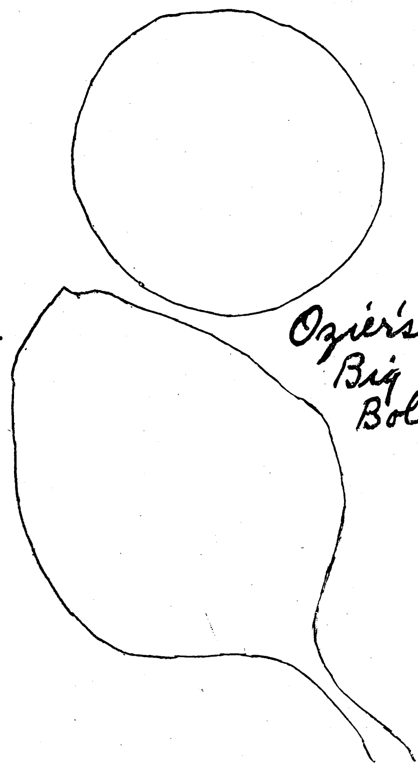

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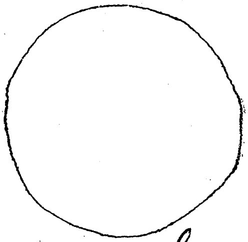

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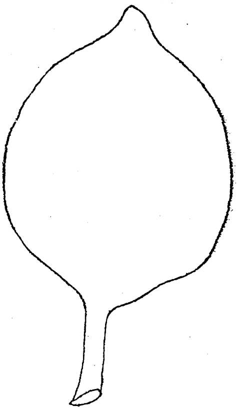

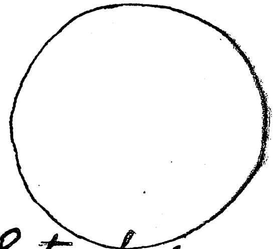

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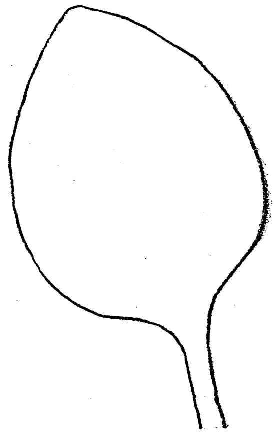

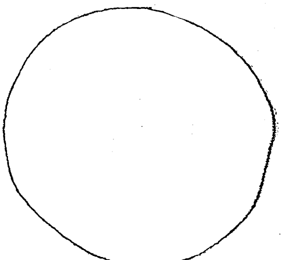

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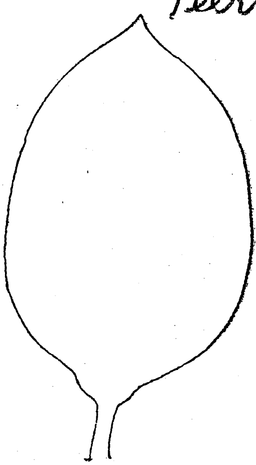

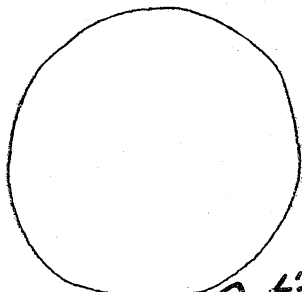

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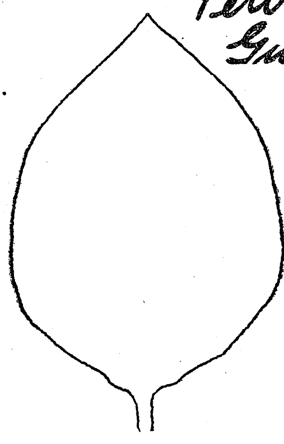

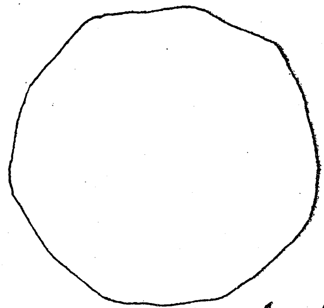

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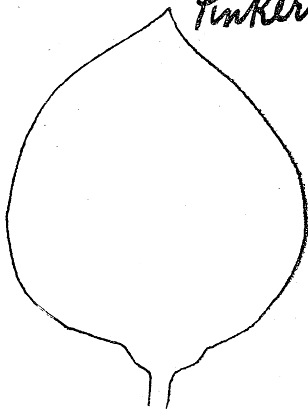

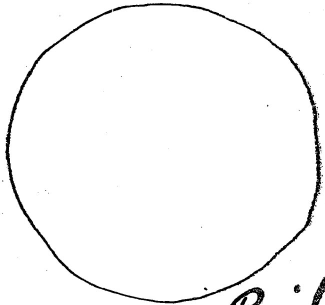

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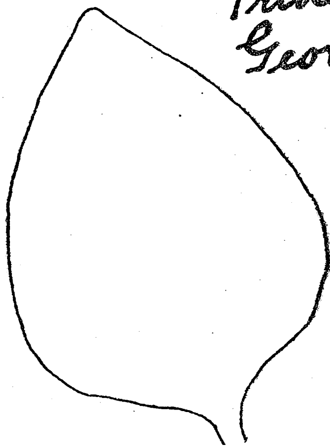

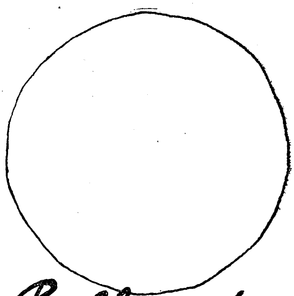

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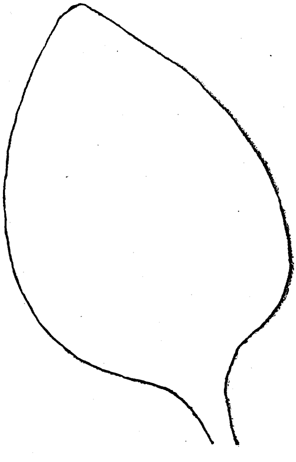

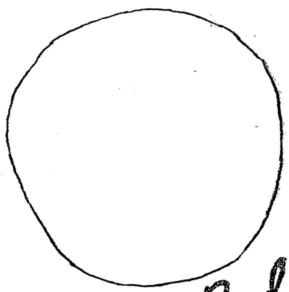

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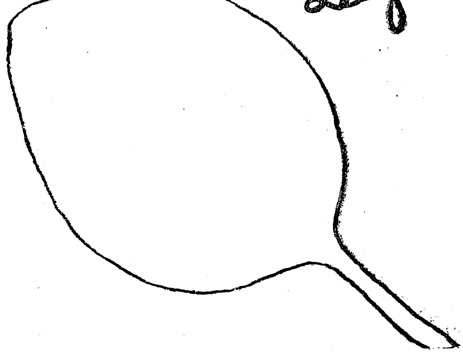

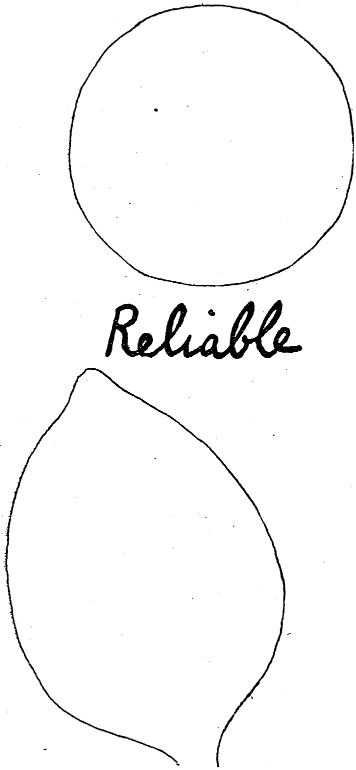

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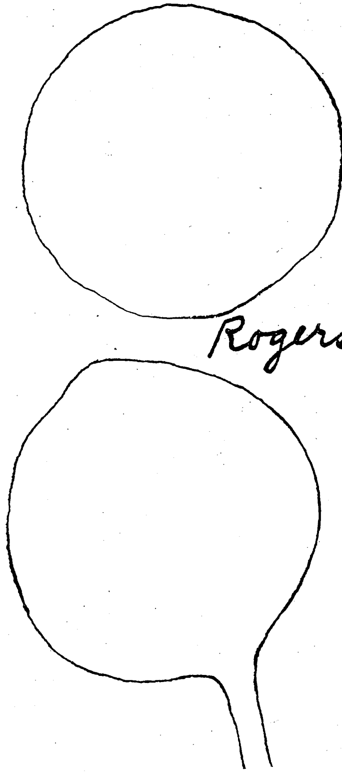

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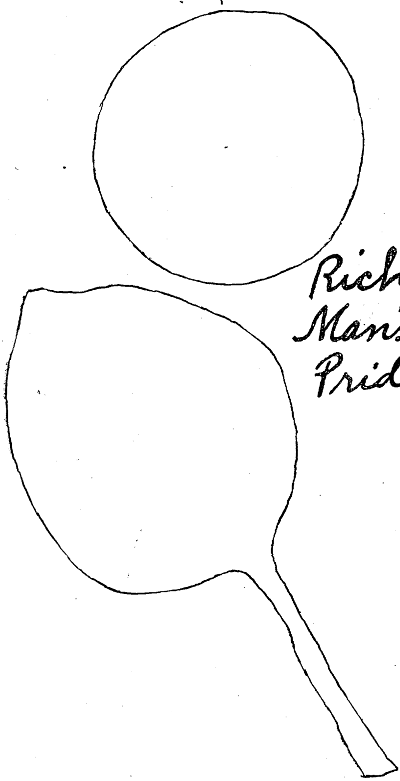

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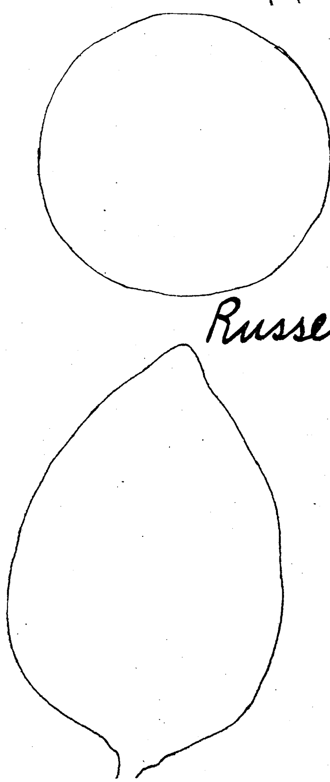

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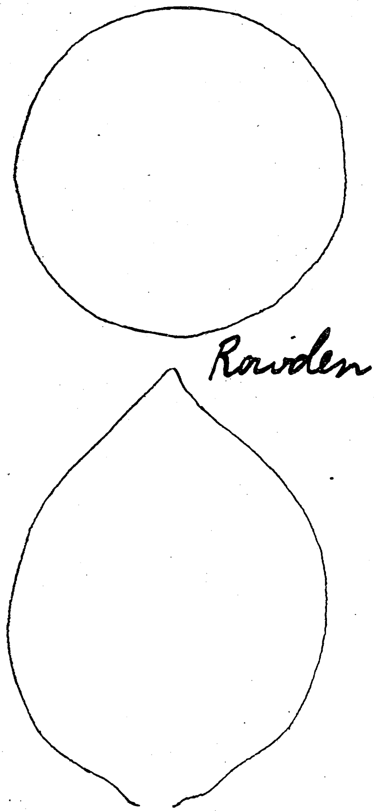
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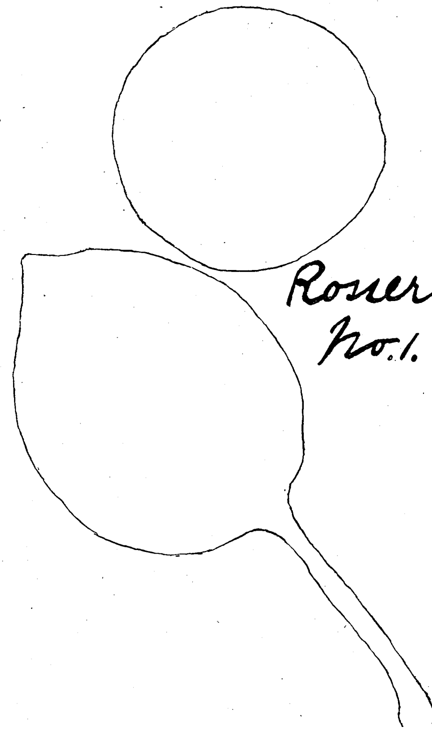
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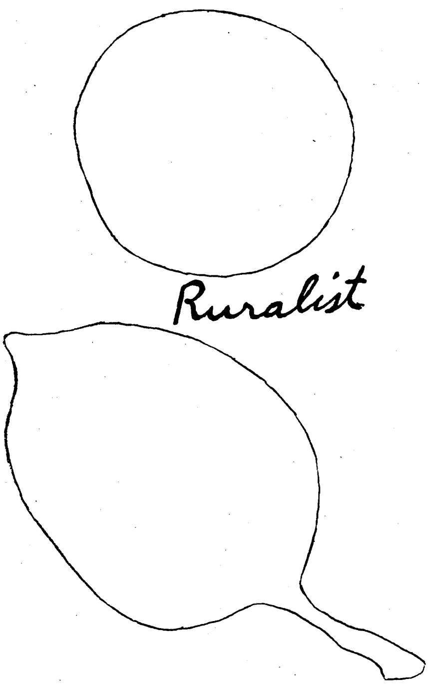
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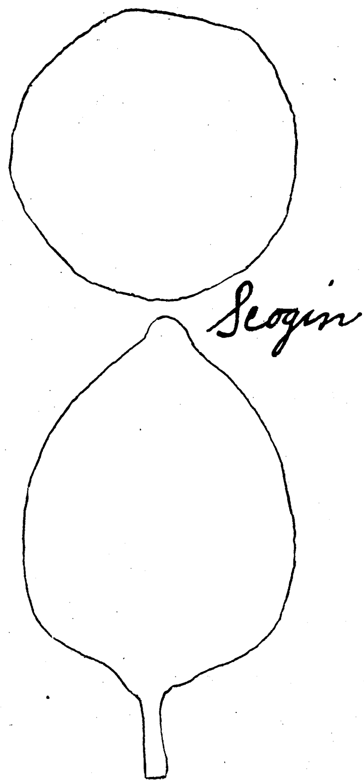
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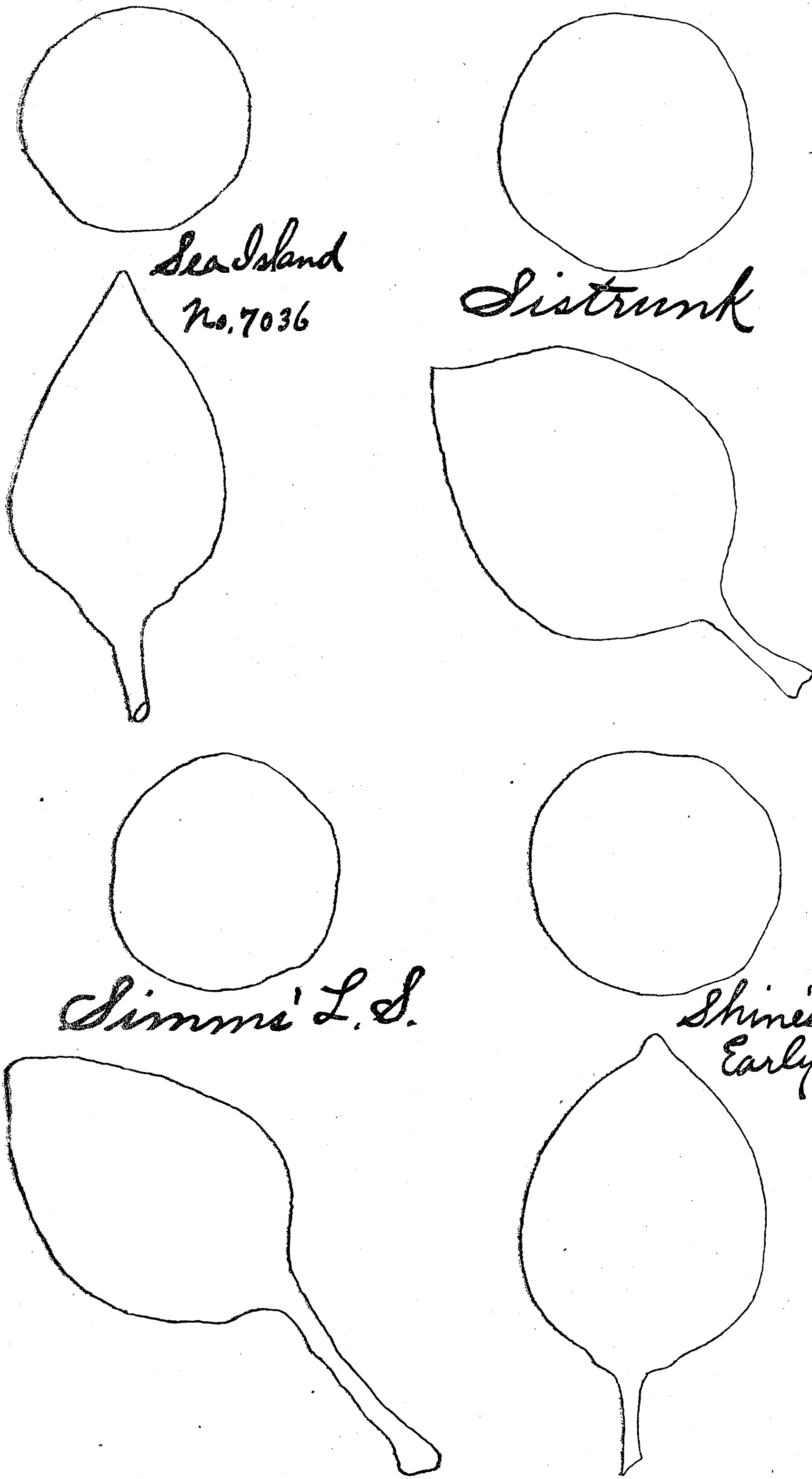
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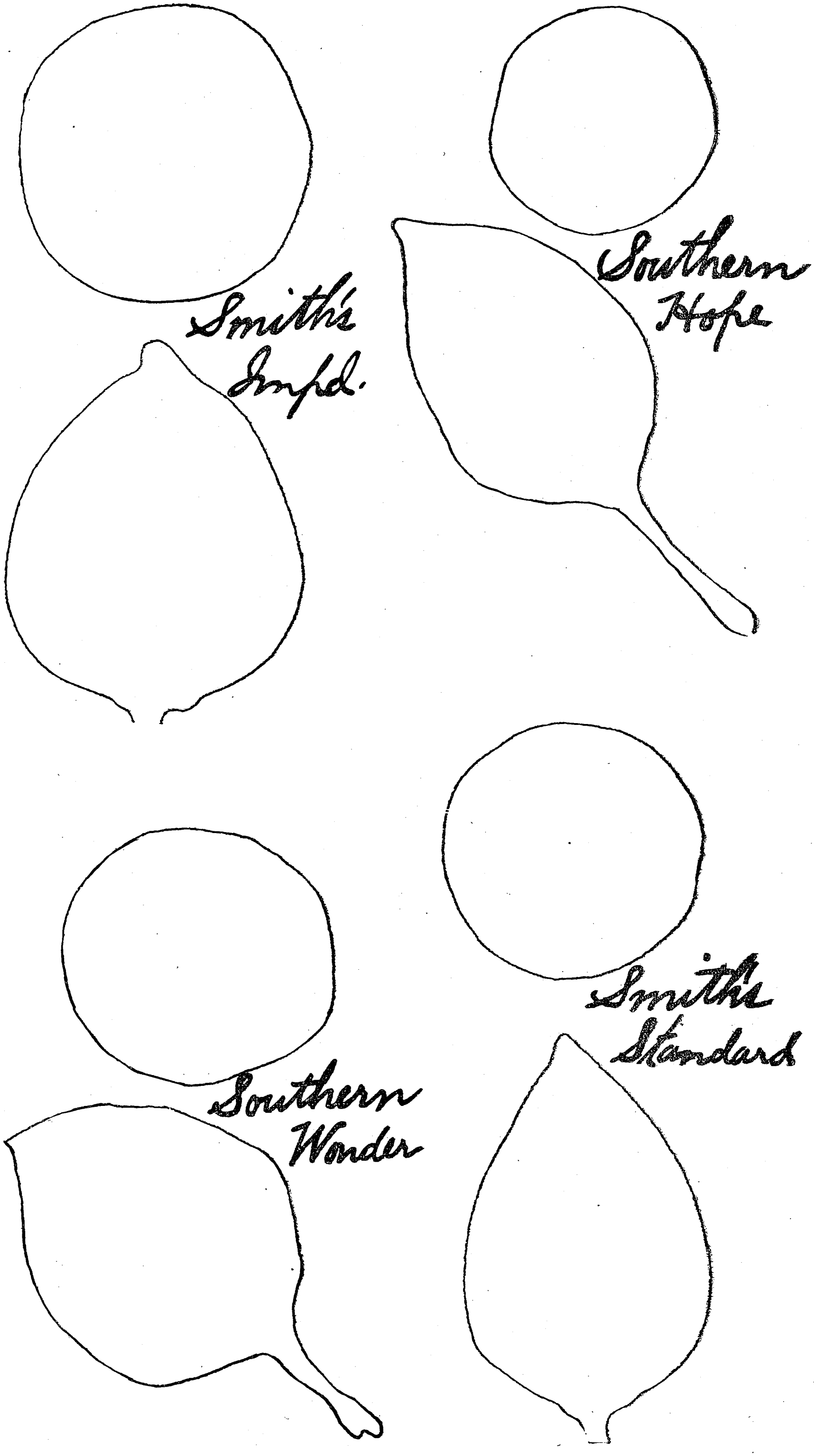
No. 7036
Sistrunk
Simms' L.S.
Shine's
Early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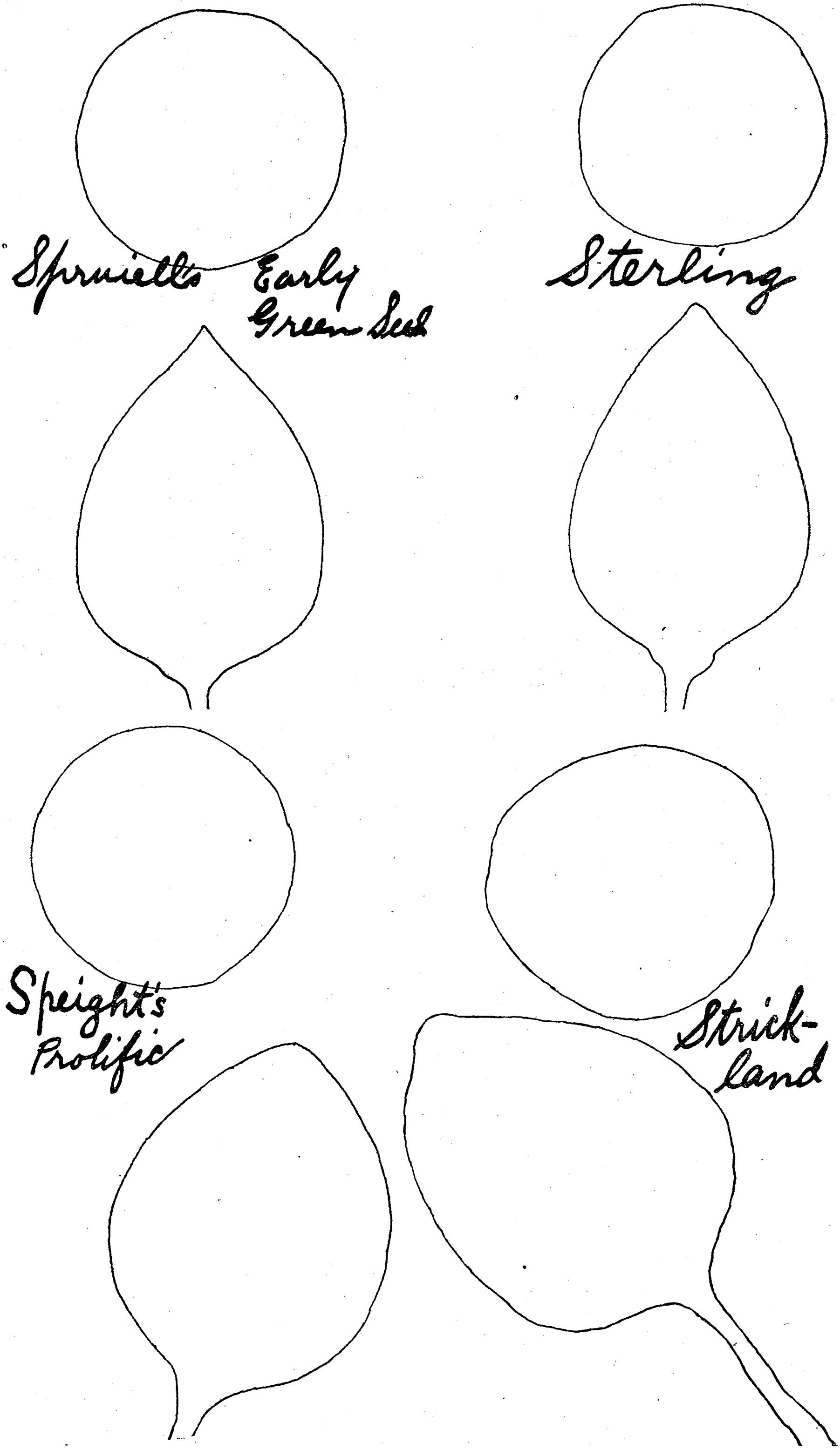
Southern Hope
Smith's Standard
Southern Wonder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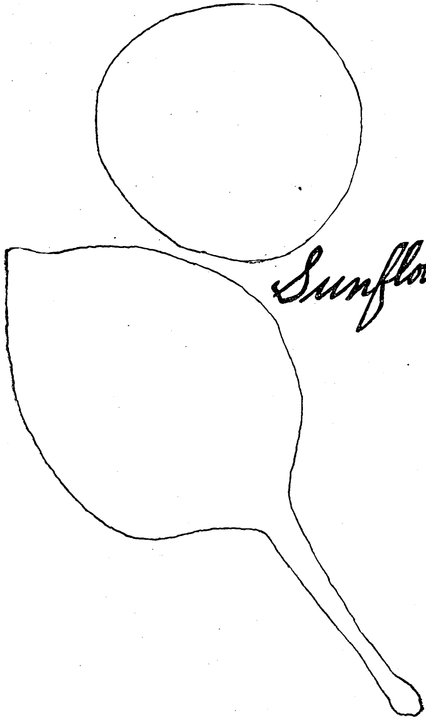
Sterling
Speight's Prolific
Strickland



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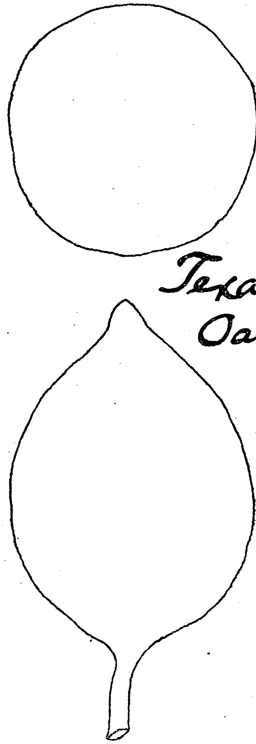

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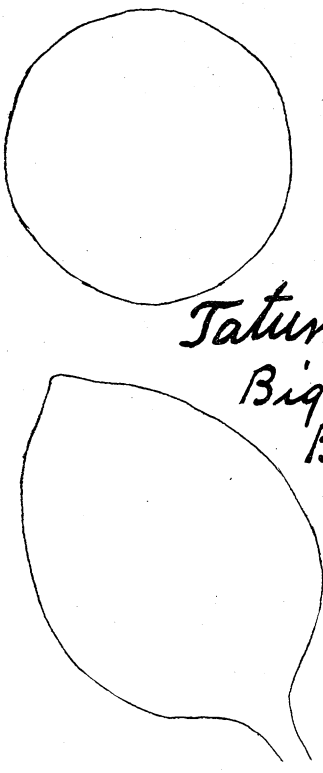

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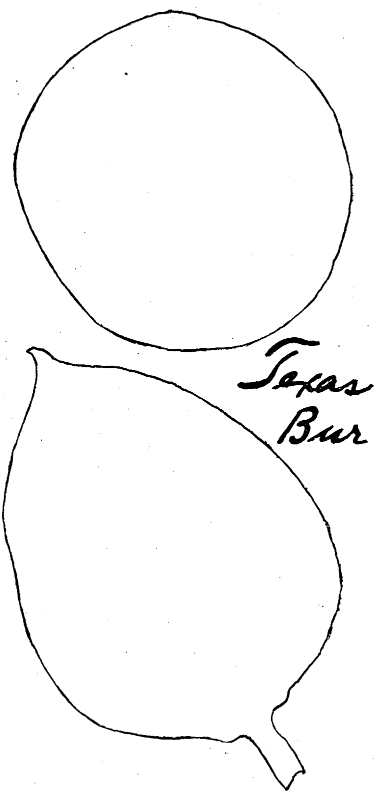

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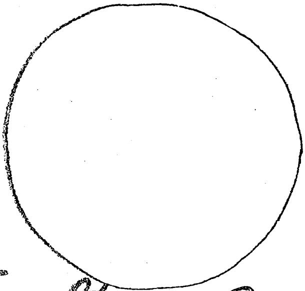

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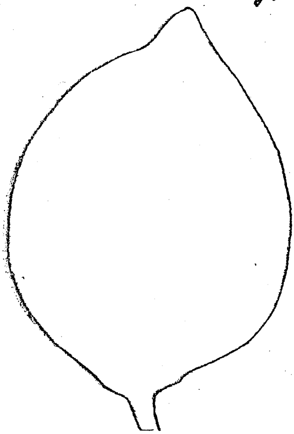

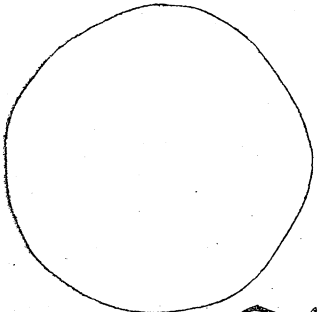

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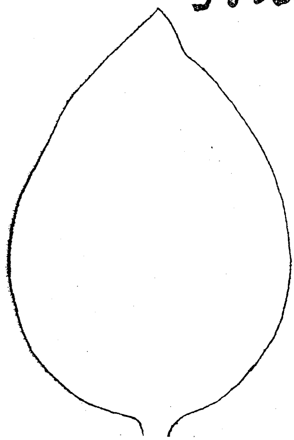

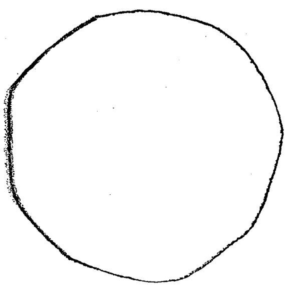

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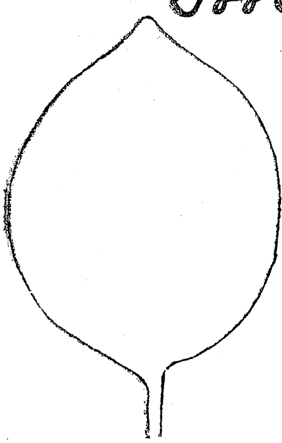
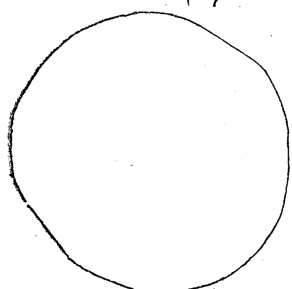
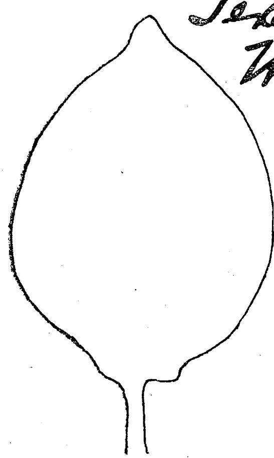
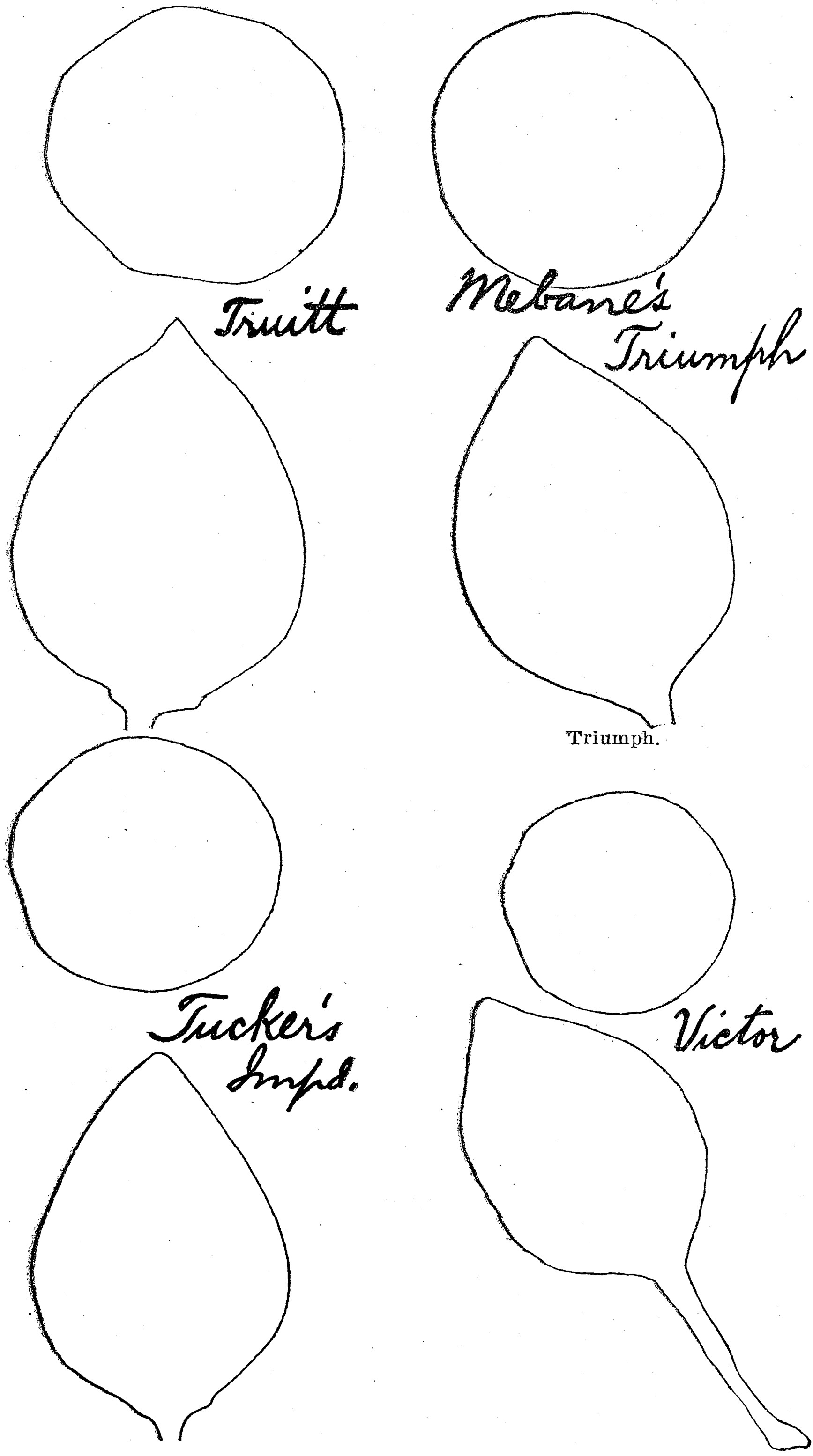
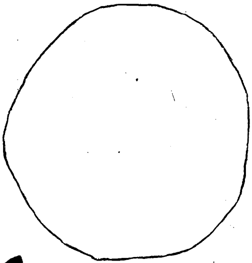




Texas Wood




Truitt
Mebane's Triumph
Triumph.
Tucker's Impd.
Victor



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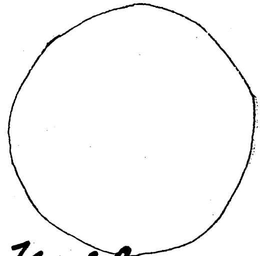

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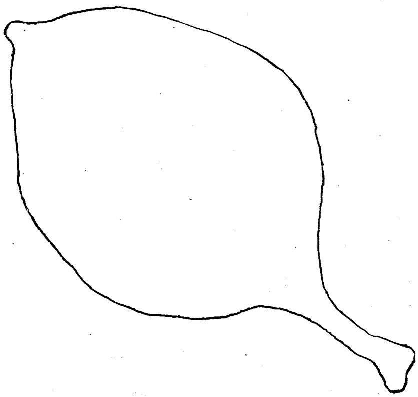

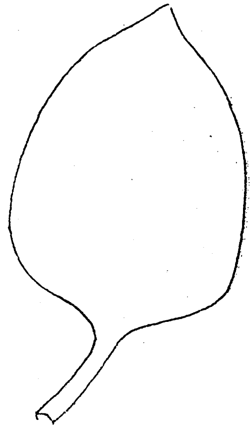

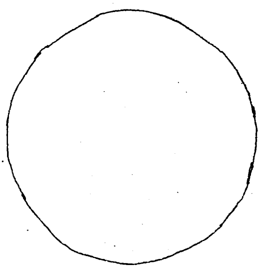

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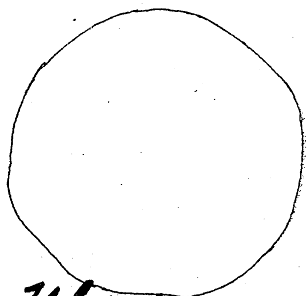

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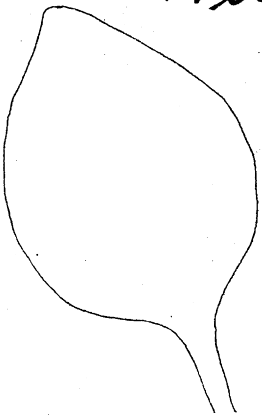

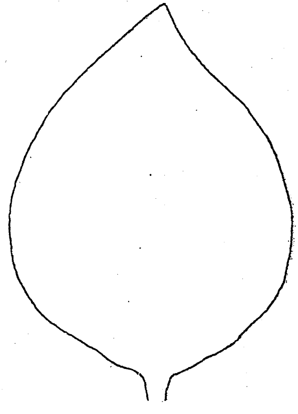

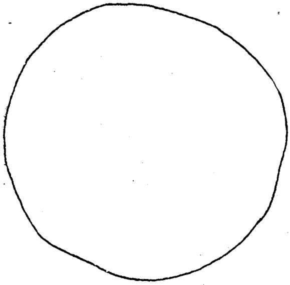

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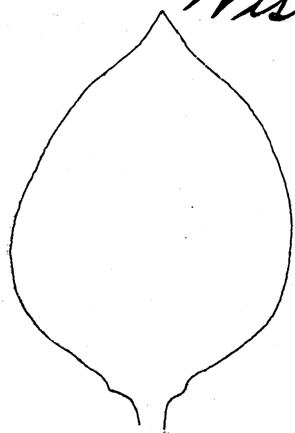

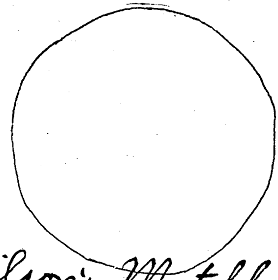

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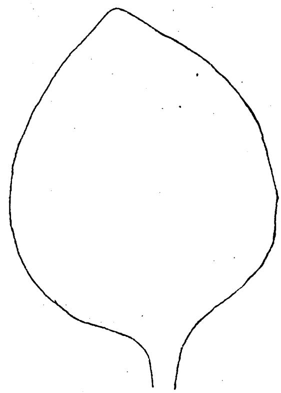
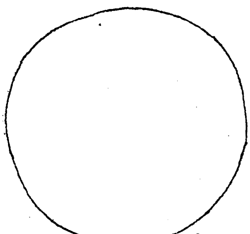
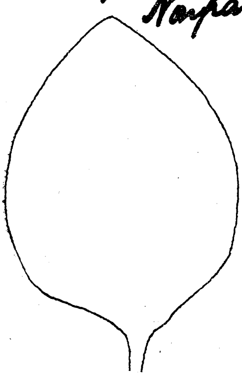
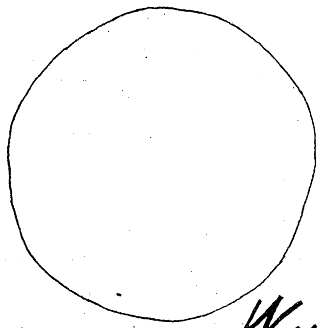


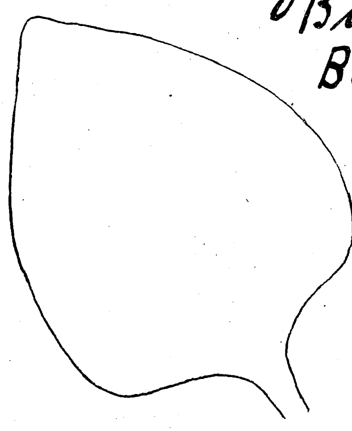


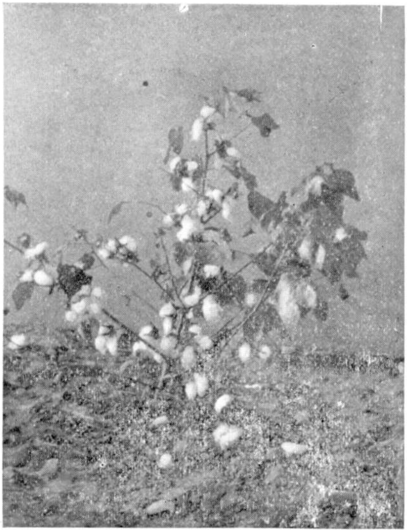
Woodfin's Nonpareil





Wyche's Big Boll





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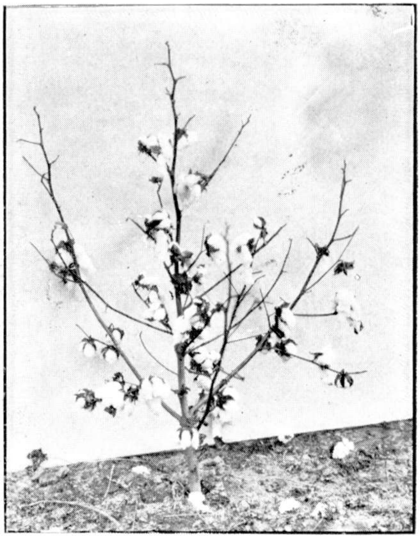

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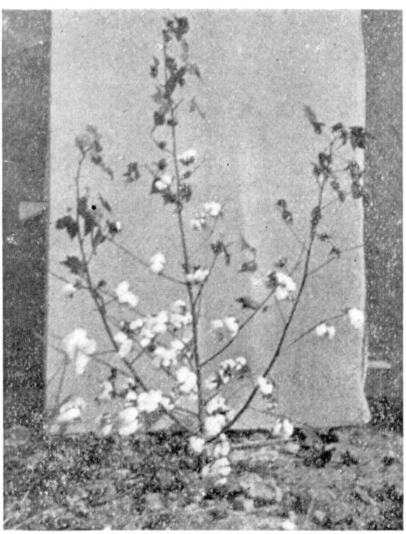

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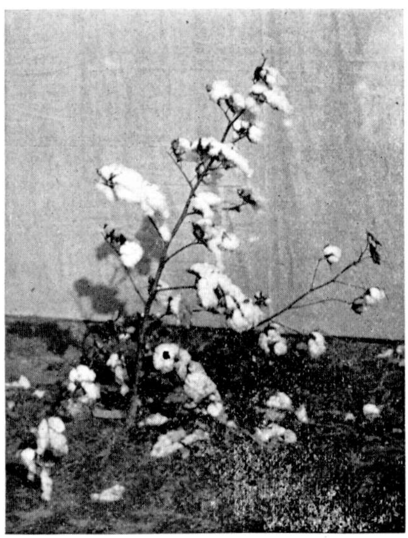
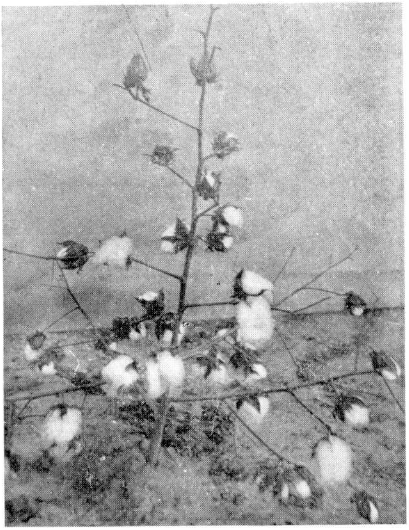


Anson Cream.

PLATE II.



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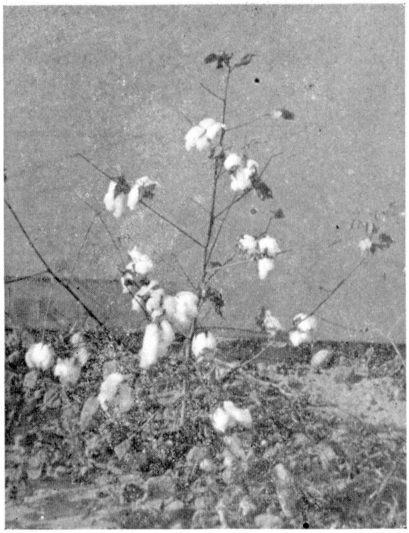

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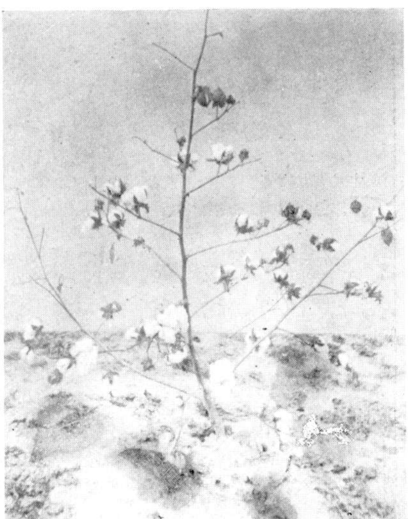

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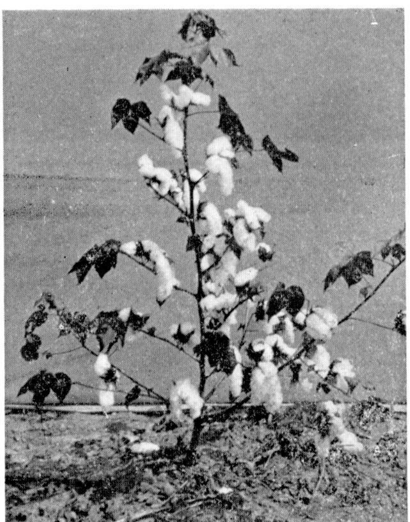

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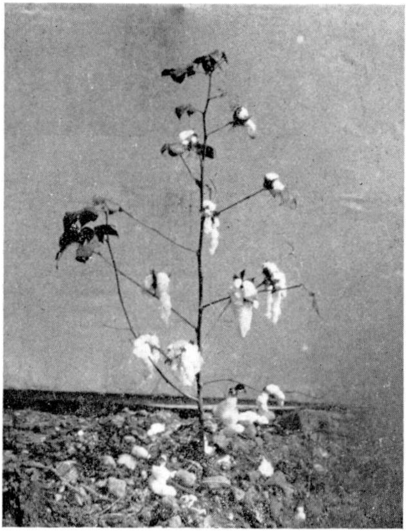

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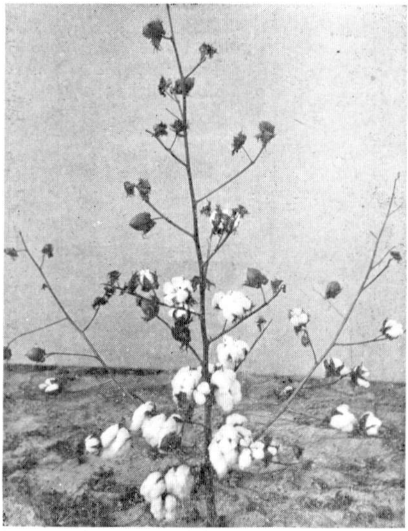

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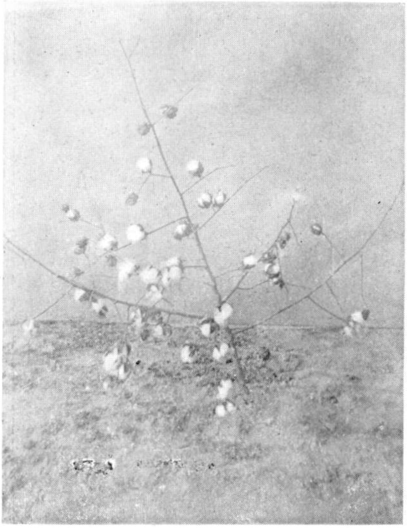

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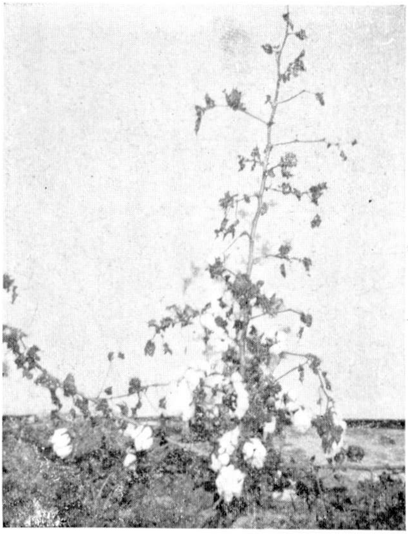
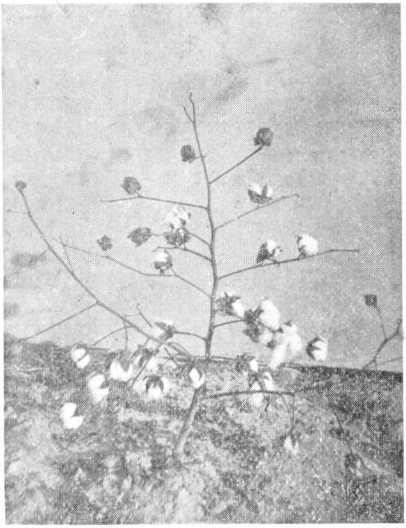


Boyd.

PLATE IV.



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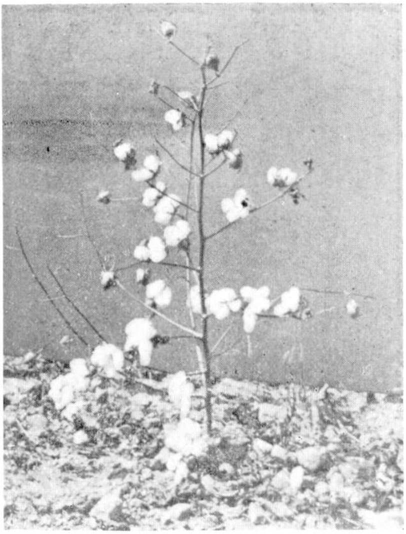

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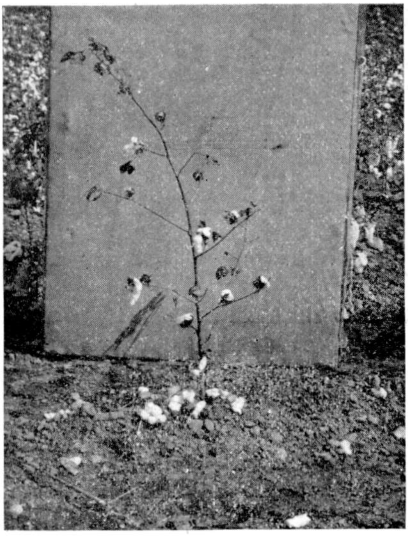

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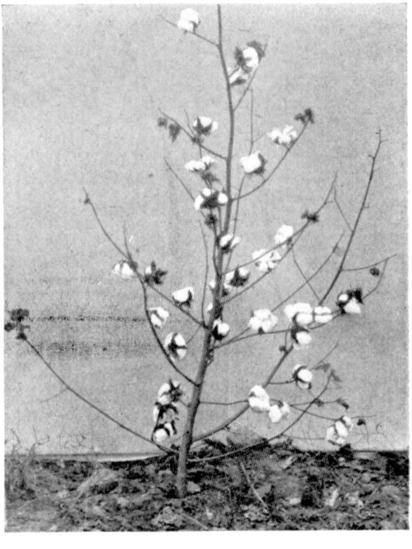

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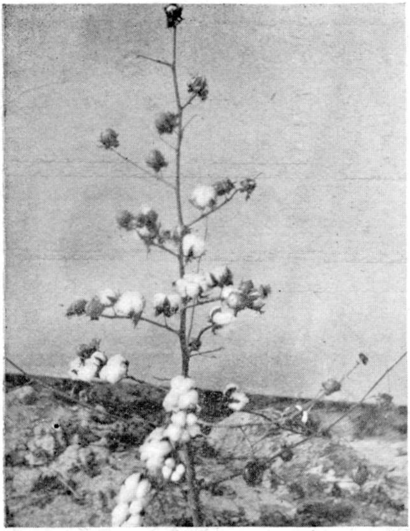

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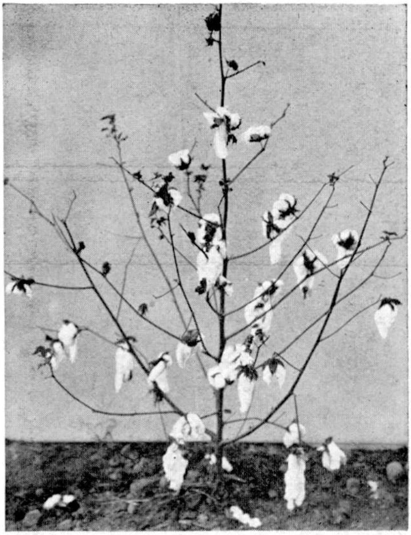

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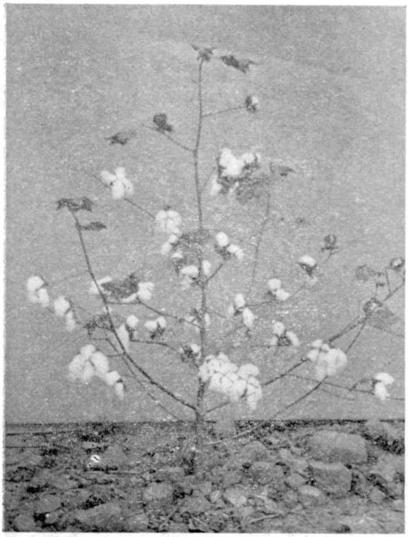

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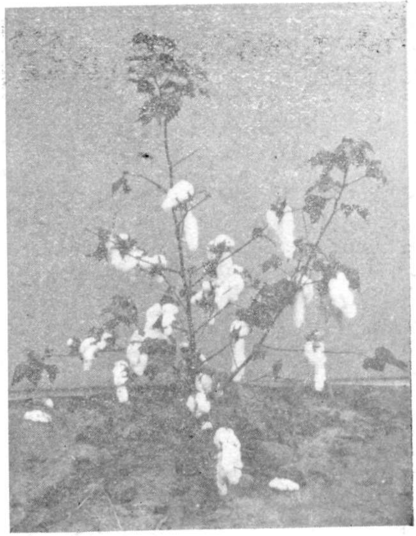
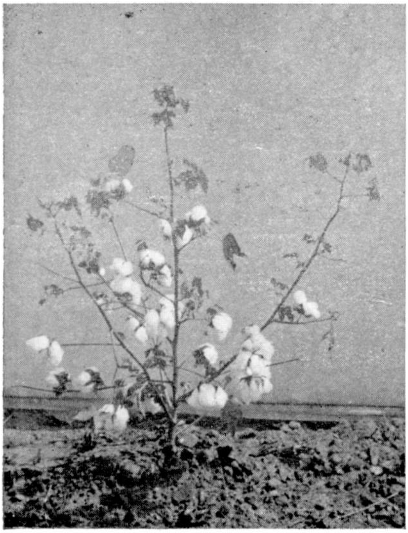
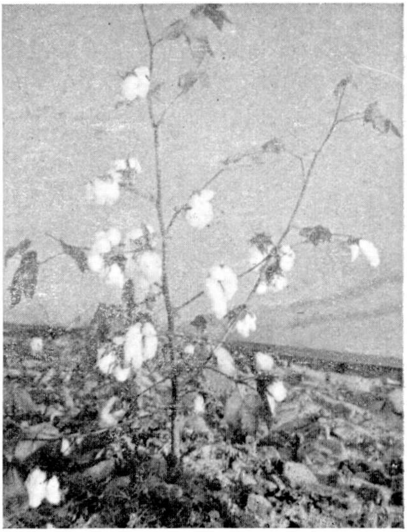


Cameron.

PLATE VI.



Carolina Queen.



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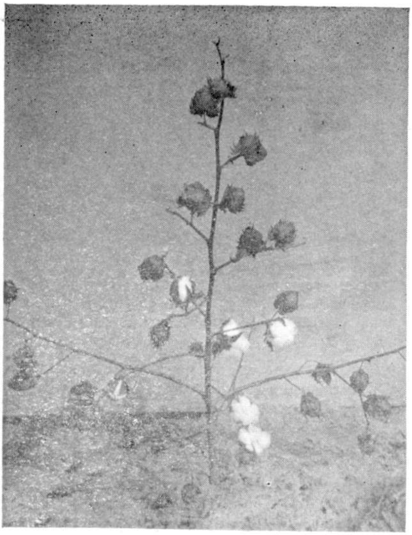

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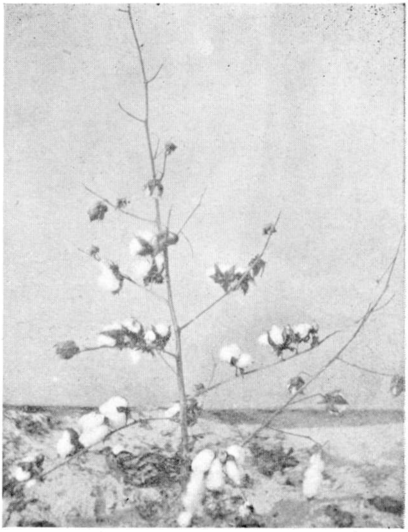

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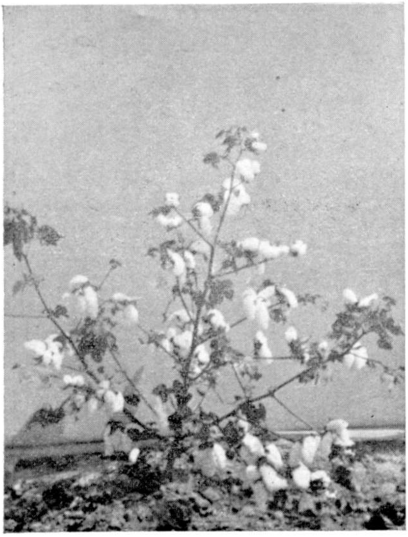

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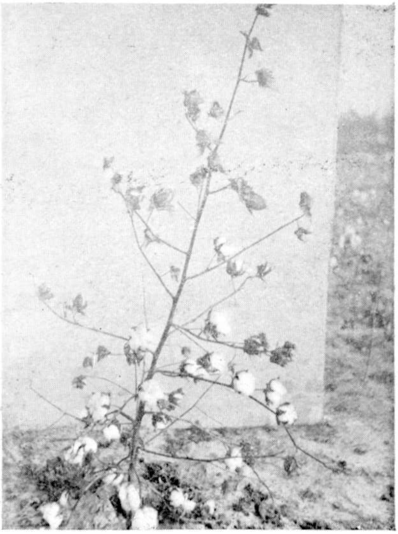
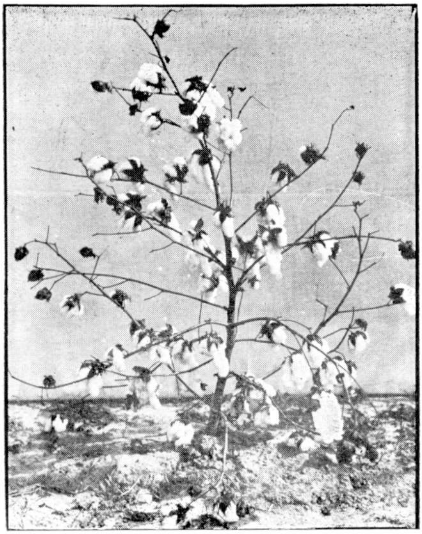
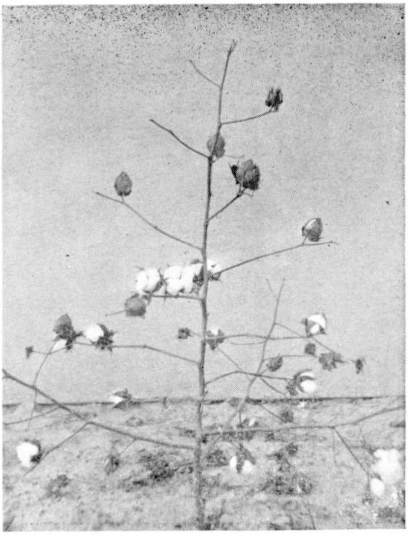


Cook Long Staple.

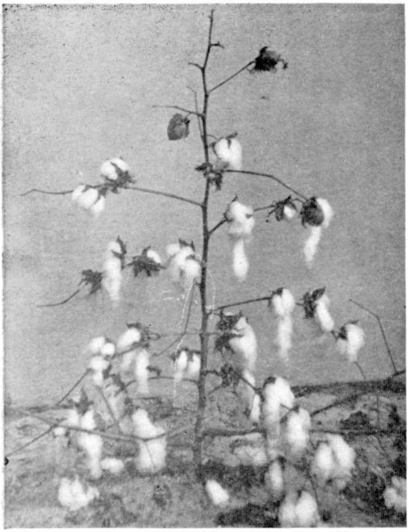


Cook Improved.



Crossland.

PLATE VIII.



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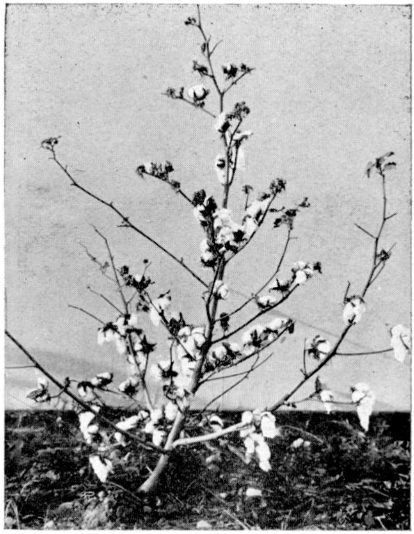

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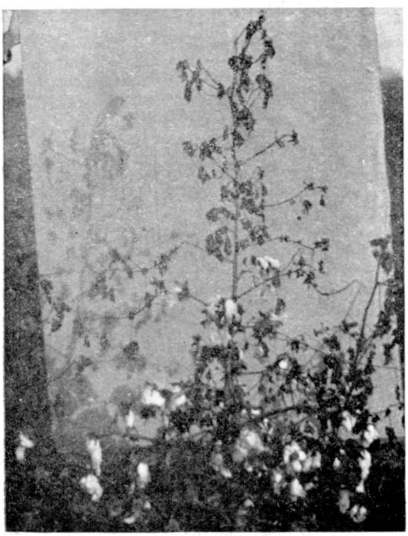
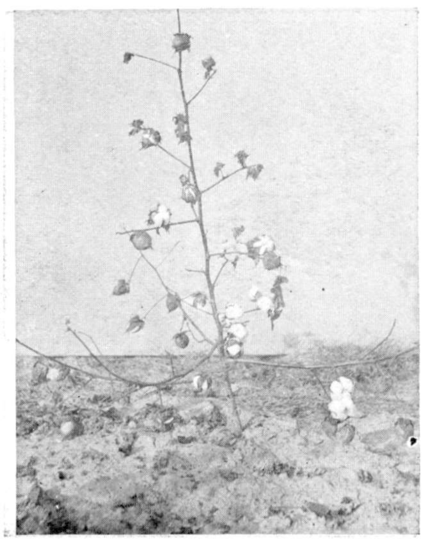
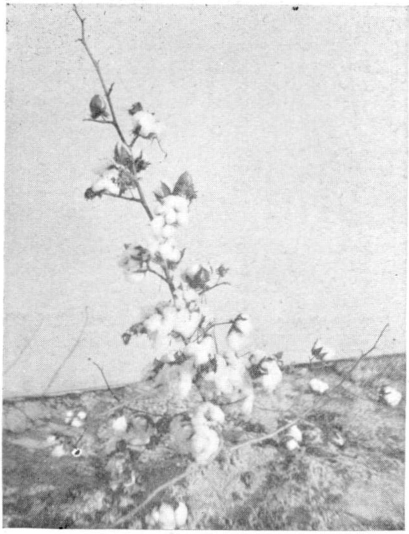


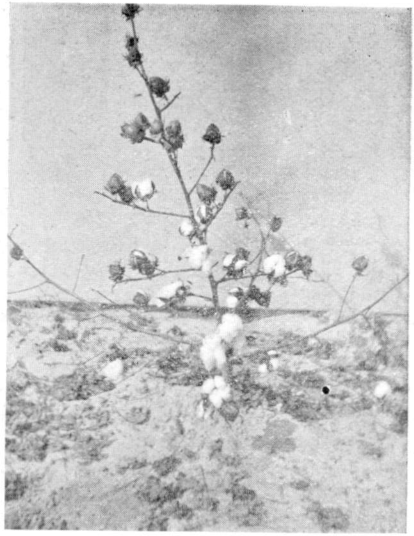
Davis Long Staple.



Diamond Six Lock.



Dickson.



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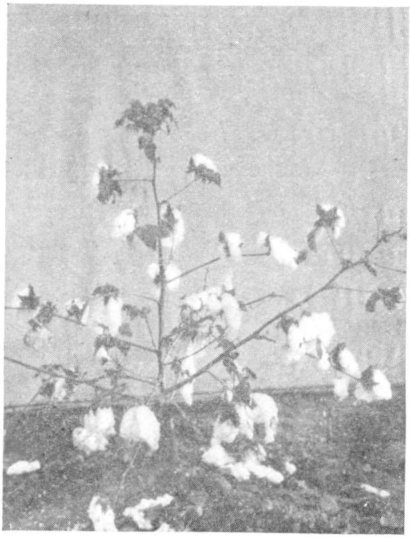

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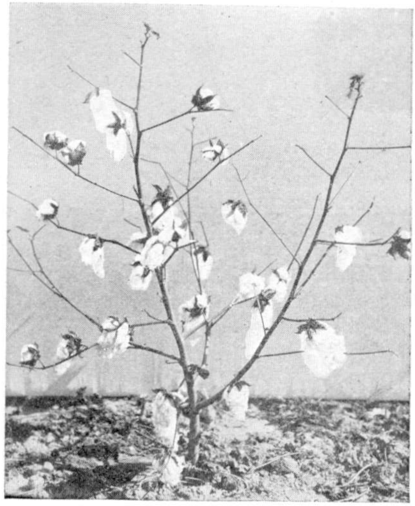
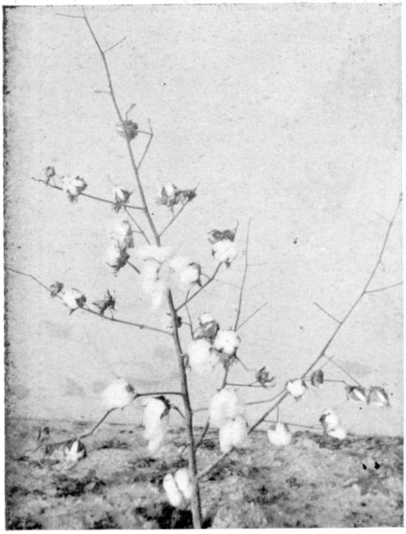


Double Header.

PLATE X.



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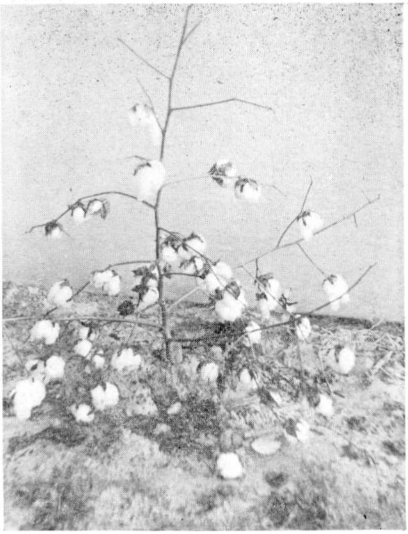

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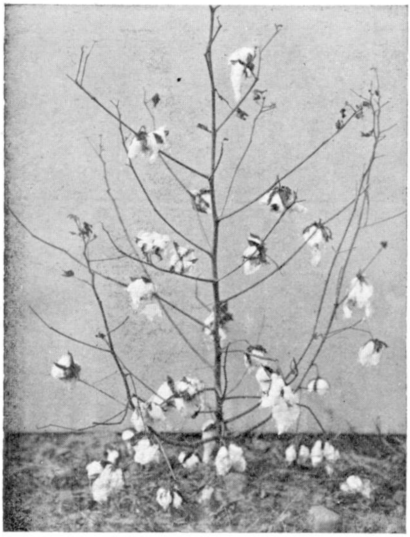

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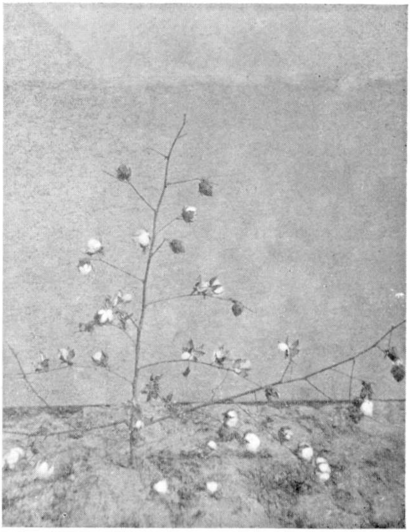
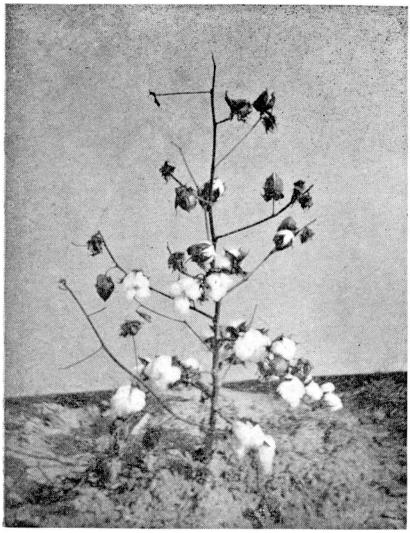


Duncan.

PLATE XI.



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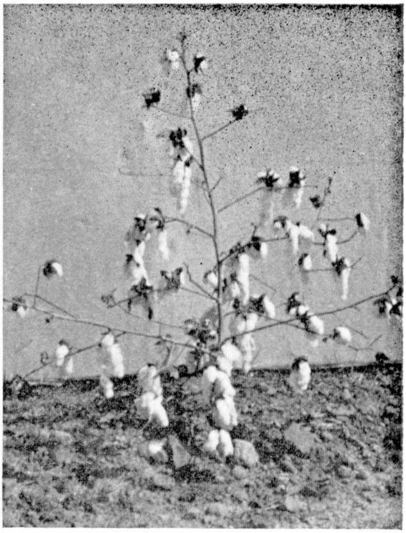
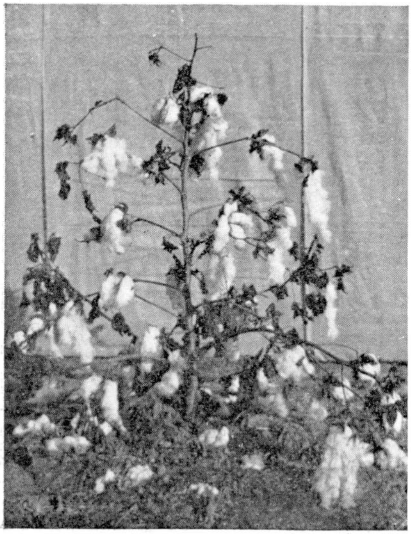


Excelsior.



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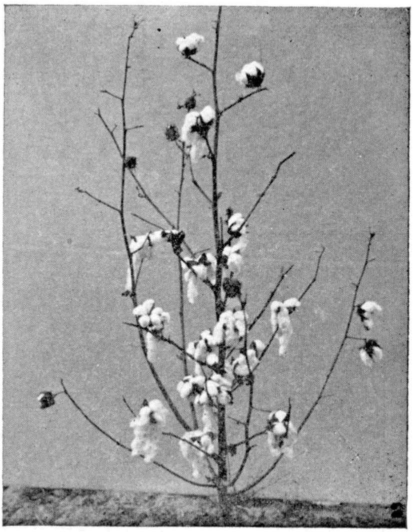
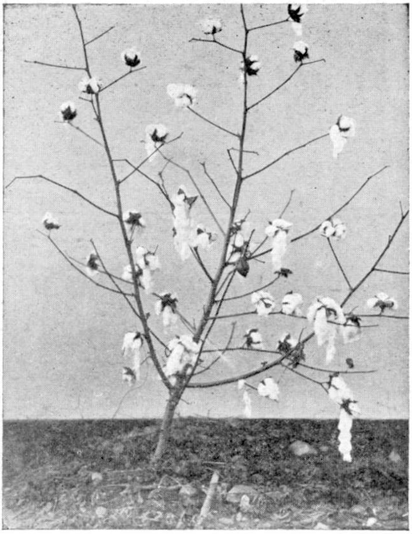


Extra Early.

PLATE XII.



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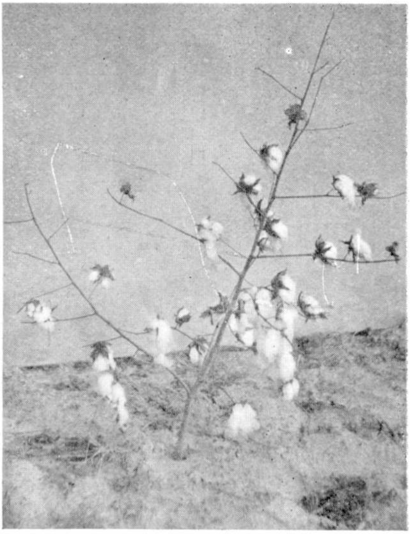

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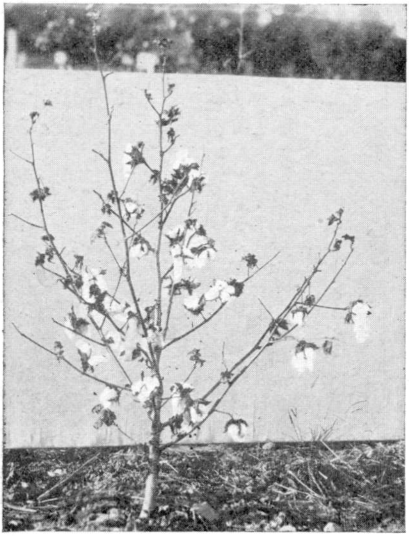

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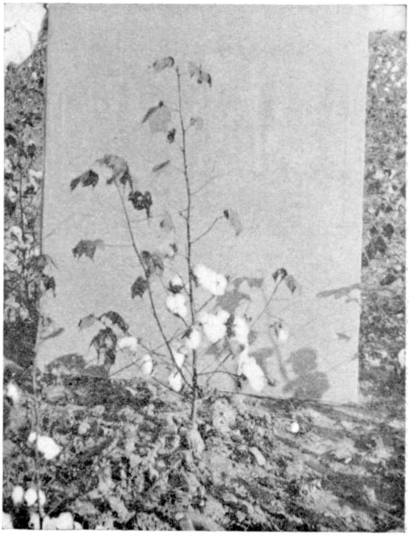

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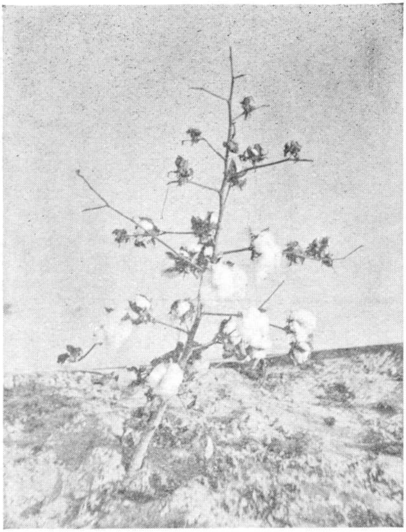
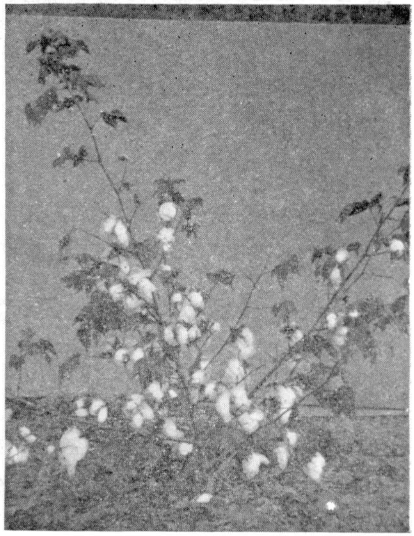


Garrard.



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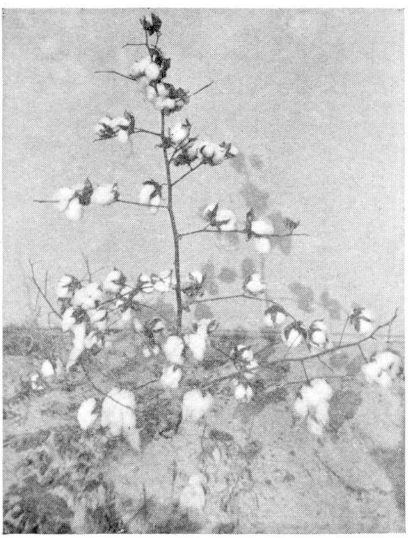

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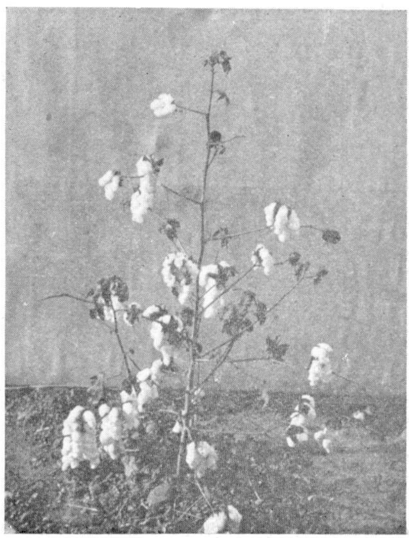
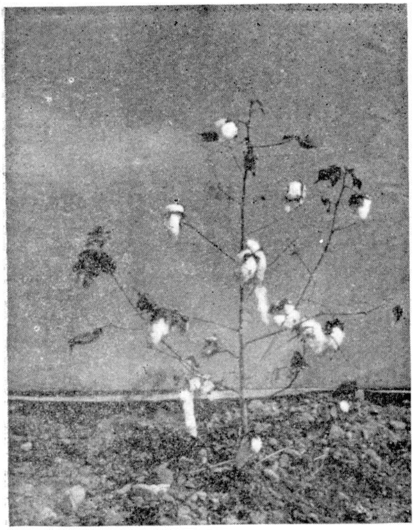
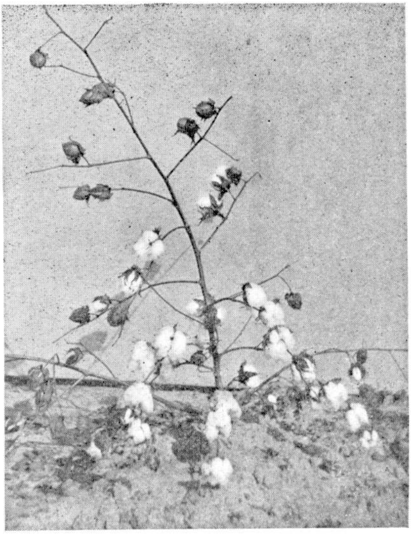


Gold Standard.

PLATE XIV.



Gregg.



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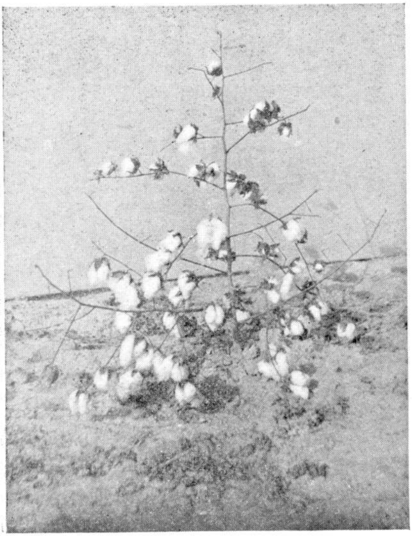

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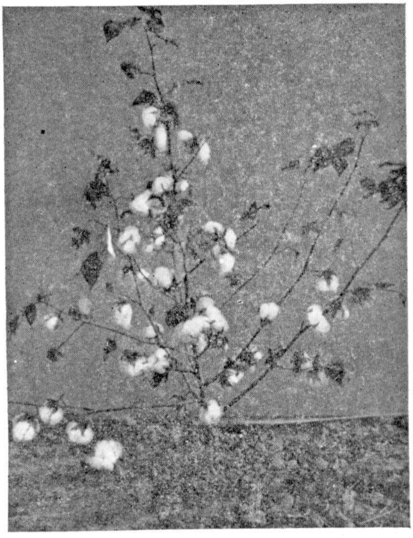

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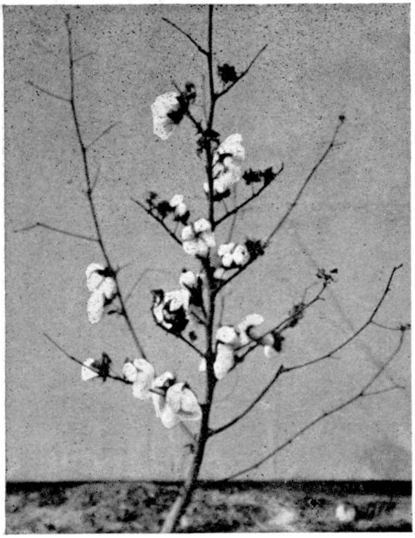

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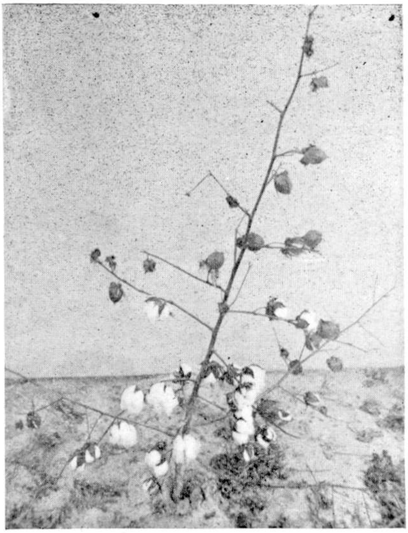

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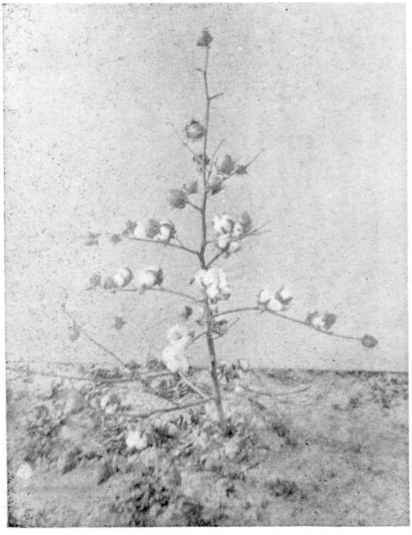

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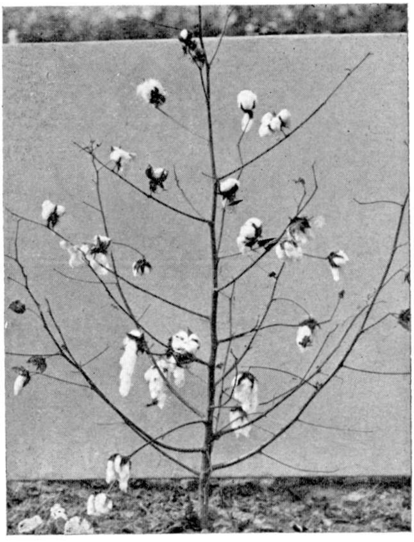
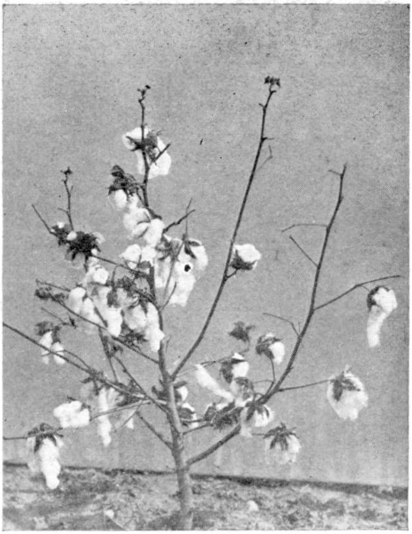


Hodge.

PLATE XVI.



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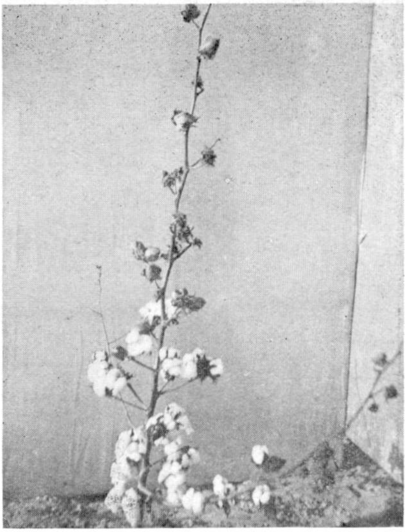
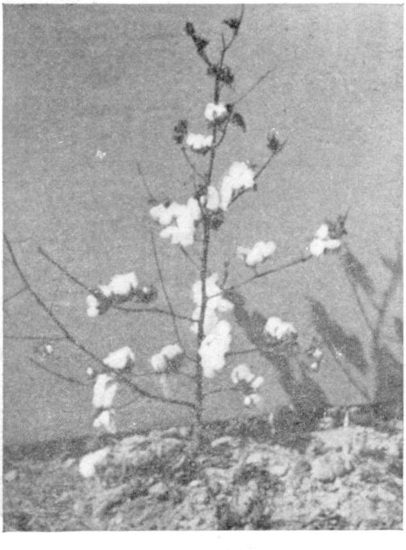


Jackson.



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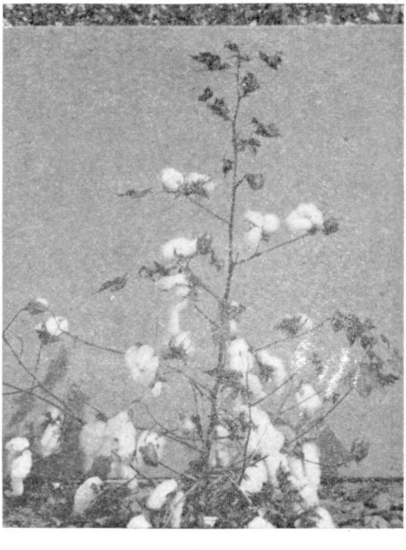
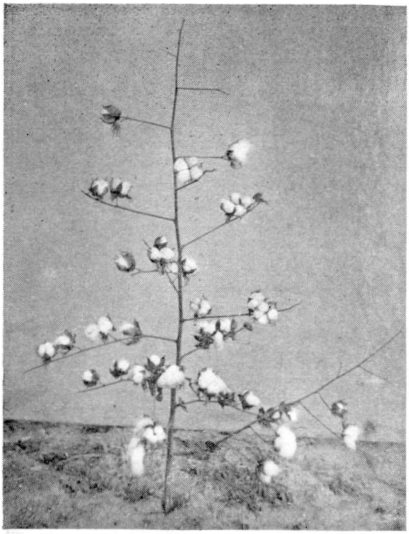


Jones Improved.



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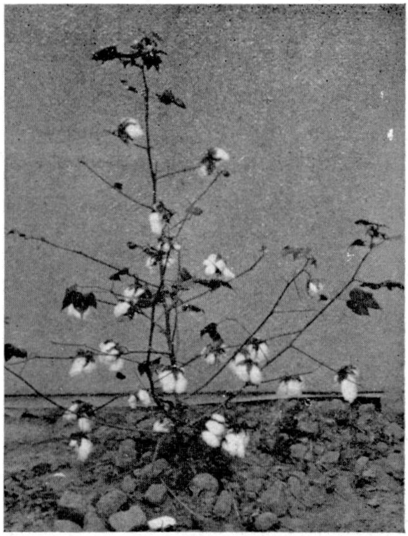

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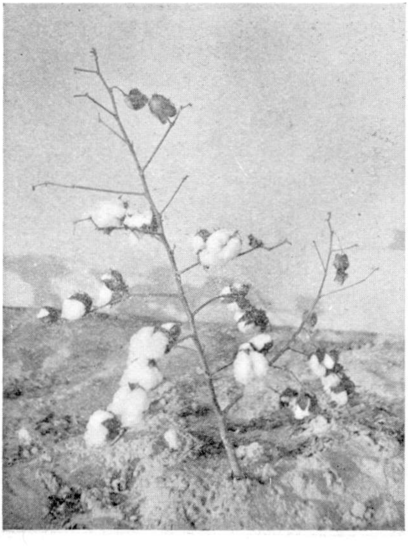

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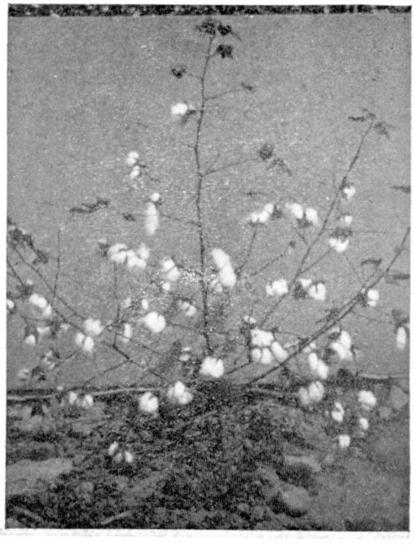
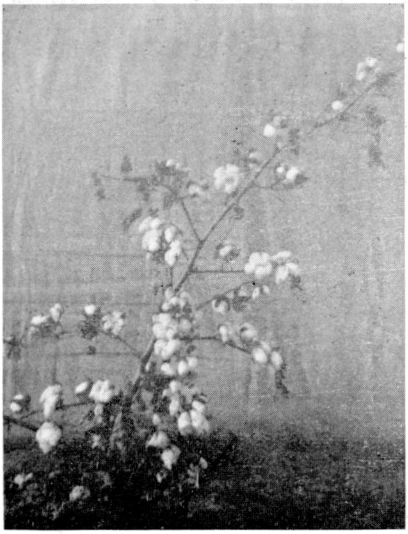


King No. 3.

PLATE XVIII.



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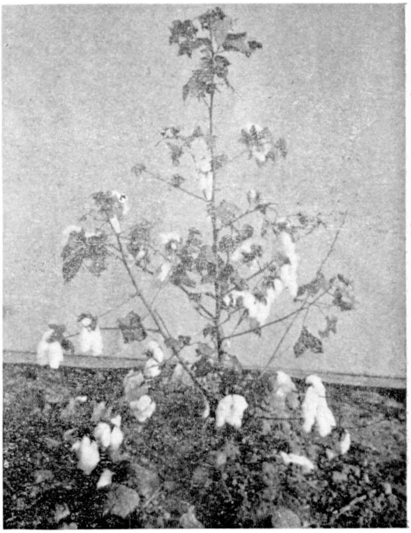

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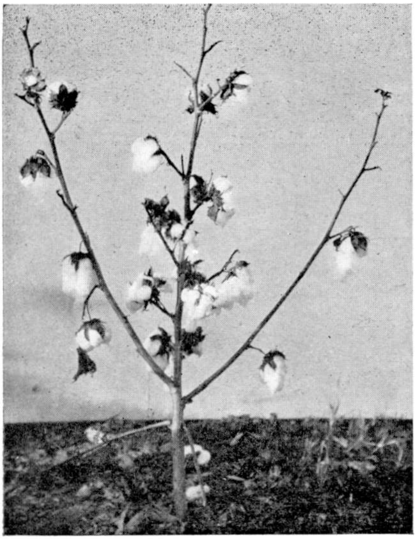

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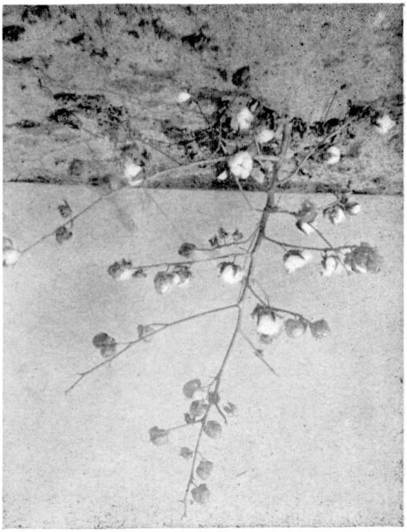

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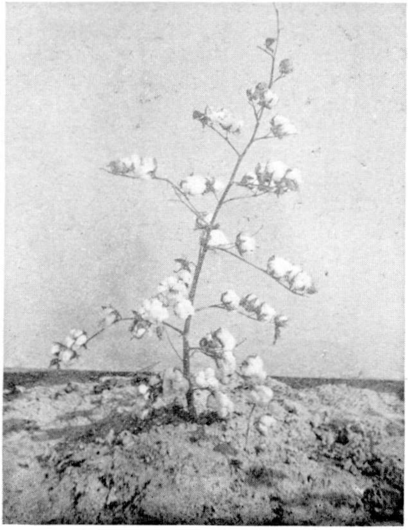

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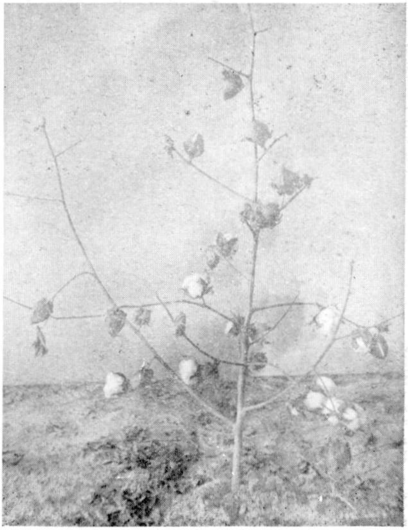

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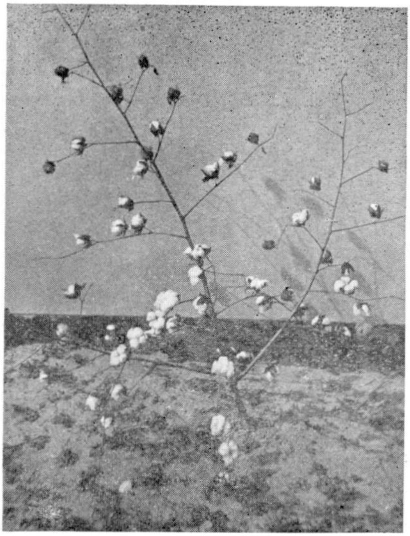

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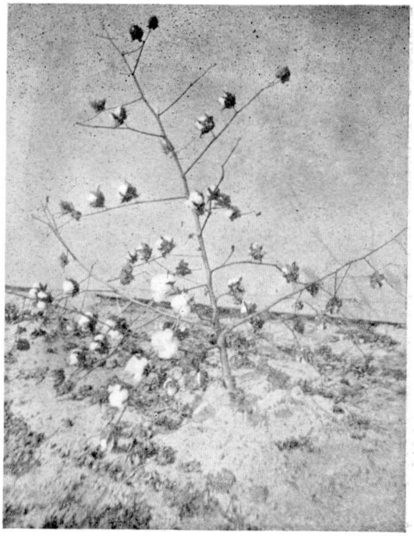
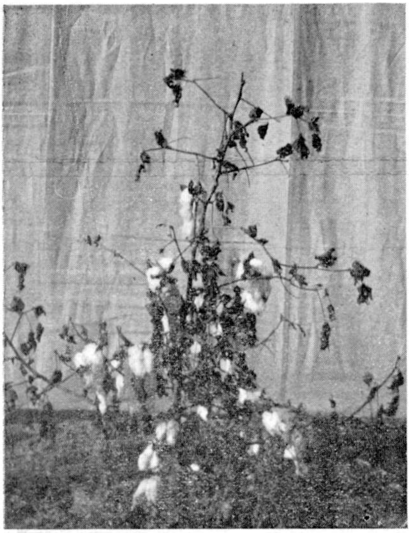


Mattis.

PLATE XX.



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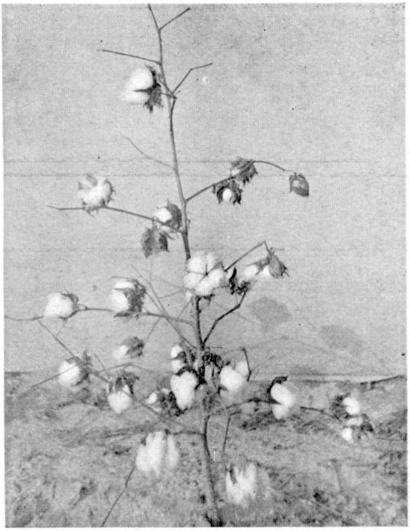

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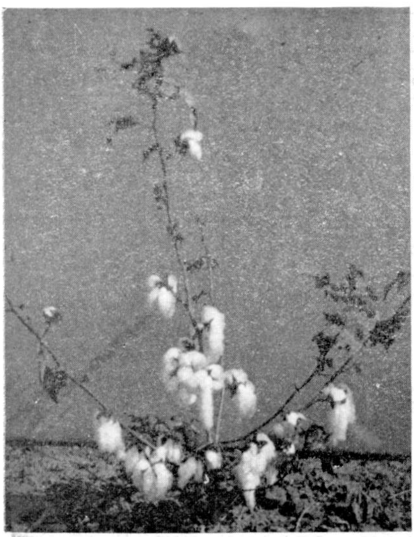
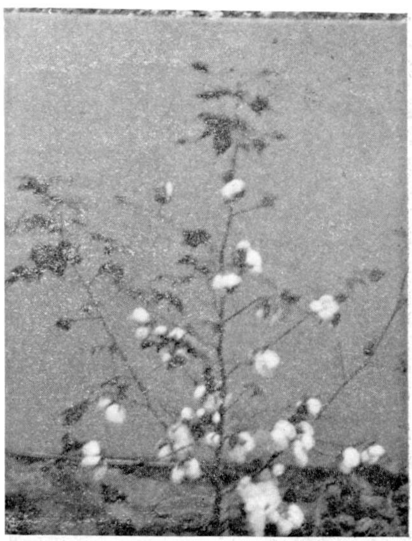


McCall.



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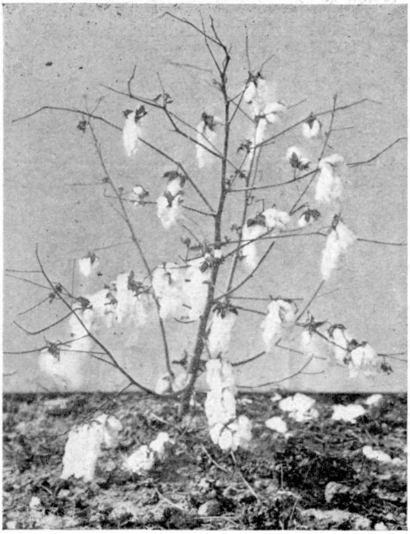

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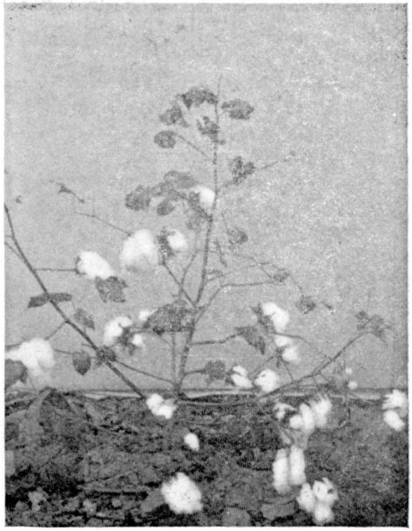
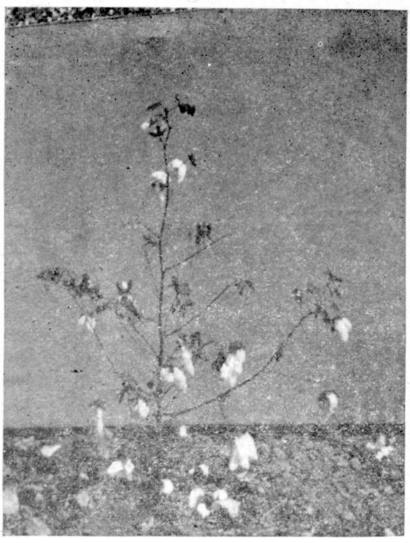
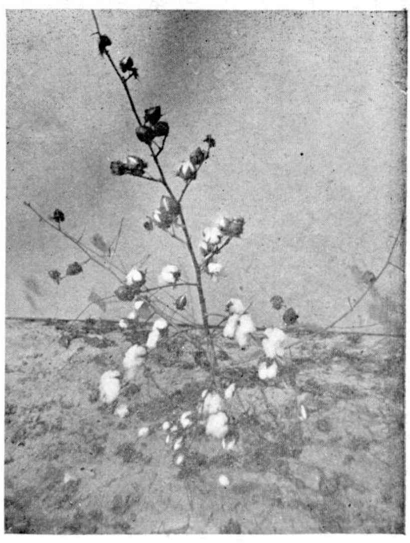


Mortgage Lifter.

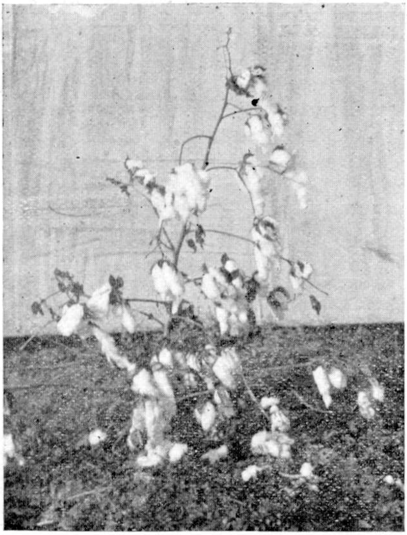


Mitchell.

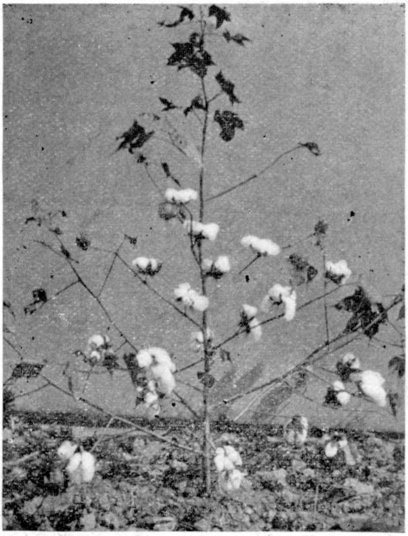


Montclare.

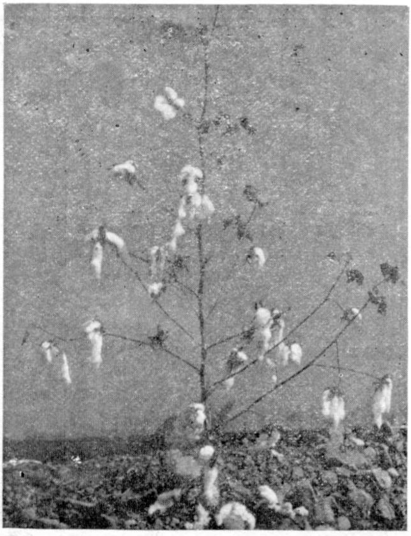
PLATE XXII.



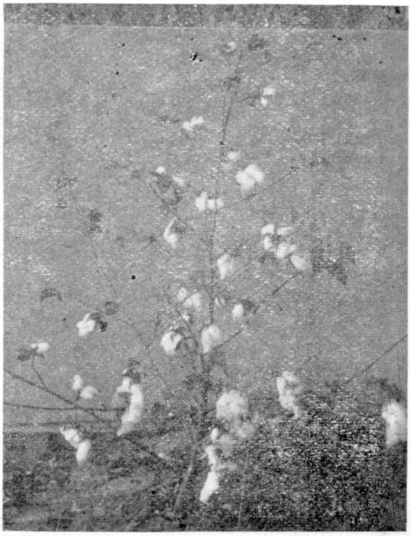
Moss.



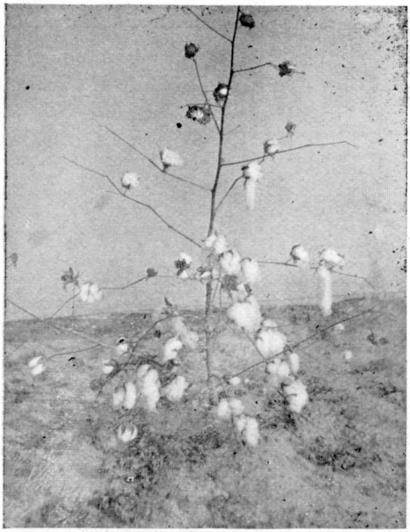
New Century.



Ozier Long Staple.



Nancy Hanks.



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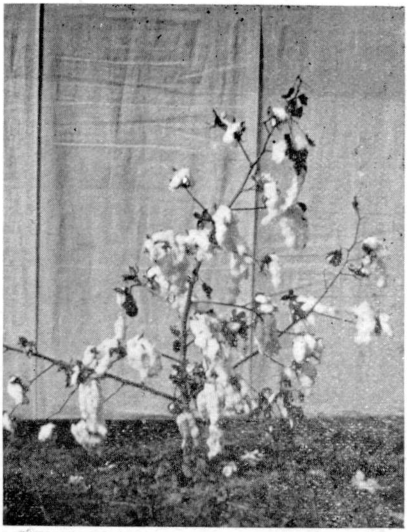

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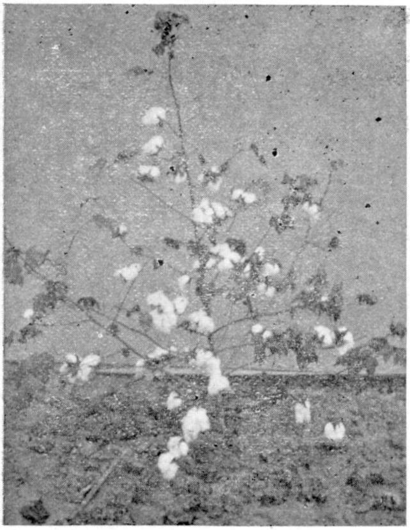
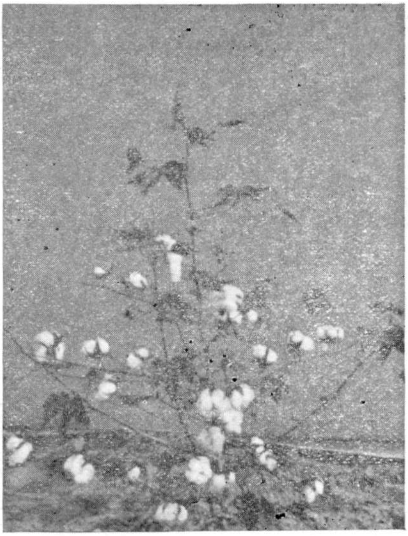
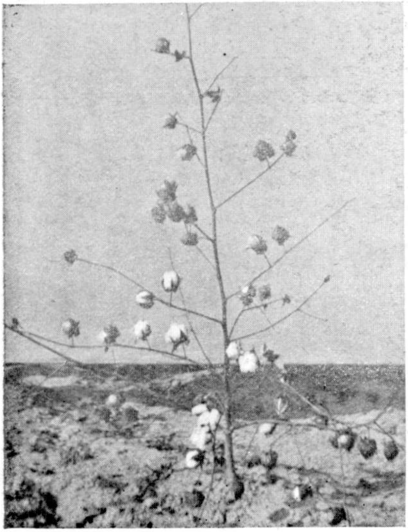


Parker.

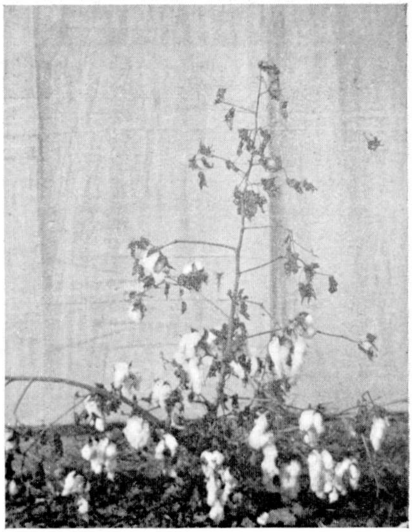


Peterkin.

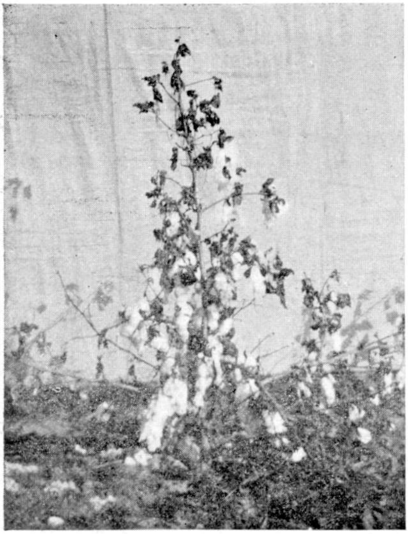
PLATE XXIV.



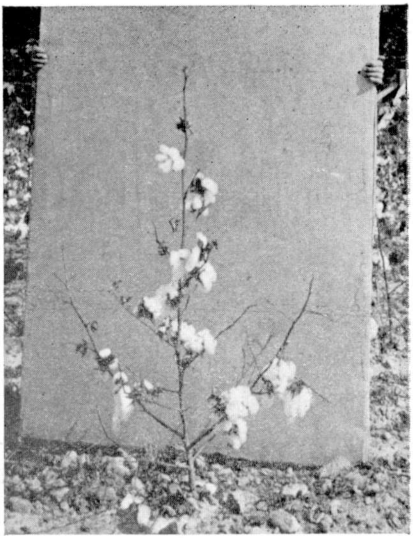
Petit Gulf.



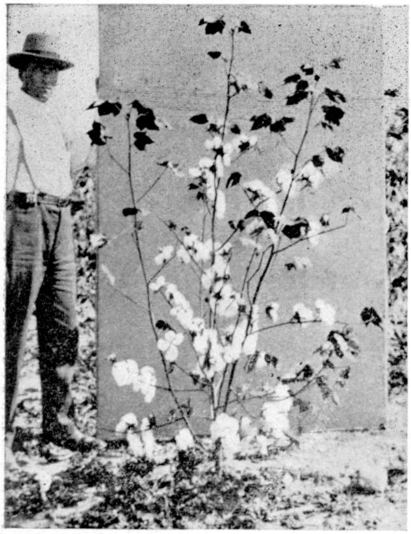
Ptomey.



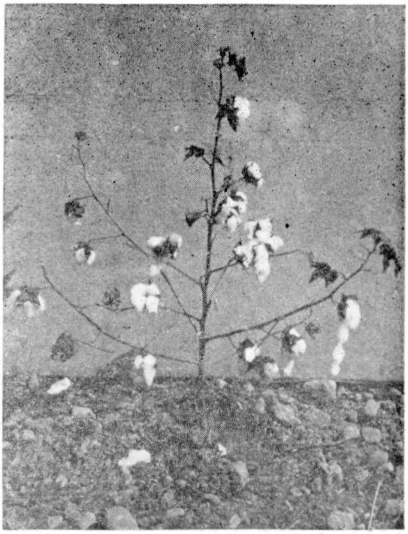
Pride of Georgia.



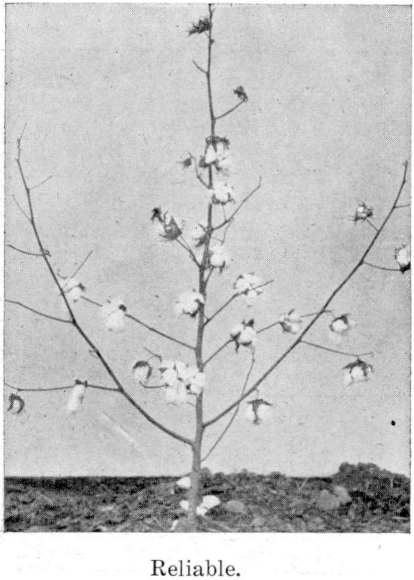
Pullnot.



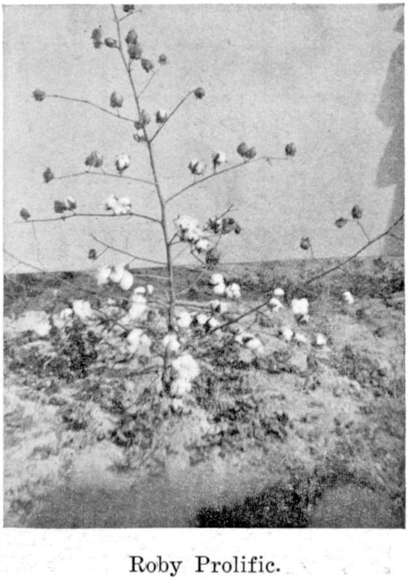
Red Leaf.



Rich Man Pride.

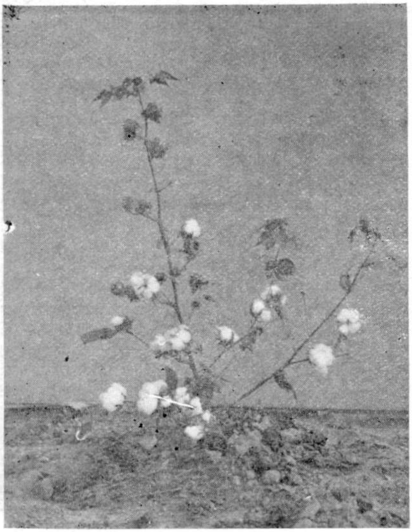


Reliable.

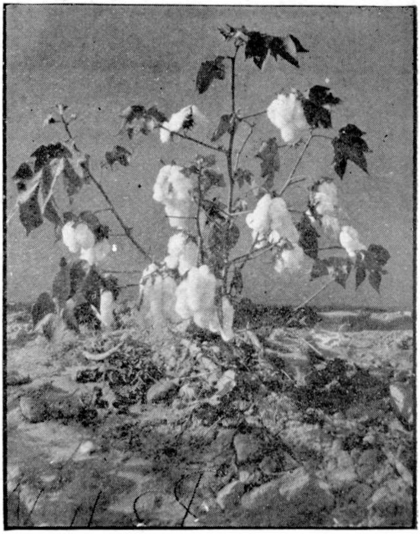


Roby Prolific.

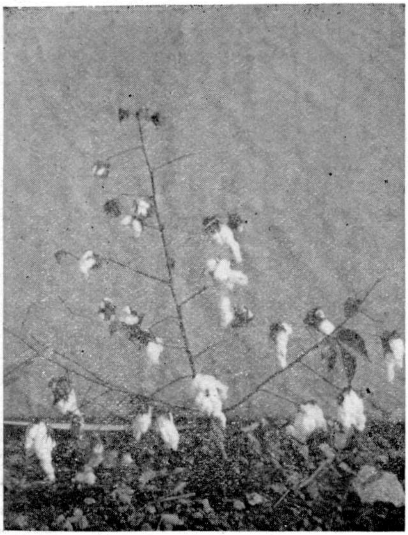
PLATE XXVI.



Rogers.



Russell.



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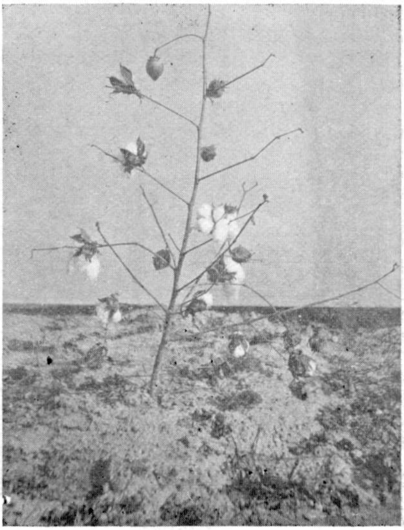
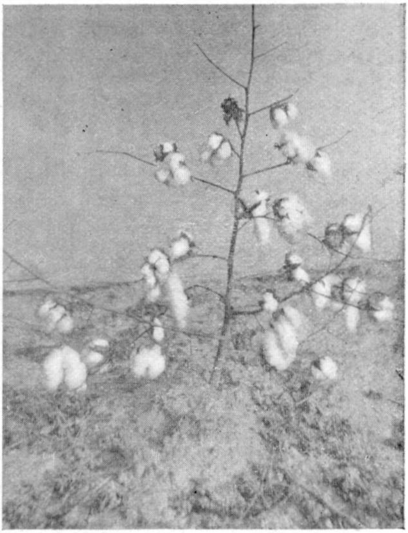


Rowden.

Ruralist.



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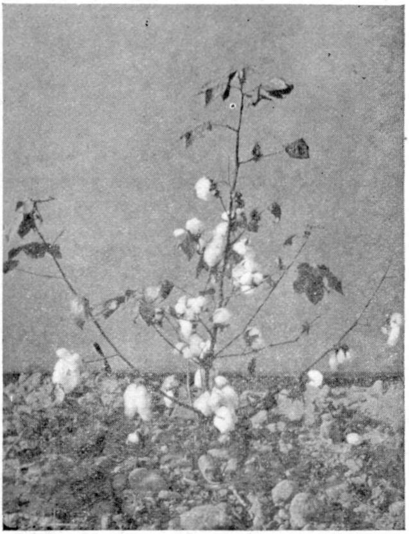

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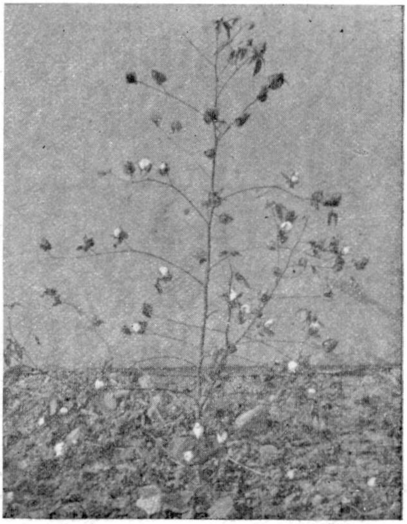
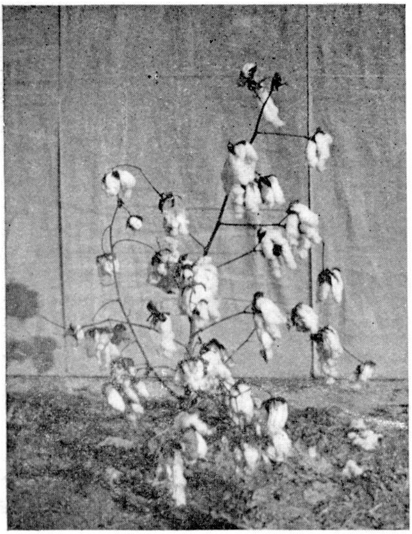


Sea Island.

PLATE XXVIII.



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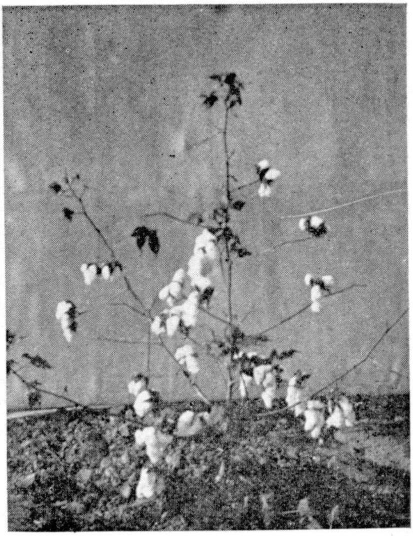

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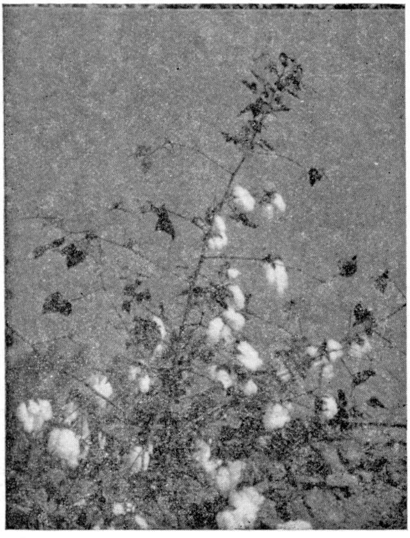

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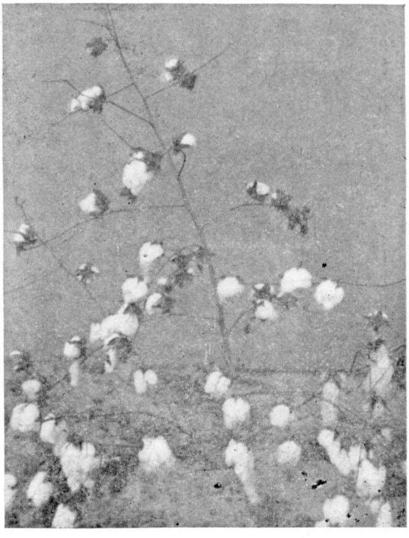
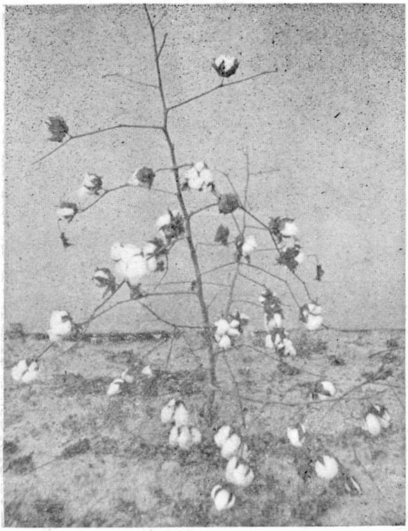


Shine Early.



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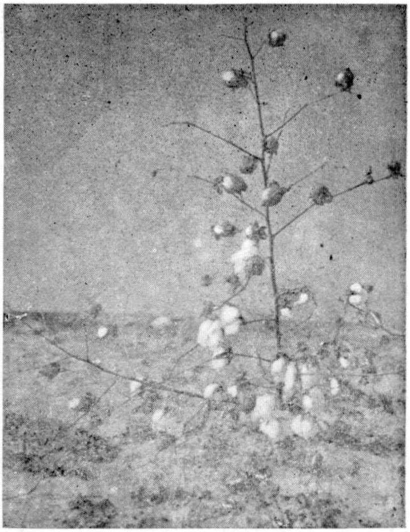

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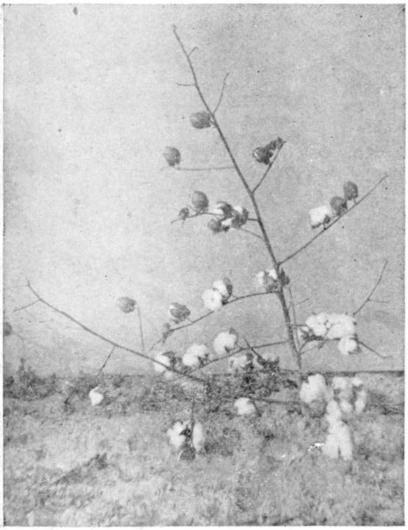

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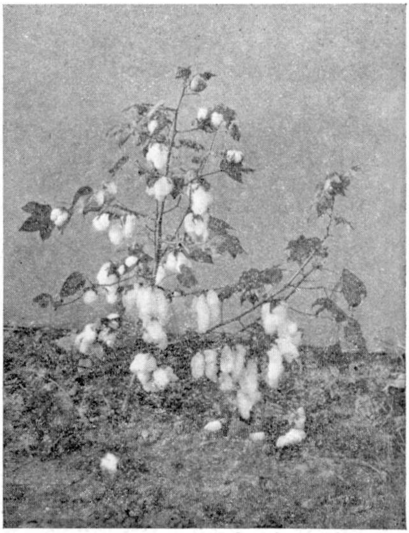
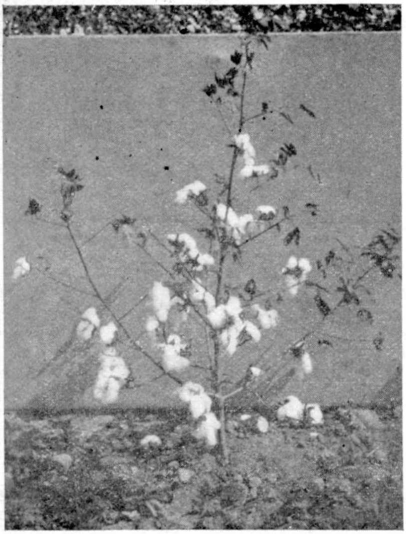


Southern Wonder.

PLATE XXX.



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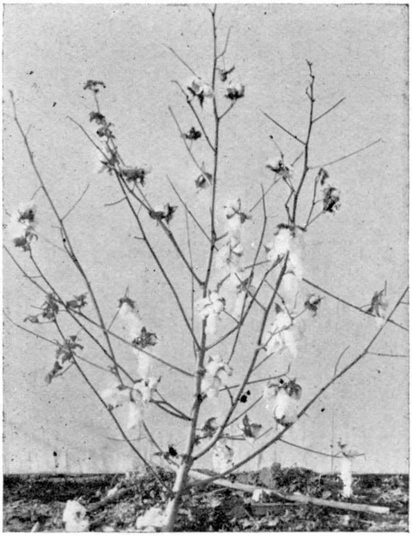

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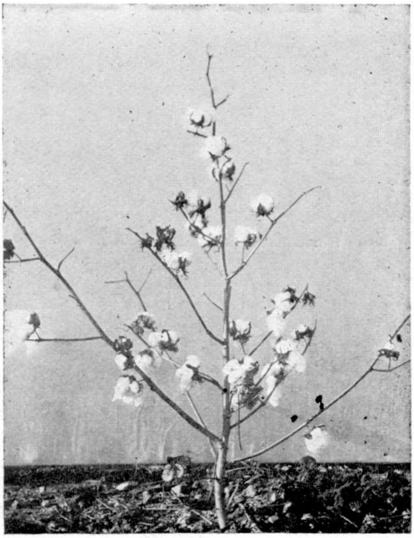

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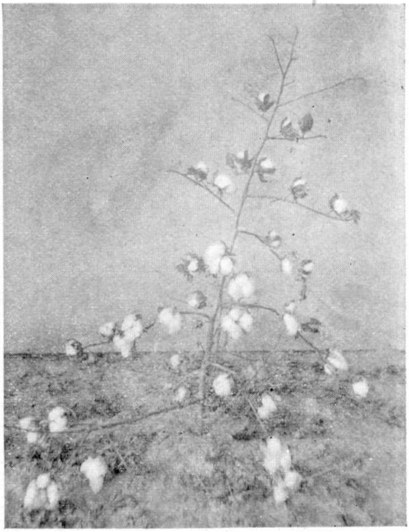
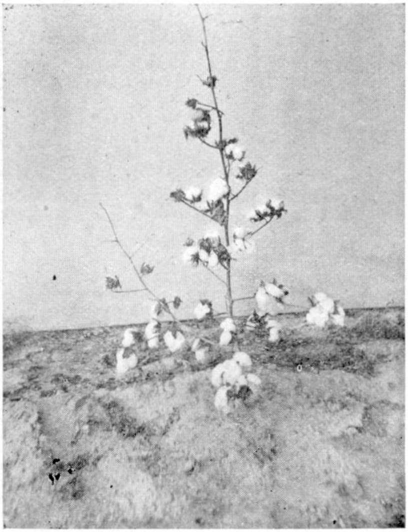


Sprueill Re-Improved.



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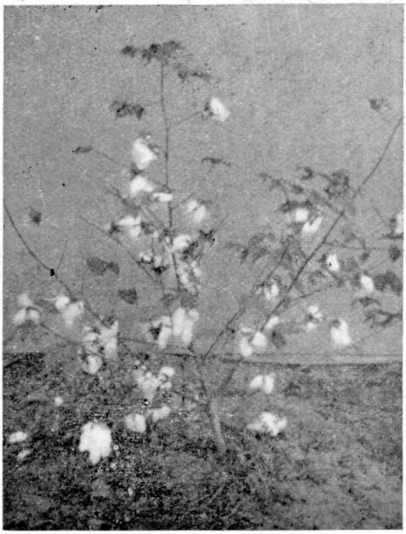

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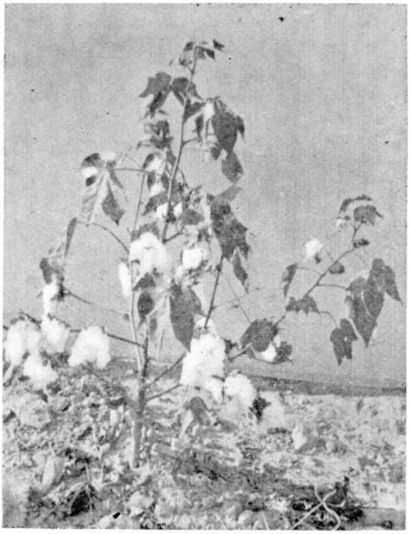

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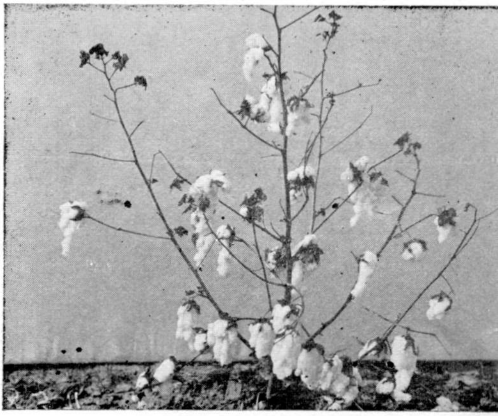

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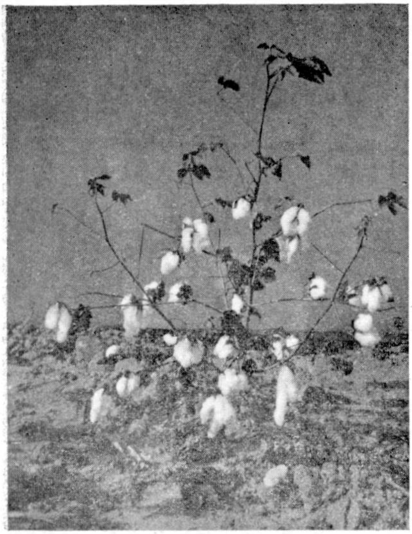

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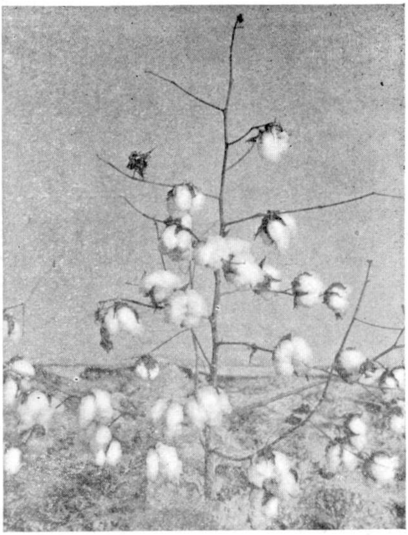
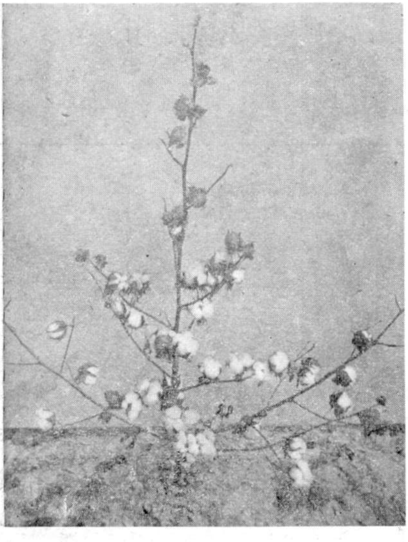
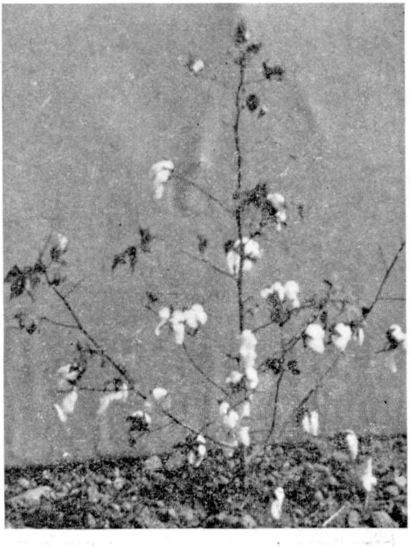


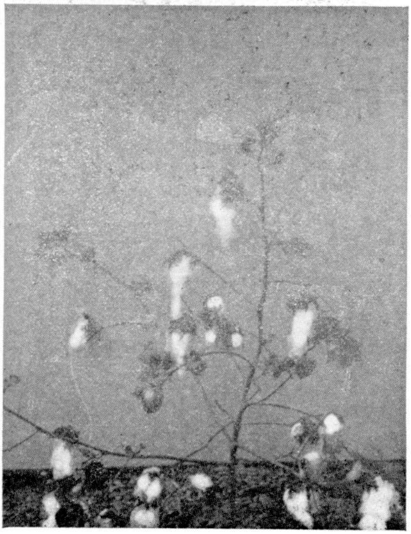
Texas Prolific.



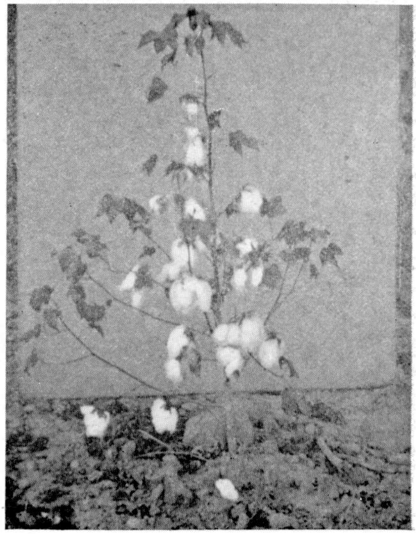
Texas Storm Proof.



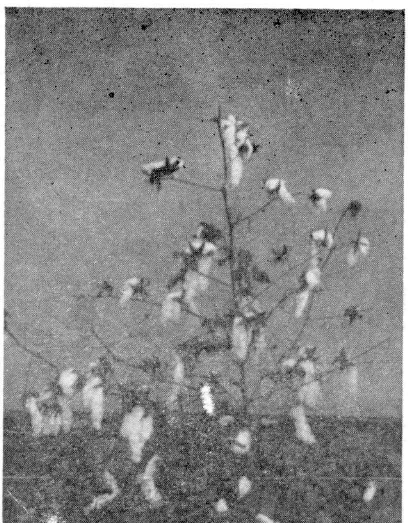
Texas Wood.



Todd.



Triumph.



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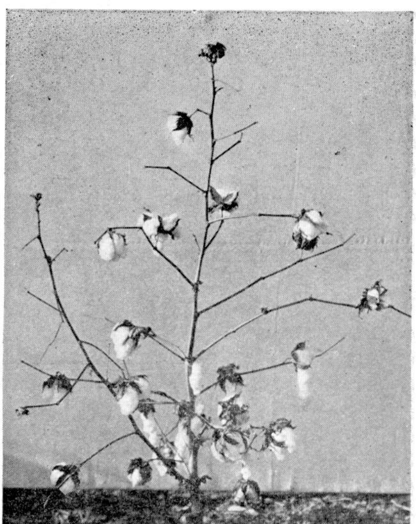

Truitt.

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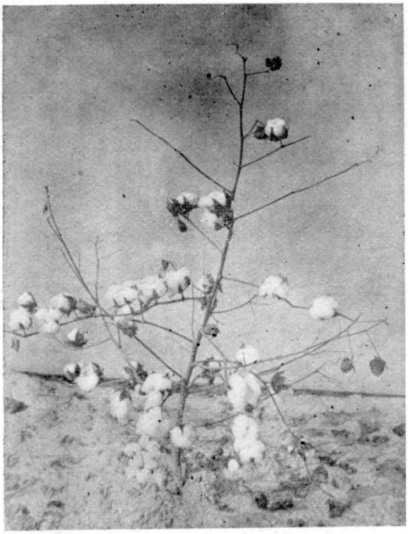

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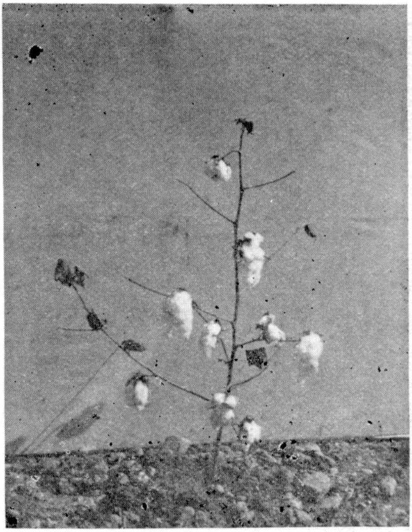

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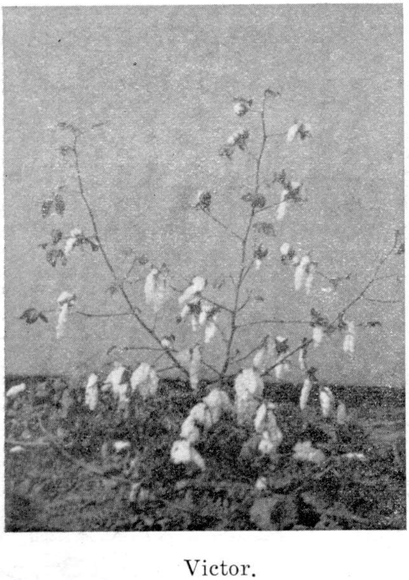

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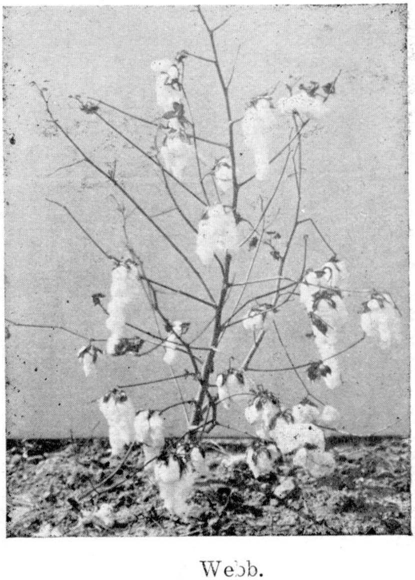

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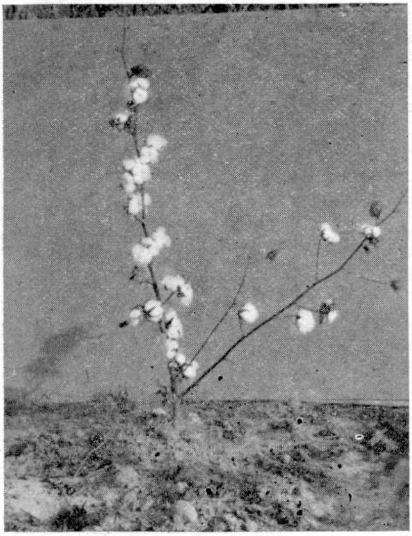

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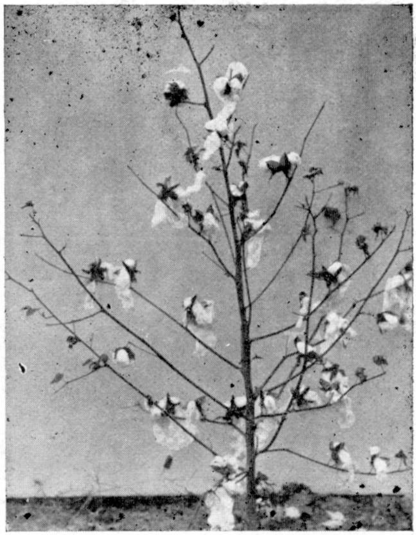

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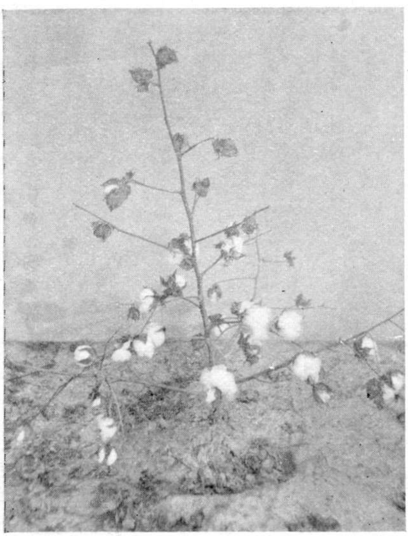

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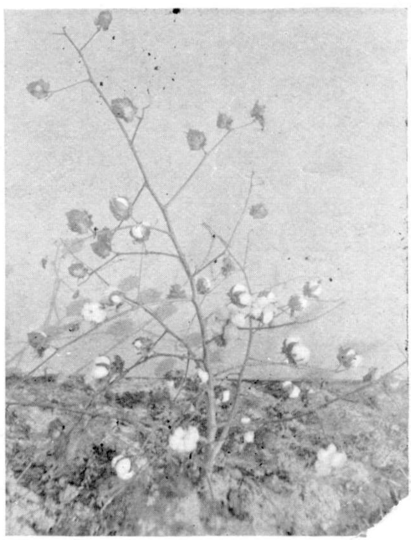
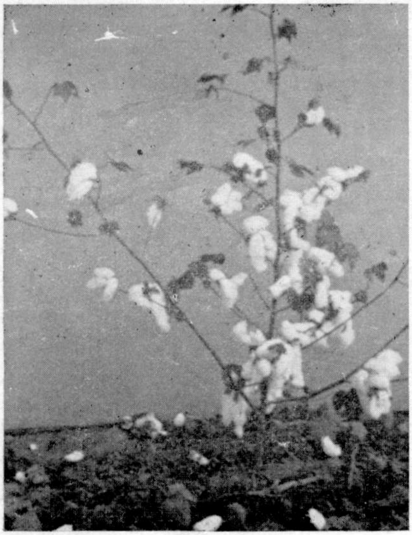


Wise.

PLATE XXXVI.



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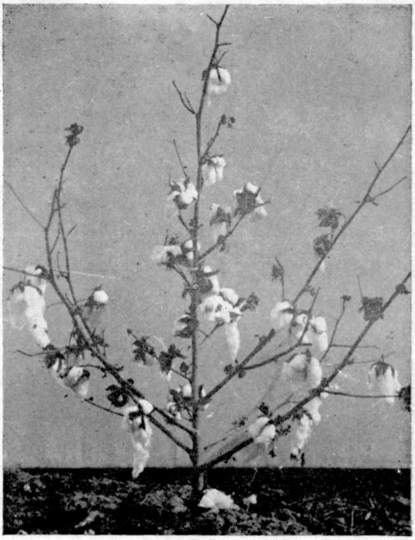

Wyche.

BULLETIN NO. 141 JULY, 1907

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute

AUBURN.

Texas or Tick Fever

BY

C. A. CARY

OPELIKA, ALA.
THE POST PUBLISHING CO.
1907

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TICK OR TEXAS FEVER.

BY

C. A. CARY.

HISTORY OF TICK FEVER.

Tick or Texas fever has existed in cattle for centuries in parts of Europe, Asia and Africa. It was brought to America by the Spaniard, who infested first the West Indies, South America and next Mexico. Into the United States it came by way of Florida and Mexico. Near the close of the eighteenth century, it appeared in Lancaster County, Pennsylvania, resulting from a shipment of cattle from North Carolina into that State. But the extensive and serious outbreaks of this fever first occurred in Texas and in the states and territories over which Texas cattle were trailed toward the north. This gave it the name Texas fever. Better to call it tick fever because Texas is in no way responsible for it and the cattle tick is the only real carrier of the primary cause of the fever.

In 1889 Theobald Smith, then in the Bureau of Animal Industry, discovered the intra-corpuscular parasites in the blood of cattle sick or dead from tick fever. In 1889 and 1890 Kilborne found by field tests that the cattle tick was the carrier of this micro-parasite from the sick to the healthy cattle. From 1895 to 1900, Connoway of Missouri, and Francis of Texas, inaugurated the first blood inoculation experiments that were in any degree successful. Dalrymple of Louisiana, Roberts of Mississippi, Butler of North Carolina, Nesom of South Carolina, Willoughby of Georgia, Dawson of Florida, and Cary of Alabama, successfully employed blood inoculations to produce relative immunity to tick fever in non-immune or susceptible cattle. It might be well to say that many attempts were made to produce immunity to tick fever in cattle by inoculations with blood serum, and by artificially and naturally infesting the cattle with ticks. Serum inoculations were failures. Tick infestation was relatively successful with sucking calves. But blood inoculations have been far more successful. Tabulated reports (not including 447 reported for the first time in this bulletin) give the following results made at the Southern State Experiment Station. Out of 4,750 cattle inoculated there were 361 deaths or 7.6 per cent. of the inoculated cattle died of inoculation fever and of tick fever following pasture infestation. Previous to this time, 50 to 90 of the breeding cattle brought from the North or imported into the tick infested areas, died the first summer after exposure to the tick infested pastures or ranges.

The protective blood inoculation has been a great boon to Southern breeders. But it in no way eliminates or stamps out the disease, or its cause, or the carriers of the cause. Blood inoculations produce a temporary, relative immunity in the breeding animals. But the loss of native Southern cattle is not decreased, the irritation caused by the ticks is not removed, the abstraction of blood from cattle by the ticks is not stopped, and the embargo on Southern cattle caused by the Federal quarantine line holding Southern cattle away from the free markets of the world for nine to ten months out of every year, is not revoked. In fact, ticks prevent Southern cattle from competing with non-infested cattle in growth and in quality and on the world markets.

Cause of Tick or Texas Fever.

The direct cause of this specific fever is a minute micro-parasite, *Piroplasma bigeminum.* It belongs to the lowest class of animal life and is in the same class and somewhat like the pirolplasma or micro-parasite that causes maleria in man. The micro-parasite of tick fever is carried from an infected cow to another cow, or ox or calf only by the cattle tick. The female tick sucks the blood from an infected or sick cow, or or calf, and this blood contains the micro-parasite. The female tick in some way transmits the micro-parasite to the eggs she lays and the seed ticks from these eggs carry the micro-parasites to the cow, or or calf upon which the seed ticks feed; and about the time seed ticks molt, or shed their skin, the cow, ox or calf may have a high fever. The micro-parasites thus pass through the old female tick, the egg and the seed ticks to get from one sick cow, ox or calf to another cow, ox or calf. When the micro-parasites get into the blood of a cow, ox or calf which has not had a severe attack of tick fever, the newly infected cow, ox or calf will have fever in six to ten days. The fever comes as a result of the destruction of red blood corpuscles or cells which are broken up or disintegrated and the waste products are the coloring matter of the blood, organic substances, urea, carbon dioxide and water. The waste products must be eliminated or thrown out of the animal's body by way of the lungs, kidneys, skin and bowels. The excess of waste products in the blood and an insufficient number of red corpuscles, so disturb the natural condition of the body as to cause a fever, and changes in the liver, spleen, kidneys, lungs and bowels. In acute cases of the fever, the red coloring material of the blood is thrown off by the kidneys and then the urine is blood red in color.

THE BLOOD IN TEXAS FEVER.1

Texas fever is essentially a disease of the blood in which tissue are sought the only constant lesions or pathological changes. The hemoglobinuria or "red water" so commonly observed in cases of Texas fever and the blood engorged spleen are both the result of changes occurring in the blood.

When the susceptible animal is first inoculated with the parasite (Piroplasma bigeminum) by the seed tick, the average condiiton of the blood as determined in northern cattle is, *Hb. 59.75 per cent., red cells 6,152,619, white cells 5,486 with the following percentages of the

* Dimock and Thompson—Am. Vet. Rev. August, 1906.

1. This article on the blood was written by Dr. Ward Giltner, assistant Veterinarian at the A. P. I. and Experiment Station.

different varieties, lymphocytes 54.22 per cent., large mononuclear 1.47 per cent., polynuclear 30.49 per cent., eosinophiles 13.15 per cent., mast cells .59 per cent. These averages would probably hold true for southern cattle were it not for the fact that most of these cattle have suffered from the ravages of the blood parasite, so that they are probably more or less constantly anemic. A case examined by the writer in September, 1906, a few hours before the animal's death, gave the following results: An incision was made entirely through the skin near the root of the tail and no blood exuded for nearly a minute. When at length it did appear, it trickled out slowly, having the appearance of a weak aqueous solution of eosin, without clotting. Hb. (by Tallquist's method) 30 per cent., red cells 2,000,000, white cells 1,620, lymphocytes 2.6 per cent., large mononuclear 3 per cent., polynuclear 94.4 per cent.

The classic researches of Smith and Kilborne on the nature, causation and prevention of Texas fever contain an exhaustive study of the number of red cells in certain aspects of the disease, also many counts of the white cells. Nearly all the leucocyte counts show an increase that amounts to a mild or to a considerable leucocytosis, but there are a few counts where the numbers run less than normal, even as low as 1500 per cmm. No relation can be determined between the number of red and white cells or between the latter and the condition of the animal as regards the disease. It is not at all improbable that such a relation exists, no efforts seemingly having been made with this end in view. The work of the above authors gives very perplexing results, such as a leucocyte count ranging from 17,000 to 21,000 associated with a red cell count of 1½ to 5½ millions and a leucocyte count from 1,500 to 2,500 with a similar number of red cells. The number of leucocytes likewise bears no determinable relation to the stage of the disease, or conditions previous to or after the disease.

Drs. Connoway and Francis* made a very extensive test with the hematokrit in an attempt to find some relation between the temperature curve and the blood changes. The hematokrit is absolutely unreliable as a means of determining the number of red cells, since the volume of red cells will vary with the size. In certain cases where many microcytes are present the hematokrit reading will be very low while the actual number of cells might be comparatively high. It is hardly worth while to go into an extended criticism of the hematokrit even when its use is limited to volumetric analysis. They were unable to establish any very definite relation between the volume of red cells and the variations in temperature, although, of course, in a general way the volume of erythrocytes is more or less decreased during an attack of fever.

A careful review of the work of Smith and Kilborne fails to show that the blood curve in Texas fever as determined by the hematcytometer corresponds at all closely with the temperature curve. All sorts of irregularities exist in comparisons by either method. Often in the acute stages of the fever with a temperature of 105 to 106 Fah., the red cells show a reduction of only 20 per cent. while, during a later stage pending either death or recovery, a temperature of 101 degrees to 102 degrees Fah. is attended by a destruction as high as 75 per cent., or the reverse may be noted. The fact remains that there are serious and constant blood alterations and invariably a fever. An examination of about 200 temperature records (made in this department) in experimental cases of Texas Fever (i. e., cases due to blood inoculation) shows that there is no typical temperature curpe.

A study of the Piroplasma bigeminum is not without interest and profit. The growth of the parasite is undoubtedly very rapid after its entrance into the blood. It attacks the red corpuscles, destroying them so much

* Drs. Connoway and Francis—Bull. No. 48, Mo. Agri. Expt. Station.

faster than they can be regenerated that their number is reduced to as few as 1,000,000 in some fatal cases. The hemoglobin thus set free colors the blood plasma and when excreted by the kidneys imparts a port-wine color to the urine. In destroying the red blood cells the parasite sets itself free and can be found in the blood plasma in the heart muscle and kidney at post mortem. In the acute stage of the fever before the number of red blood cells has been very greatly reduced, the periphral blood and organs show great numbers of the Piroplasma within the cells, while in fatal cases when the febrile stage has passed away and the destruction of red cells has been extreme, few of the parasites will be found in the cells, but a great many free in the plasma in the kidney especially. There are many interesting features in the study of the biology of the Piroplasma and such a study has a practical bearing, but limited space prohibits dealing with it here.

The red blood corpuscle of the cow averages about six microns in diameter. The Piroplasma bigeminum as it usually occurs in the corpuscle during the fever, is a pear-shaped organism and two are usually found in a cell with their apices or "stem ends," so to speak, approximating each other. Their diameters are about 2 to 4 microns by 1.5 to 2 microns, so that they occupy about one-fourth the cubic contents of the cell. It will be readily seen that their presence alone would decrease the oxygen-carrying power of each cell invaded about 25 per cent.; but, as intimated above they are not passively located in the cells, but actively destroying the cell and setting free the hemoglobin, the oxygen-carrying element. Whether they secrete any toxic substance aside from their direct destructive action has never been determined. There are good reasons to doubt the presence of either a toxin or its natural sequel, an antitoxin.

Drs. Connaway andFrancis tried to determine "whether sterile blood serum of immune southern cattle contains any chemical substance of the nature of an antitoxin or toxin that might be utilized pracitcally in stimulating at least a passive immunity in susceptible cattle." The results of their experiments along this line indicates that the serum contains no toxin substance since no untoward physiological effects follow its use in enormous quantities, while it evidently contains no antitoxin, since its use has no effect in lessening the severity of a subsequent or impending attack of the fever.

Dalrymple, Morgan, and Dodson of the Louisiana station were able to confirm the results and show further that the serum has no curative properties after the attack has begun. In practically all the work of this nature i. e., the transfusion of blood or blood serum, the material is secured from a so-called "immune" cow or one that has passed through an attack of the fever or at least has or has had ticks on her. Schroeder estimates that in the ordinary immune cattle there is not over one parasite to several million corpuscles. This may increase to one to fifty in fatal cases. As shown by Dr. Smith, in fatal cases the parasite is set free in the blood plasma and occurs there in many of the internal organs. Blood serum in such cases and taken from such sources would undoubtedly serve the same purpose in producing immunity as the entire blood, and it is possible that in some cases where the red cell destruction is severe, the peripheral blood may contain extra-corporeal parasites, though this is doubted by Smith.

The number of corpuscles affected often reaches ½ to 1 per cent., but if this number is exceeded fatal results usually attend. If recovery takes place as the fever subsides, the number of parasites decreases. Dr. Cary and the writer have found Wright's stain most satisfactory for demonstrating the Piroplasma and unless one has plenty of time to hunt and a mechanical stage to assist in the search, it is better to await a fatal case and secure smears from the heart muscle, kidney or liver.

August Mayer, having had disastrous personal experience with the ticks, makes out a strong case against that carrier of disease. He estimates that a cow can carry as many as half a million ticks of different stages of growth, and since four different broods may be carried in one season, a single animal may in one season furnish food for a million ticks. Three hundred thousand ticks will withdraw 200 pounds of blood from their victim, a loss nearly as great as can be replaced by an animal under conditions to make the greatest gains. This is a direct loss independent of the destruction of the blood cells within the body.

It has been frequently shown that, when an animal has been subjected to accidental or experimental hemorrhage of a degree approaching in severity the loss in Texas fever, that the natural regeneration of the blood occurs in several days. In these cases of simple hemorrhage the processes of regeneration consists in, first, a slight apparent increase in the number of corpuscles due to concentration, followed by a diminution due to replacement of a volume lost by fluid free from corpuscles and then a gradual replacement of the lost cells by the peculiar processes of cell division. In Texas fever there is a loss of red cells due, not to their withdrawal from the vascular system, but to their destruction within the vessels and the debris there formed has to be eliminated. This overtaxes the liver and ultimately the kidneys. To the presence of this waste substance may possibly be attributed the various symptoms of the disease that can not be accounted by the results of a simple removal from their functionating power of a large number of red blood cells.

Not the least interesting part of Texas fever is the condition in which it leaves the great mass of cattle that live from year to year. The so-called "immunity" in southern cattle is not a true immunity but rather a tolerance of the parasite, that keeps the animal from suffering an acute attack of the fever under ordinary circumstances. However, it is a condition of unstable equilibrium and a slight environmental change, such as intense heat, severe exertion, adverse change of blood, or certain undetermined factors tending to lower the animal's resistance; or, on the other hand, a slight or considerable increase in the number of the invading organism, suffice to bring on acute and often fatal attacks of the fever. Many cases can be recalled to prove the soundness of this theory. Northern cattle can not come safely South, southern cattle can not stay safely South. The suggestion by Dr. Schroeder is timely, that some one in the South make an extended examination of the blood of a herd of tick infested cattle. The blood picture secured in such an investigation would make an interesting comparison with the results at hand on the blood of northern cattle.

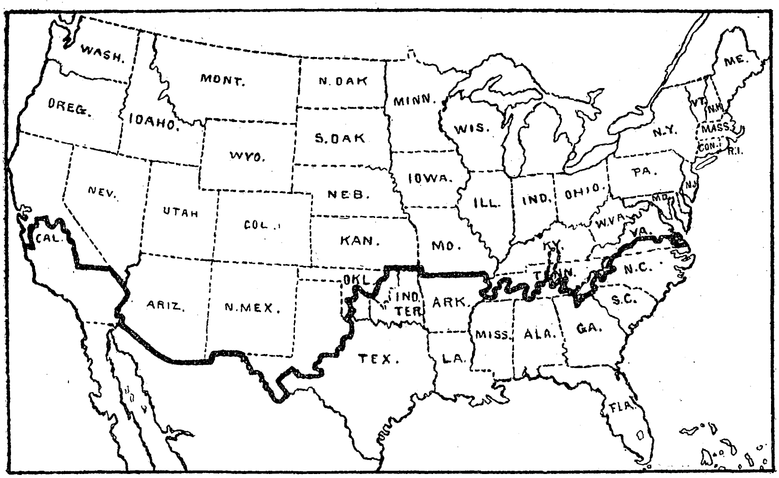


FIG 1.—Boundary line of the district infected with Texas Fever. (From Bureau of Animal Industry Bul. 258.)

LIFE HISTORY OF THE CATTLE TICK.

The large, fat female tick when completely filled with blood taken from its host, drops to the ground, crawls under leaves, litter or down into manure heaps and in a few days begins to lay eggs. In six to fifteen days she may lay 1,500 to 4,000 eggs. As the female lays eggs she gradually shrinks in size and dies in a few days after laying her last eggs. The eggs are small, oval, brown and waxy. They may hatch in 12 to 30 days after being deposited by the old female, or may live over winter and hatch in the spring. We have taken no records in Alabama where they hatched in less than 20 days. From the 1,500 to 4,000 eggs come the same number of seed ticks. These are six-legged, lively, brown larval ticks and a little larger than chicken mites. They crawl upon grass blades, weeds, shrubs or any object near their locality, and there await the coming of a cow, or or other animal. But the seed tick can not eat grass, weeds or anything else except the blood of cattle, horses or mules, and unless the seed ticks can get blood they will starve to death in one to four months in summer and one to seven months in winter. When they get upon cattle, they crawl up to the soft and thin parts of the skin, and begin to suck blood from the host. This is the time they inoculate the cattle with the Micro-parasite of tick or Texas fever. In about six days the seed tick sheds its skin (molts) and then becomes an eight-legged nymph. In eight to twelve days more the nymph tick sheds its skin (molts) a second time. Up to this time the male and female are about the same size, and just after the second molting the female becomes fertilized. The male grows little if any larger, but the female gradually enlarges for six to twelve days and then rapidly becomes engorged with blood during the next two or three days before dropping off the cow or ox. Thus the life cycle is completed. The shortest time of the life cycle is about thirty-five days in summer and six to eight months in winter.

A tabulated statement of the life history of the cattle tick for summer and winter may be stated as follows:

SUMMER.	WINTER.
May to October	October to May.
1. Egg laying time—6 to 15 days	30 to 60 days.
2. Hatching time—12 to 30 days	30 to 210 days.
3. Seed tick may live without getting on cattle, horses or mules 30 to 120 days.	30 to 240 days.
4. After attaching to the skin of cattle, females mature and drop off in 15 to 35 days	25 to 60 days.

EXPLANATION OF FIGURE 2.

1, larva of cattle tick (×25); 2, same (natural size); 3, mature female and eggs; 4, hide showing cattle ticks; 5, blood cells cells containing Texas-fever protozoa (× 1,000); 6, male cattle tick(× 15), 7, same (natural size); 8, young female cattle tick (× 15); 9, same (natural size); 10, various stages of cattle ticks.

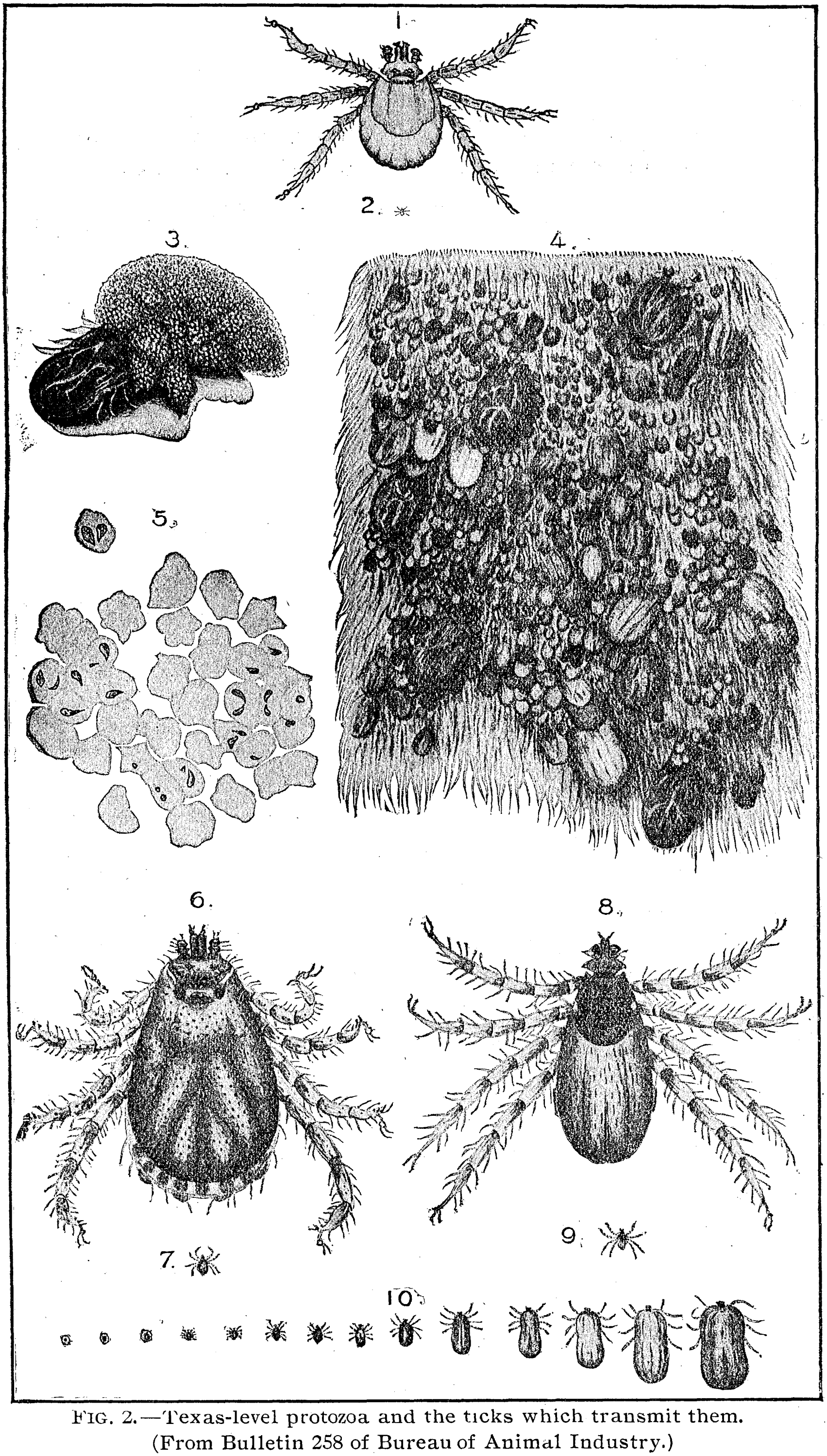


FIG. 2.—Texas-level protozoa and the ticks which transmit them. (From Bulletin 258 of Bureau of Animal Industry.)

Symptoms of Tick Fever.

1. The presence of small ticks or large ticks should lead one to expect sick cattle to have tick fever. Frequently the ticks are so small that the ordinary observer can not see or find them. Twenty-five infected seed ticks applied to a non-immune may produce tick fever. A cow or calf may have a hundred seed ticks on it and they may not be seen or found by an inexperienced observer. Look closely and feel carefully on the inside of thighs, on the escutcheon, on the abdomen, drew lap and all over the body.

2. Determine the history of the sick animal or animals. Have they been moved from a non-ticky place to a tick infested one? Or have ticky cattle been brought into the pasture? Staked cattle are usually free of ticks and non-immune. Many town cows are tick free and susceptible. All very young calves are susceptible. All cattle from above the quarantine line and all cattle from tick free places or farms are susceptible to tick fever.

3. The temperature rises before any other noticeable changes occur in the infected animal. The normal ranges from 101 to 103 degrees Fah. and the fever will range from 103 to 107. The temperature will be higher at night or late afternoon than in the morning. The high temperature may continue for two to ten or more days, then drop to the normal. In chronic cases there may be variable periods of rising and falling of the animal's temperature. Just before death the temperature falls and sometimes to sub-normal.

4. The appetite is lost in acute cases and is variable and capricious in chronic cases. Rumination is also suspended in acute cases and is not resumed until recovery begins.

5. The bowels may be inactive. Loss of appetite, suspension of rumination, and inactivity of the bowels indicate that the functions of the alimentary canal are suspended. The lining of the intestines and fourth stomach may be more or less inflamed and the inactivity may be

in part due to this inflamed condition. Inactivity of the bowels may be due to paralysis resulting from the action of toxic waste products on the nervous system and to excessive action of the kidneys. The third stomach or manifolds may contain very dry food material. This is due to the high fever and the excessive loss of water from the system. Generally in the early stages of tick fever, the bowels are more or less loose and sometimes a condition similar to diarrhoea may be present. The feces or manure may sometimes be streaked with blood or covered with mucous and sometimes it is greenish yellow in color as a result of an excessive amount of bile in it. Sometimes the feces are black. Gases may distend the stomach and intestines when the food is undergoing fermentation. This occurs in long standing inactivity of the bowels. Again the condition of the bowels varies with the food the animal has eaten. Green feeds and cotton seed are laxative in action, while dry feed is constipating. Plenty of water helps to keep the bowels open.

6. Respirations are accelerated in acute cases, the animal breathes shallow and quick as in congestion of the lungs. This is caused by stimulation of the respiratory center, which is excited by an excess of carbon dioxide and a deficiency of oxygen in the blood.

7. The pulse in acute cases is rapid, soft and weak. In chronic cases it may be slow and weak.

8. The kidneys are usually very active in acute cases. In mild cases the urine may be quite dark in color, and in severe cases it may be blood red. This is not blood but the coloring matter of the broken down red blood cells. Not every case will pass red colored urine, but some cases among a number of sick animals will pass red colored urine. This is one of the most positive symptoms of tick fever; and many persons call it "red water" or "bloody murrain" on account of the red colored urine.

9. Some cases get very weak, wabble around, fall and lie down most of the time or until dead.

10. Some chronic cases have a cough and stand

around with head down and back arched, and usually become separated from the rest of the herd. They prefer the shade and are fond of standing in the water.

11. Some cases become wild and somewhat crazy or violent. This is due to insufficient or improper supply of blood to the brain or to absorption of toxic materials from the stomach or intestines. A wabbling gait and inability to see may also be present.

12. An animal in fairly good condition rapidly loses flesh and becomes tucked up in the abdomen.

13. Cows will often abort during or after an acute or sometimes after a chronic attack of the fever. Bulls lose their vigor and are often useless for breeding for one or two years.

14. A small swelling may appear under the lower jaw or between the branches of the lower jaw. This is usually present in chronic cases and is generally associated with a cough.

Diagnosis of Tick Fever.

1. The positive test is finding the micro-parasite in the red blood cells. This is rather difficult to do before the animal dies, because it is not often that the piroplasma is found in the blood of the skin or subcutis in sufficient numbers to be easily and quickly found. Slide smears of the blood taken from the heart muscle or the kidney will usually contain numerous intra-corpuscular parasites. The blood may be stained with Loefflers alkaline methyl blue after it has been fixed by heating up to 110 to 120 degrees C. for 2 hours. The stain should remain on the slide for one to one and a half minutes, wash in water and then dip for an instant into a one-third per cent. acetic acid solution to remove the excess of diffuse stain in the red blood cells; wash in water and mount in water or dry and mount xylol balsam or dry and examine by using immersion oil on the slide.

With Wright's stain the blood smear will need no fixing; keep the stain in the slide for one to five minutes;

wash with water, dry and examine with high power. The writer was the first one to use Wright's stain in demonstrating the piroplasma of tick fever in the blood of cattle.

2. Black Leg or Black Quarter is often confounded with tick fever. This usually attacks young cattle under two years old and not very young calves or older cattle. It usually attacks fat yearlings instead of the poor ones. Before death and after death there is a swelling over the upper part of a front limb or hind limb or on some part of the body. This swelling crackles when the hand is rubbed over it, indicating the presence of gas under the skin. Cutting open the swelling permits a dirty red liquid to escape and exhibits muscle and connective tissue that appear as if they had been par boiled. Smears from this may be stained and the specific bacteria of black leg may be found. Also the material may be injected under the skin of a calf, sheep or a small laboratory animal and produce the specific disease.

3. Haemorrhagic septicaemia is not unlike a chronic case of tick fever. The presence or absence of the piroplasma will identify the one or the other. This characterized by well defined haemorrhages and numerous haemorrhagic spots under the pleura, peritoneum and epicardium. Sometimes the urine is stained red but not as frequently so as it is in tick fever. This disease is said to be caused by a specific germ (*Bacillus bovi-septicus.*) The outbreaks of this trouble are localized.

4. Anthrax may be mistaken for tick fever or the reverse may be true. In this the specific germ, *Bacterium anthracis,* may be found and it attacks horses, mules, cattle, sheep, goats, rarely hogs and occasionally man.

5. Stomach worms and hook worms in the alimentary canal may produce an anaemia not unlike that of chronic tick fever. In this, search for the worms in the feces of the suspected cases. These worms and tick fever may both be present in an animal at the same time.

TABLE I. *A Comparative Study of Four Specific Diseases.*

Disease:	Haemerrhagic Septicaemia	Anthrax or Charbon	Black Leg	Tick fever
Cause	Bacillus bovisepticus	Bacterium anthracis	Bacillus Feseri	Piroplasma bigeminum (a protozoan)
How spread	Unknown	Food, water, flies, carcasses, etc.	Food, water, discharges, carcasses, etc.	Cattle ticks
Extent of single outbreak	Localized	Local centers and wide spread	Local. Often one farm or one pasture	Tick infested areas
Favorable season	Any season	Hot, dry weather after wet spring	Spring, summer and fall, hot and dry	Summer and fall but may occur any season
How germ enters body	Unknown	Digestive tract, lungs, skin	Skin (?)	Tick innoculation through skin
Susceptible Animals	Nearly all	Horses, mules, cattle, sheep, goats, man	Young cattle, sheep, goats	All cattle at some life period
Mortality	Very high	Very high	Very high	High in old cows and low in young cattle
Beginning and course	Acute, sudden. Chronic slow	Usually rapid	Generally rapid	Acute, rapid; chronic, slow
Local swellings	Slight or absent	Acute, occasional; Chronic, frequent	Very marked and gas under skin	Absent usually
Urine	Rarely blood stained	Often blood cells, stained or dark	Rarely blood cells stained or dark	Often blood stained or dark, albumen
Manure	Often blood stained	Often blood and mucus	Constipation and manure bloody	Blood stained, mucus and bile
Blood after death	Normal and clotted	Dark, tar black, clots, slow or slight	Normal, except at swelling	Thin, light in color and clots slowly
Haemorrhages	Often present and clearly defined	Spleen often ruptured	None	Usually none
Serous surfaces	Numerous blood spots on them	Blood spots and red serum in serious cavities	Serum in abdomen	Blood spots on epicardium and endocardium
Spleen	Normal, except surface blood spots	Large, dark and soft	Normal	Very large, soft, blue-black
Liver	Blood spots on surface	Engorged with dark blood	Usually engorged	Engorged with blood and bile
Kidneys	Blood spots on surface	Congested usually	Normal or engorged	Sometimes pale, usually engorged and black
Lymph glands	Blood stained near blood lesions	Often red or black and large	Normal	Slightly enlarged rarely red

AFTER DEATH CONDITIONS.

1. If the animal was sick for several days, the carcass will show emaciation, but fat animals may die suddenly and then the carcass indicates that the animal was in good condition as to flesh and nourishment.

2. In cutting through the skin it appears pale, as if there were little or no blood in the skin or subcutis. When blood is found in these tissues it appears "watery" or "thin" and does not coagulate readily.

3. The rumen or paunch may contain more or less semi-liquid material. The third stomach or manifolds, usually, in acute cases, contains very dry feed. The mucous membrane of the fourth stomach and of the small intestine will exhibit raw or eroded surfaces or patches. The contents of the intestines may exhibit an excess of bile, some blood and mucous, and the fecal matter may be soft or more or less dry and hard.

4. The spleen is usually enlarged or engorged with blue-black blood. A cut surface will let the contents flow out and it will appear like black-berry jam in color and consistency. This is broken down red blood cells and waste materials of the blood.

5. Kidneys are congested and often enlarged in acute cases. In chronic cases they may appear normal to the naked eye.

6. The bladder may contain red colored urine, dark colored urine, normal colored urine, or be empty. As a rule in a number of cases that die of tick fever, red urine will be found in some of the cases.

7. The liver is usually greatly enlarged and filled with blood and bile having a brown mahogany or yellow color. The gall bladder is distended and the bile is thick with flakes of mucous.

8. The lungs may be congested or may be normal.

9. The peritoneum and pleura may present a few colored patches or haemorrhagic spots or patches. These are not constant.

10. The heart may have the right ventricle "distended

with blood, full or clotted, according to the time elapsing between death and the examination. The left ventricle is usually firmly contracted and may contain a small quantity of fluid or clotted blood." (Smith.) The small haemorrhagic spots under the epicardium and endocardium are quite constant, they are more numerous on the outside and inside of the left ventricle.

11. The subcutaneous tissues, the mucous membranes of the mouth and eyes may become more or less yellow in acute tick fever cases. The fat of the body may be also yellow. The yellow coloring of white tissues is due to an absorption of bile. It is not always present. And yellow fat is not always due to tick fever. In many cases the mucous membranes of mouth and eyes are very pale.

12. Secure smooth slide smears of blood from the kidneys, the heart muscle and the liver. Stain with Wright's stain and examine with high power lens for the intra-corpuscular micro-parasite. Or examine with high power a fresh mount of blood from a kidney or the heart muscle for the micro-parasite.

IMMUNITY.

Immunity to tick fever is a relative term. It is not absolute. When an animal is not susceptible to an attack of a given disease, the animal is said to be immune to that disease. Immunity may be acquired by having the given disease one or more times, by natural resistance of certain species of animals for certain diseases, by introducing specific anti-toxins into the animal body. In tick fever, the only known means of producing immunity in cattle is by giving the animal one or more mild or severe attacks of the fever. Blood inoculation, or artificial tick infestation, are the only ways of artificially producing this immunity. Natural tick infestation may also produce immunity in a varying degree. The fact is that a cow, steer or ox must have an attack of tick fever once every year or several times every summer or its immunity is lost within two or more years. Just as a man can have a series of attacks of malaria so may cattle have a series of attacks of tick fever. It is true that one cow has been known to carry the micro-parasite in her blood for thirteen years; but thousands and thousands of native southern cattle that have had one or more attacks of fever, die every year from one severe attack or several attacks in one season.

Moreover, it is not infrequent that animals upon the range or in pasture pass through a time of gross infestation of ticks and then die in the winter from chronic tick fever or an acute tick fever brought on by reduced resistance and cold weather. A man may have malaria year after year if he is exposed to new infection every year. So may cattle have tick fever one or more times each year if they are exposed to gross tick infestation.

The micro-parasite of tick fever varies in virulency and cattle vary in their degree of susceptibility or resistance. Moreover, the resistance or susceptibility of the individual animal varies with the condition of the animal, its age and its vitality or vigor. A very fat or a very poor animal possesses low resistance; an old animal is less able to throw off the waste products and repair the loss of blood cells than a young one; a weak animal from any cause is also less resistant. Yet there are individual animals that have a low index of resistance from a condition of the blood or from some unknown cause. And there are times when the micro-parasite acquires an increased virulency. The passing of the parasite through non-immunes or the frequent and rapid transmission of it through cattle is said to increase its virulency. This in part accounts for the greater virulence of parasites and the greater number of deaths in native cattle in the fall. The micro-parasite has passed through two or more generations of ticks and through the body of one or more animals, without having low temperatures to reduce or retard its activity.

Inoculating With Infected Blood.

1. First inoculate suckling calves or cattle that are in good healthy condition, eight to twelve months old. Older cattle are much more frequently killed.

2. Inoculate any time from the last of November to the last of March, and it is always best to inoculate the cattle in the South near the place where they shall live.

3. For the infected blood secure a two year old heifer, steer or bull that has had tick fever within a year, or that has had a gross infestation of cattle ticks during the second summer of its life.

4. Secure a sterilized hypodermic syringe (capacity 2 to 3 drams) having two or more strong and sharp sterilized hypodermic needles, a pair of scissors and a sharp scalpel knife, three or four small sterilized, one ounce, breakers or wide mouth bottles, containing a sterile glass rod or small sterile spoon; some absorbant cotton, and some 5 per cent. creolin or other good antiseptic.

5. Every animal to be inoculated should be tied or haltered in a narrow stall before the blood is drawn.

6. Cast the two year old from which the blood is to be drawn or secure it in a standing position. Clip the hair or clip and shave the hair over the jugular furrow or vein and wash with creolin solution and absorbant cotton. Have the assistant to press on the jugular vein near the base of the neck. Press the large hypodermic needle or an aspirating needle into the jugular inclining the point forward and inward. When the needle penetrates the vein the blood will flow freely through the needle. Catch the blood in the sterile beaker or wide mouth bottle. When the beaker or bottle is nearly full, let an assistant take it and stir the blood vigorously and continuously with the sterile glass rod or spoon. The quantity of blood drawn may be regulated according to the number of cattle to be inoculated. As soon as possible after drawing the blood, fill the hypodermic syringe with blood and inoculate the cattle as rapidly as possible, injecting one cubic centimeter under the skin of each animal. The side of the neck and over the shoulder are convenient places for the injection.

7. The dose of blood varies with the age. A young animal will take a relatively larger dose than an old one.

One cubic centimeter is enough for any animal and I have killed old cattle with one-half a cubic centimeter of blood. The second inoculation should be a dose two to three times as large as given at the first.

8. If the first inoculation is made about Dec. 1st the second may be given Feb. 1st to 15th. If the first inoculation produces a severe form of fever do not give a second.

Care of Cattle After Inoculation.

During the inoculation fever, green and laxative feed should be given to them. Have plenty of salt and good water within reach all the time. If the bowels become constipated, a dose (one to two pints) of raw Linseed oil or Epsom Salts (one to two pounds) will usually relieve the constipation. Avoid excessive use of drugs. The fever will run its course and must run its course if it produces any degree of immunity. Therefore, it is unwise to try to break up the fever with drugs.

When the inoculated animal gets off its feed and refuses to eat, wait with patience for one day or more before forcing any food down it. Sweet milk and fresh thin oat meal gruel may be given by bottle per mouth. Be careful not to strangle the animal in giving it. Calves respond well to such treatment, but older animals struggle more and are often injured by pouring the liquid down the trachea. It is not well to let a tick fever animal lie down all the time, especially if it can stand on its limbs and walk. Get it up, rub its legs and let it walk slowly, but not rapidly, for a short time. If the weather is hot and the animal's temperature is above 105 degrees Fah., the animal may be given a sponge bath three to six times per day.. Regulate the baths by the temperature of the air and the animal. When the temperature of the animal falls, stop the baths. If the inoculated animal passes the primary inoculation fever, the second rise of fever may occur between the twenty-fifth and the fortieth day after the inoculation. It is at this time that some cases die. But good care may tide them over.

In preparing for winter inoculation always sow plenty of rye, barley, winter wheat and winter oats for green winter pastures. Nothing will carry cattle through the inoculation fever better than plenty of green pasture, supplemented with plenty of good hay or silage and some grain or concentrated feed like corn, oats and shorts and a little cotton seed. During the summer following the inoculation, see that the animal never becomes grossly infested with ticks. A good pasture, with an abundance of pure water, and salt in constant reach are essentials. Shade and running water or large pools into which the hot cattle can wade and stand will help. Remember that a large number of inoculated and tick infested cattle become stunted, and are poor breeders for one or two years.

TABLE II. *Record of all the Blood Inoculation Made at this Station up to Jan. 1906.*

KIND OF CATTLE	No.	Sex	Where Bred	Age	Immune	Non Immune	Times Inoculated with Blood	Deaths by Inoculation	Deaths during 1st Summer	State	County	Ticks Many	Ticks Few	
Hereford	1	Cow	Ky.	5 yrs.	.....	yes	1	....	......	Ala.	Bullock	......	yes	
"	1	Heifer	Ky.	10 mos.	......	yes	1	......	......	Ala.	"	......	yes	
"	1	Bull	Ky.	1 yr.	......	"	1	......	......	Ala.	"	......	yes	
"	1	Bull	Ky.	6 mos.	......	"	1	......	1	Ala.	Tallapoosa	......	......	
"	1	Cow	Ky.		......	"	1	......	1	Ala.	Wilcox	yes	......	
"	1	Calf	Ky.	6 mos.	......	"	1	......	1	Ala.	"	"	......	
"	1	H.	Ky.	14 mos.	......	"	1	......	1	Ala.	"	"	......	
"	1	Bull	Ky.	18 mos.	......	"	1	......		Ala.	"	"	......	
"	1	Bull	Ky.	1 yr.	......	"	1	......	1	La.	......	......	......	
"	1	Bull	Ky.	1 yr.	......	"	1	......	....	La.	......	......	......	
"	1	Bull	Ky.	1 yr.	......	"	1	......	....	Ala.	Autauga	......	yes	Smith
"	2	Cows	Ky.		......	"	1	......	....	Ga.	McIntosh	......	yes	Davis
"	2	Bulls	Ky.	2 yrs.	......	"	1	......	1	"	"	......	"	"
"	1	H.	Ky.	2 yrs.	......	"	1	......	1	"	"	......	"	"
"	1	H.	Ky.	1 yr	......	"	1	......	....	"	"	......	"	"
"	1	Bull	Ky.	1 yr.	......	"	2	......	....	"	"	......	"	"
"	3	Calves	Ky.		......	"	1	......	....	"	"	......	"	"
"	1	Bull	Ky.	1 yr.	......	"	2	......	....	Texas	......	......	"	
"	1	Bull	Ky.	1 yr.	......	"	1	......	....	N. C.	......	......	"	
"	2	Bulls	Ky.	1 yr.	......	"	1	......	....	Ala.	Baldwin	"	......	
"	1	Heifer	Ky.	20 mos.	......	"	1	......	1	"	Baldwin	"	......	
"	1	Cow	Ky.	4 yrs.	......	"	1	......	1	"	Dallas	"	......	Packard
"	1	Calf	Ky.	6 mos.	......	"	1	......	1	"	"	"	......	"

TABLE II. *Continued*

KIND OF CATTLE	No.	Sex	Where Bred	Age	Immune	Non Immune	Times Inoculated with Blood	Deaths by Inoculation	Deaths During 1st Summer	State	County	Ticks many	Ticks Few	
Hereford	1	Heifer	Ky.	14 mos.	......	yes	1	......	1	Ala.	Dallas	yes	......	Pachard
"	1	Bull	Ky.	2 yr.	......	"	1	......		"	"	"	......	"
"	1	Cow	Ky.	5 yrs.	......	"	1	......	1	"	Talladega	"	......	Hill
"	1	Bull	Ky.	1 yr.	......	"	1	......	....	"	"	"	......	Robinson
"	1	Heifer	Ky.	1 yr.	......	"	1	......	....	Ga.	......	......	......	Leigh
"	1	"	Ky.	18 mos.	......	"	1	......	1	Ala.	Hale	"	......	Allen
"	1	"	Ky.	1 yr.	......	"	2	......	....	"	"	"	......	"
"	2	Heifers	Ky.	2 yr.	......	"	1	......		"	Chilton	......	......	1 Died March 12, 1904, Gulledge
"	1	Bull	Ky.	15 mos.	......	"	1	......	1	"	Jefferson	......	......	Lovell
"	6	Heifers	Ky.	12 to 20	......	"	1	......		"	Clay	"	......	Street, 1 Heifer inoculated twice
"	1	Bull	Ky.	18 mos.	......	"	1	......	4	"	"	"	......	Street,
"	1	Cow	Ky.	6 yrs.	......	"	1	......	....	Cuba	......	"	......	Beattie
	5	Bulls	Ky.	2 yrs.	......	"	1	......		"	......	"	......	"
"	1	"	Ky.	15 mos.	......	"	1	......	1	Ala.	Clark	....	......	First District Agricultural School
"	1	"	Ky.	6 mos.	......	"	1	......	....	La.	......	"	......	Bland M. Pleasant, La.
"	1	"	Ky.	5 mos.	......	"	1	......	....	Ala.	Lee	"	......	Floyd
"	1	"	Ky	15 mos.	......	"	1	......	....	"	Chambers	"	......	Andrews
"	1	"	Ky.	12 mos.	......	"	1	......	....	Ga.	......	"	......	Maddox & Young, Moreland, Ga.
"	1	"	Ky.	3 yrs.	......	"	1	1	....	Ala.	Lee	......	......	Died 31 days after inoculation
"	1	H.	Ky.	2 yrs.	......	"	1	1	...	"	"	......	......	" 35 " " "
"	1	Cow	Ky.	6 yrs.	......	"	1	1	....	"	"	......	......	" 36 " " "
"	1	Bull	Ky.	14 mos.	......	"	1	1	....	"	"	......	......	" 39 " " "
"	1	Cow	Ky.	3 yrs	......	"	1	1	....	"	"	......	......	" 34 " " "
"	1	Bull	Mo.	1 ...	......	"	1	......	....	"	Sumter	......	"	H. A. Haralson, Coatopa, Ala.

TABLE II. *Continued*

KIND OF CATTLE	No	Sex	Where Bred	Age	Immune	Non Immune	Times Inoculated	Deaths by Inoculation	Deaths During 1st Summer	State	County	Ticks Many	Ticks Few		
Hereford	1	H.	Mo.	1 yr.	....	yes	1	....	....	Ala.	Sumpte		yes	H. A. Haralson Coatopa Ala	
"	9	H.	Mo.	8 to 18 m	....	"	1	....	....	"	Dallas	yes		J. E. Dunaway, Orrville, Ala.	
"	1	Bull	Mo.	10 mos.	...	"	1	....	....	"	"	"		" " "	
"	1	"	Va.	10 mos.	....	"	2	....	....	"	Lee	"		C. G. Lee, Opelika, Ala.	
"	40	H. & B.	Ky.	12 mos.	....	"	3	....	6	"	Talladega			Giltner Thornton Cattle Co.	
Angus	2	Bulls	Mo.	8 mos.	....	"	2	....	....	Texas		"		Robert Adams, Alford, Texas, (Elliotts)	
"	1	"	"	10 "	....	"	2	....	....	Ala.	Lee	"		Whatley, Opelika, Ala. (Elliotts)	
"	5	"	"	7 to 10	....	"	2	....	....	"	Sumter	"		W. G. Little, Livington Ala. (Elliotts)	
"	4	Heifers	"	6 to 11	....	"	2	....	....	"	"	"		" " " "	"
"	4	"	"	8 to 12	....	"	2	....	....	"	Washington	"		H. K. Milner, Birmingham, Ala.	"
"	3	Bulls	"	8 to 14	....	"	2	....	....	"	"	"		" " " "	"
"	1	"	"	8 mos.	....	"	2	....	....	"	Talladega	"		N. C. Rew, Talladega, Ala.	"
"	1	Heifer	"	6 "	....	"	2	....	....	"	"	"		" " " "	"
"	1	Bull	"	6 "	....	"	2	....	....	"	Macon	"		C. F. Darnell, Notasulga, Ala.	"
"	2	"	"	12 "	....	"	2	....	....	"	Talladega	"		W. L. Thornton, Talladega, Ala.	"
"	1	Heifer	"	7 "		"	2	....	....	"	Lee	"		Ala. Experiment Station	"
"	1	Bull	"	12 "	....	"	2	....	....	"	"	"		" " "	"
"	1	"	"	12 "	....	"	2	....	....	"	Lowndes	"		J. E. Callier, Calhoun, Ala.	"
"	1	Heifer	"	7 "	....	"	2	....	....	"	"	"		" " " "	"
"	1	Bull	"	7 "	....	"	2	....	....	"	Colbert	"		J. S. Kernachan, Florence, Ala.	"
"	1	"	"	6 "	....	"	2	...	1	Cuba		"		W. F. Ward, Auburn, Ala.	"
"	1	Heifer	"	5 mos.	....	"	1	....	....	Ala.	Sumter	"		W. G. Little Livington, Ala.	
"	1	"	"	3 mos.	....	"	1	...	..	"	"	"		T. J. Smith, " "	
"	2	"	"	5 mos.	....	"	1	...	....	"	"	"		Allison Bros., Bellany, "	1904
"	1	"	Ky.	20 mos.	....	"	1	....	....	"	Lowndes	"		Norwood & Callier, Calhoun, Ala.	1905

TABLE II. *Continued*

KIND OF CATTLE	No.	Sex	Where Bred	Age	Immune	Non Immune	Times Inoculated	Deaths by Inoculation	Deaths 1st Summer	State	County	Ticks Many	Ticks Few	
Angus	1	Heifer	Ill.	33 mos.	....	yes	1	....		Ala.	Lowndes	yes	......	" " " "
"	1	Bull	Ky.	9 mos.	....	"	1	....		"	"	"	......	" " " "
"	4	"	Ky.	8-12	....	"	1	....		"	Wilcox	"	......	Boykin, Akerville, Ala.
"	5	Heifers	Ky.	8-12	....	"	1	....		"	"	"	......	" " "
Short Horn	34	"	Tenn.	8-18mos	....	"	1	....		"	Dallas	"	......	J. E. Dunaway 1903-'04
"	1	Bull	"	8 mos.	....	"	1	....		"	"	"	......	"
"	15	"	Mo.	12 to 15	....	"	2	....	5	Tex.	....	"	......	Amer. Short Horn Breeders Ass. 1904-05
"	1	"	Iowa	15 mos.	....	"	2	....	1	Ala.	Chambers	"	......	A. S B. A. Slaughter, LaFayette
"	2	Heifer	Mo.	12 to 15	....	"	2	....	1	"	"	"	......	A. S. B. A. " "
"	1	Bull	Mo.	12 mos.	....	"	2	....		"	Lee	"	......	" Edwards, Opelika, Ala.
"	2	H.	Mo.	10 mos.	....	"	2	....	1	"	"	"	......	" " " "
"	1	Bull	Mo.	12 mos.	....	"	2	....		"	Dallas	"	......	" C. Kirkpatrick, Cahaba
"	1	"	Mo.	14 mos.	....	"	2	....		"	Perry	"	......	" S. L. Scott, Marion, Ala.
"	1	Heifer	Mo.	12 mos.	....	"	2	....		"	"	"	......	" " " "
"	1	Bull	Kan.	14 mos.	....	"	2	....		"	Lee	"	......	" G. C. Floyd, Opelika "
"	11	Heifer	Mo.	7 to 12	....	"	2	....		Miss.	....	"	......	" A. T. Stoval, Okalona, Miss
"	5	"	"	8 to 12	....	"	2	....		Ala.	Washington	"	......	" H. K. Milner
"	2	Bulls	"	12 mos.	....	"	2	....	1	"	"	"	......	" "
"	1	"	"	12 mos.	....	"	2	....		"	Sumter	"	......	" W. G Little
"	1	Heifer	"	12 mos.	....	"	2	....		"	"	"	......	" R. Seale
"	2	"	Kan.	12 mos.	....	"	2	....		"	"	"	......	" "
"	4	"	Mo.	10 mos.	....	"	2	....		"	Clay	"	......	" J. C. Street, Opelika
"	1	Bull	"	10 mos.	....	"	2	....		"	"	"	......	" " "
"	1	"	"	10 mos.	....	"	2	....		"	Lee	"	......	" T. Wimberly

TABLE II. *Continued*

KIND OF CATTLE	No.	Sex	Where Bred	Age	Immune	Non Immune	Times Inoculated	Deaths by Inoculation	Deaths During 1st Summer	State	County	Ticks Many	Ticks Few	
Short Horn	1	”	Mo.	12 mos.	....	yes	2	....		Ala.	Lee		yes	A. S. B. A. Ala. Expt. Station
”	1	”	Ky.	15 mos.	....	“	1	....			Dallas	yes	......	” C. Kirkpatrick Cahaba, ’05
”	9	Heifers	Ky.	8 to 10	....	“	1	....			“	”	....	” ” ” ’04
”	16	”	Ky.	6 to 10	....	“	1	....	6		“	”	....	” ” ” ’05
”	2	Heifers	Ky.	4 to 7	....	“	1	....	1		Marengo	”	......	R. Seale Livingston, Ala.
	1	Bull	....	6 mos.	....	“	1	....			Sumter	”	......	Edmonds, Coatopa, Ala.
	1	Bull	....	4 mos.	....	“	1	....			Sumter	”	....	J. L. Horn, Coatopa, Ala.
”	1	Bull	....	10 mos.	....	“	1	....			Butler	”	......	J. T. Watt, Greenville, Ala.
”	1	”	Mass	8 mos.	....	“	1	....			Elmore	”	......	W. E. Benson, Kowaliga, Ala.
”	2	”	......	4 to 7	....	“	1	....	1		Marengo	”	......	R. L. Seale, Livingston, Ala.
”	9	Cows	Pa.	1 to 16y	....	“	1	2			Macon	”	......	Tuskegee Normal School 1903-1904.
”	3	Bulls	Pa	2 to 3	....	“	1	....			Macon	”	......	“ “ “
”	5	Bulls	Ky.	8 to 12	....	“	1	....			Talladega		....	Giltner Thornton Cattle Co.
”	6	Bulls	Ky.	8 to 12	....	“	1	....			Wilcox		......	B. L. Boykin, Ackerville, Ala.
”	37	Heifers	Ky.	8 to 12	....	“	1	....	2		Wilcox		......	“ “ “
Gurnseys	11	Cows	N.Y.	1 to 12	....	“	1	2			Macon	“	......	Tuskegee Normal School 1903-1904
Holstein	7	Cows	Pa.	2 to 9	....	“	1	2			Macon	“	......	“ “ “ “
”	1	Heifer	N.Y.	8 mos.	...	“	1				Sumter	“	......	W. K. Pickens Livingston.
Jerseys	9	Cows	Pa.	1 to 12y	....	“	1	2			Macon		....	Tuskegee Normal School 1903-1904.
”	3	Cows	Ky.	4 to 12	....	“	1	7			Lee		....	1903-1904
Grades	70	Cows	Pa.	1 to 16	....	“	1–2	1	2		Macon	“	......	Tuskegee Normal School
”	1	”	Ky.	7 yrs.	....	“	1						......	
”	1	”	Ky.	6 yrs.	....	“	1						......	
”	1	”	Ky.	4 yrs.	....	“	1						......	
”	1	”	Ky.	15 yrs.	....	‘	1		1				......	
Total 448					....			21	48				....	
45					....				4				......	No. inoculated previous to the 448
Total 493					....			21	52				......	Total No. up to Jan. 1 1906.

Table II gives a record of all blood inoculations up to January 1, 1906:

The percent of deaths from inoculation is................ 4.26

The per cent. of deaths the first summer after inoculation 10.54

The total per cent. of deaths........................ 14.80

One hundred or more of these cattle were too old and not a few were either too fat or too poor to withstand the inoculation. Out of 106 inoculated at Tuskegee, 15 died of inoculation fever and only one died during the first summer. The majority of the 106 were over two years old. While the average per cent. of deaths is high, taking the cattle at any age as they come and in all conditions; with a great variety of kinds of care and treatment, the losses are not as great as one should expect were like conditions presented.

Selected Temperature Records Following Blood Inoculations for Immunity.

TABLE III

DATE		46		169		58		32		37		86	
1904–1905		am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
December	1	103.8	105.1	102	103.1	101.3	102.3	104	105	103.1	104	101.2	103.3
	2	103.2	103.8	104	104	104.2	104.1	104	104.4	103.4	103.8	104.3	104
	3	104.5	103.9	104	103.9	104.2	104.5	104	104.1	102.2	105.4	103.5	105.4
	4	102.9	102.5	103.8	103.1	104	103.4	104.9	103.2	105.4	103.5	104.2	104
	5	103.8	103.5	105	103	103.2	104.5	104.5	104.2	104.5	105	103.9	104.5
	6	101.5	103.8	103.1	102.8	101.4	102.5	105.1	104.5	103.4	104.8	102.9	104.2
	7	101.8	102.9	101.8	104.5	103.4	103.4	104.9	105	103.1	104.5	105	106.1
	8	105.4	104	102.8	102.2	105	104.4	103.5	104.8	104.8	105.5	105	104.2
	9	104	105.9	102	102.2	104.5	104.1	104	105.1	105.1	106	105.9	105.9
	10	105.9	104.1	103.4	102.5	105.1	104.8	104.1	101.8	105.5	106	104.5	105
	11	101.5	106	101.5	102.9	104.8	104.1	103.5	103.1	102	103	104.5	102.9
	12	103.1	103.8	102.8	102.2	102.5	101	103.5	103.1	103.5	102.9	104.8	103.8
	13	101.9	104	102	103.8	101	102	101	103	101.5	101.9	103	103.8
	14	103.9	101.8	101.2	102.4	101	101.3	103.1	103.1	102.9	102.9	101.1	102.9
	15	102	102.3	101.9	102.3	101	101.3	103.8	103.6	103.9	103	101.9	102.8
	16	101	102.4	102.1	101.9	101.9	102	103	104	104	103.1	101.5	101.5
	17	102	102.4	102	102.6	102	102.5	104	102.8	103.2	102.6	103.9	103.3
	18	101	102.5	102.5	103	101.8	102	104	105.4	103.1	102.9	102.1	104.5
	19	101	102.9	101.8	102.9	103	102.9	102	103	102.1	103.2	102.9	103.8
	20	101	103	102.4	103.8	102.1	103.2	102.9	104.5	101.9	102.8	103.9	103
	21	101.5	104	102	103.5	103	104.9	102.4	103	102	103.2	102.9	104.5
	22	101.8	101.9	100.9	102.9	104.5	105.9	103.9	103.5	102.8	103.4	102	102.9
	23	102	103.8	101.8	103.8	106.5	106.9	103	103.8	103.5	106	102	103.5
	24	102.9	102.4	102.8	101.8	105	102.6	103.8	101.5	105	102.4	102.8	100.2
	25	103.4	104	103.4	102.4	102	103.2	103.5	104.6	102.6	102.8	103	103
	26	103.8	104.2	103.4	102.3	102	104.6	104	106.1	103.2	102.5	103.2	103.3
	27	102.5	99	102.6	101	102.8	100.[illegible]	[illegible]04.6	103	103.5	99.6	104	100.3
	28	101.3	101.9	103.6	103.3	101	103.3	102.2	101.8	101.8	104.5	101.3	102
	29	101.7	102	102.8	103.5	101.5	102.9	101.3	102.9	101.7	102.4	102.2	102 4
	30	101.2	102.8	104	105.4	102	103.2	102.9	103.5	101	101.9	105.5	104.4
	31	102	102.9	102.5	104.5	103.5	103.8	104	104	101	103.2	100.9	103.8
January	1	101.4	102.9	102.2	103.9	103.9	105.2	104	105	101.9	102.6	103	104.4
	2	103	102.8	102	105.5	103.9	103.9	105	105	102.9	103.2	102	100
	3	102	103	102.9	105.2	103.9	104.2	103.9	105.5	102.8	104.2	102.9	103 5
	4	102.5	102.9	100.9	104.8	101.9	102.5	105	103.9	102.9	103.8	102	104
	5	103.5	104	102	104.5	102	103.5	105.8	103.6	103.5	104.9	103	103.6
	6	103.5	103.9	104.5	104.5	103.9	103.5	105.4	104.8	104.5	103.5	103.5	104 5
	7	102.5	103.8	103.4	105.2	102.9	104.2	104.2	105.9	103.9	104.5	103.5	104
	8	104	104.5	104	104.9	103.8	104.9	103.5	107	105	105	102.5	104
	9	103.9	103.8	103.4	103.9	104	105	103.2	104	104.4	102.5	104.4	104.5
	10	104	103.2	103.5	104.8	103	104.8	103.5	103.8	104	105.8	105	105.2
	11	103	102.2	102.5	104	105	102.9	104.4	105.5	104	106	104	104.5
	12	103.2	102	104	103	104.9	103	105	103.5	105.2	105	105.5	104.2
	13	103	102.5	104.2	102.5	103.2	102.8	104.5	102.5	105	104.5	105	103.8
	14	102.5	104.5	102.4	102.5	102.9	102	102	103.5	103.5	101.2	104.4	103.8
	15	101.9	104	101.8	102.5	101.5	102.2	102.8	101.5	104	104	102.8	105
	16	104	104.5	101.5	103.5	101	102.5	101.8	102.8	103.2	104.5	102 4	104 8
	17	102.4	103	100.9	104	100.5	102.5	102.4	103.5	103	104	101.5	103.2
	18	102	103.2	100.5	102	101	102	103	104	103.5	104.4	101.2	103
	19	102.5	103	101.9	101.9	102.5	104.5	104.5	104.5	103	103.5	103	102 5
	20	102.9	102	101	101.5	104.5	103.5	103.9	102	103	103	103.5	103
	21	101.4	102.5	101.5	101.5	103	104	102.9	104.5	102.5	102	101	103.2
	22	101.5	102.5	102	101.5	102.5	101.5	103.5	102.5	102.5	104	101 5	102 4
	23	101.9	101	101.5	100.5	100.4	102.9	101.9	101.5	102 5	102 5	102 4	102
	24	103.4	102.5	100.5	101.9	101.5	101.8	103	103	101	102.8	101.9	103
	25	100.9	101	101	102	100.5	101.2	102.5	101.5	102	[illegible]	101	101.9
	26	101.5	102.5	102.5	101.9	100.5	102.5	102.4	101.9	101.5	101.5	101 8	101
	27	102.2	102.5	103.2	102	101.9	101.2	102.5	102.9	101	103.2	102.5	102.5
	28	100.4	103	101	102	101.4	101.8	102.9	102.5	102	100.5	102	103
	29	101	102.8	100.9	101.2	102	101.2	101.9	102	101.5	102.9	101.8	101.4
	30	102	102.8	102.8	101.5	102	102.4	103	102	101.5	100.5	103.2	101.5
	31	101	102.9	102.5	102	101.5	102.5	101.5	103	102.5	101	103.5	104

Table III. Continued

DATE 1904–1905		46		109		58		32		37		86	
		a m	p m	a m	p m	a m	p m	a m	p m	a m	p m	a m	p m
February	1	101	101.5	101.5	101.5	102.2	101.9	101.9	102.5	101.9	101.5	102	102.9
	2	101	101.5	101.2	102.5	101.5	102	104.5	102	102	102	102	101
	3	102.5	102.5	102.5	102.9	101	100.9	101.9	102	102.9	102.5	102	102.9
	4	100.9	100.5	101	102	101	101.5	102	102.2	102	100.9	101	102.2
	5	102	102.5	101	102.9	101.2	102.9	103	102.5	102	102.5	100.5	101.5
	6	101.5	102	102.9	101.5	101.5	101.9	103.1	102	103.5	102	102	100.9
	7	100.5	101	101	102	101	102.9	101.5	101.5	101.9	102	102	100.9
	8	101.5	101.5	101.5	101.5	102.5	103.2	102.2	102	102	101.5	100.5	102.5
	9	101.5	102	102.4	102.2	102	102	102.8	102.5	101.9	103.5	102.4	103
	10	101.5	102	101	103.2	101.8	102.5	102	102.5	101	103	103.5	103.9
	11	103	102	102	102.2	102	101.5	102	102.5	103	101.5	100.9	102
	12	101	101.4	102.5	102	100.5	102.5	103.6	102.3	101.8	101.5	101.4	101.6
	13	102	100	101	101	101.5	102.4	102.8	101.2	102.5	100.5	102	100
	14	101.5	102.3	101	102.2	102	103.5	101.5	102.9	101.6	102.5	100.2	102.5
	15	101.4	101.9	101	102	100.8	102.5	101.4	101.5	101.6	102.5	101.5	102 5
	16	100.2	102.5	100.5	101.5	101	102.5	101.8	102	100.3	101.5	101.8	102 5
	17	101.9	102.5	101.5	103	102	102.5	101.5	102.6	101.8	102.8	101.5	102 6
	18	102.5	102.5	100.6	102.8	104.5	104.5	101.9	101	101.5	102.5	101.5	102.9
	19	102	102.5	102	103.2	105	104.5	101.5	102	102	100.5	100.9	101.5
	20	102	103	103	102	102.9	104.3	101.5	102.9	101.2	102.2	102	101.8
	21	102.5	103	102	102	103.2	105	102	101.9	100.2	102	101.5	102
	22	101.5	101.6	102	103	102.6	101.2	102	103.5	101.9	103.8	102	103.2
	23	101.5	102	102.5	102.5	102.9	103	102	103.5	102.9	103.2	103.5	102.8
	24	100	102.5	102.5	102.5	100.5	102.5	101.5	102.9	102.9	103	101.9	101
	25	102.5	103	102.9	103	101.5	102.5	102.9	103	103	103	102.9	103.5
	26	101	101.9	102	104	103	102.5	102.5	103.5	102.5	104	102.5	101.5
	27	102	103.4	101.5	104	101.4	103	102.5	103.5	102.5	103.5	101	103
	28	102.8	102.8	103	103.4	103.8	103.5	102.5	103.5	102.5	103.5	102	102.9
March	1	103	103.8	102	103	102.9	103	102.2	103.5	103	104	102	102.5
	2	104	101	103.5	104	102.5	103.4	102.5	105	104.5	104.2	102.5	103
	3	100	101.5	102	103.5	102	103.5	102	104	103.5	105	100	102.2
	4	101.5	102.9	103	104	101.5	102.9	103	104.2	102	104	101.9	103
	5	.....	.....	104	103.5	102	103.5	103.5	105	103.5	104.5	101.5	104.5
	6	.....	.....	103	103.9	104	104.5	104.5	104	104.5	105.2	103.5	103.9
	7	.....	.....	103.5	103.5	101.5	103	103.2	104.5	103.5	104.8	101.9	102 6
	8	.....	.....	102	103.5	104.2	104	101	102	104.2	105	103	103 5
	9	.....	.....	101.5	102.3	103	104	102.5	103.4	102	103.5	103	103
	10	.....	.....	103	[illegible]	102	102.5	100.9	102.6	103	103.5	103	103.1
	11	.....	.....	[illegible]	[illegible]	100.9	101.5	102	101.9	103.5	102.6	101	101.5
	12	.....	.....	102.9	103	101.9	102.5	101.5	101.9	102.5	103	101.9	103
	13	.....	.....	102.5	103.6	102	102.5	102	103	102.9	102.9	102	101.5
	14	.....	.....	102.2	103.5	101.5	103.5	102	103.6	102.5	104	101.5	102.2
	15	.....	.....	102.9	104.4	101.2	103.2	103	103.8	102	104.5	101.2	103.5
	16	.....	.....	103	105	103	104.2	105	104.5	102.2	104.6	103.2	102
	17	.....	.....	103	104.2	101.2	103.9	103	103.6	103.5	104.9	103	103.5
	18	.....	.....	102.5	104	102	103.5	101	103.9	102.5	103.9	102	103.5
	19	.....	.....	102	103.2	102.5	104	103	103.5	103	104.9	102	103.9
	20	.....	.....	102	103.5	101.9	104	102	104	102	104.2	102	103.2
	21	.....	.....	102	103	102	103.7	102.9	103	102.5	104.5	102.3	103.5
	22	.....	.....	103	102.5	103	104	102.8	104	103	104.9	102.5	103.5
	23	.....	.....	102	103.9	103.5	103	102.5	103.9	104	104.5	102.5	103
	24	.....	.....	102	102	101.9	104	102.5	104	103.5	105	102.5	103.9
	25	.....	.....	102	102.5	103	104	101.5	104	104	104	102.5	102.9
	26	.....	.....	101.9	102.9	101.9	104.5	102	103.9	103	104	102	103.5
	27	.....	.....	101.5	102.9	101.2	104.5	102.5	103.9	101.5	105	102	104
	28	.....	.....	101	102.5	102.9	105.5	102.9	103	102.5	105	103.5	104.5
	29	.....	.....	.....	.....	101.5	102.5	.....	.....	104	104.4	101.5	102.2
	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Table of Selected Temperature Records of Inoculated Cattle that Died of Inoculation Fever.

TABLE IV.

DATE		538		649		644		650		648		609	
1907		am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
January	16	100.8	101.2	101	101.2	104	101.4	101	106.3	101	101.2	101.6	101.8
	17	101.2	102	101	101	101	102	102.4	102	101	101	101.6	101.8
	18	104.4	100.6	100.6	101.6	101	101.6	102.4	100.2	101.4	101.6	101	102
	19	101.2	102	101.8	101	100.8	101.4	102.2	101	101.3	101	101.4	100.8
	20	101.6	103	101	101	101	102.4	100.4	102	102	101.4	100.4	101.8
	21	101.6	104	101.8	104	102.4	102.2	102.2	104.2	100.4	101	101.4	102
	22	105	104.8	105	102.2	104.6	105.6	101.8	101	101	101.6	101.8	102.6
	23	101.4	104	102.6	105.8	104.4	102.8	100.4	102.2	101.8	102.2	101.4	102
	24	100	101	105.6	105	104	104.8	101.4	102	103.6	104	101	102.3
	25	102.2	102	104	100	102	105	101.6	101.2	102	102.4	101	102.1
	26	100.4	100.6	99.8	101.8	102	102	101.2	98.4	101.2	103.6	101.8	102
	27	101.6	104	101.2	101	101.6	101.4	102	102.4	101	104	102.2	102
	28	101.6	101	102.2	102.8	101	101.4	100	101.8	103	103.4	101.8	99.3
	29	101.4	100.4	103.4	101.4	102.5	102.6	101.6	99.5	104	105	101.6	101
	30	102	103.8	102	103.4	101	102.4	102	102	102	103.2	101.6	101.4
	31	101.4	102.4	103.4	104	102.2	102	102	104.6	103	101	102.4	103
February	1	102	103	102	103	103	102.2	100.6	102	103	102	102.4	101.8
	2	101.4	103.2	102	101.2	103	104.6	101.6	101.6	101	102.2	102	102
	3	103.8	103.2	102	103	103	101.9	101.2	101.2	101	102.2	102	103
	4	100.6	103	102.2	103	103	103	101	104	101.7	102	102.2	102.4
	5	100	103.2	101.6	102.2	103	102.8	101.2	103.2	101	103	101	102
	6	101	103	103	103	102.8	103	102	102.8	101.2	103.2	102	103
	7	102.2	102.8	102	102.2	103	103.4	103	103	102.1	102.8	101.8	102.2
	8	102.6	104.2	102.4	102	102.2	105.6	101.6	102	102	104	101.8	106.2
	9	103.4	103	103	102	104.3	104.9	101.6	102.3	103	103.9	104	104.2
	10	102.8	102.8	101.2	102.3	103	105.3	102	102.4	101.8	102.5	103	105
	11	101.4	100	102.2	99.4	104	105.4	101	100.2	100.8	100	104.4	105
	12	104	104.6	101.4	102.4	104.6	104.2	101.8	102	101	102.7	103.8	104.2
	13	104.8	104.8	102	101.4	103.2	103.6	101.8	100.8	101	104	99.2	101.6
	14	104.6	103.2	101	101.6	104	105.6	101.8	100.2	104.4	103.8	103	104.6
	15	99	101.8	101.4	102.8	102.8	102.6	102.2	102	100.2	100.8	98.5	99.4
	16	99	.....	101.6	102	102	103.4	101.7	100	101.4	101.2	100	100
	17	.....	.....	102.6	103	104.2	105.6	102	102	101.4	103.6	100	100.5
	18	.....	.....	103.8	104	101.6	102.3	102	101.6	102.6	102	.....	.....
	19	.....	.....	102.6	103.4	104.2	104	103.8	99.1	103	104	.....	.....
	20	.....	.....	102.6	103.4	103.5	104	101.8	.....	102.2	103	.....	.....
	21	.....	.....	102	102.6	104	103.2	.....	.....	103.2	102.2	.....	.....
	22	.....	.....	103	105.4	104	103.8	.....	.....	103.6	104.5	.....	.....
	23	.....	.....	98	101.8	104	105.6	.....	.....	103.4	102.3	.....	.....
	24	.....	.....	102	105	102	105.6	.....	.....	101	101	.....	.....
	25	.....	.....	102	105.4	98.5	104.6	.....	.....	100.2	100.6	.....	.....
	26	.....	.....	99	102	101	105	.....	.....	.....	.....	.....	.....
	27	.....	.....	100.2	104	102	103.6	.....	.....	.....	.....	.....	.....
	28	.....	.....	101	102.4	100.8	101.3	.....	.....	.....	.....	.....	.....
	29	.....	.....	101	.....	100	102	.....	.....	.....	.....	.....	.....
March	1	.....	.....	.....	.....	100	101.4	.....	.....	.....	.....	.....	.....
	2	.....	.....	.....	.....	99.4	101	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	102	100	.....	.....	.....	.....	.....	.....
	4	.....	.....	.....	.....	98	99	.....	.....	.....	.....	.....	.....
	5	.....	.....	.....	.....	98.5	98	.....	.....	.....	.....	.....	.....
	6	.....	.....	.....	.....	98.8	.....	.....	.....	.....	.....	.....	.....
	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE IV. *Selected Records of 15 Deaths from Inoculation*

Number of the Animal	Days after 1st Inoculation Died	Days af er 2nd Inoculotion Died	Highest Temperature	Lowest Temperature	Age, Breed, Condition of Animals, Etc.
691	13		107.4	97.8	Grade Jersey
611		22	105.6	99.8	
607	11		107.2	100.6	
649	46		105.8	98.	
580	17		106.8	96.	
655	18		107.2	99.8	
650	37		104.6	98.4	Very fat Gurnsey 12 yrs. old
648	41		105	100.	Very old cow
609	35		106.2	98.5	Jersey cow, 9 yrs. old
646	13		106.4	100.	
623	18		106.8	100.4	Holstein cow, 8 yrs. old
658	13		107.2	103.	Short Horn cow
654		9	107.	100.	Short Horn cow, 4 yrs. old
538	33		104.8	99.	Grade Holstein cow, 7 yrs. old
644	52		105.6	98	Grade Gurnsey cow, 8 yrs. old

This table shows that a small number die after the second inocululation and that the temperature falls to sub-normal just before death.

The following descriptions of eight kinds of ticks were compiled by Mohler from Salmon and Stiles' work on "The Cattle Tick" and these and Figs. 1, 2, 3 and 4 are taken from Farmers' Bulletin No. 258 of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C.

TEXAS FEVER, OR CATTLE, TICK (*Boophilus annulatus.*) —Figure 3, No. 1a, shows the natural size of an adult female Texas-fever tick, whose characteristic markings are better brought out in No. 1, magnified four times.[a] This tick may be readily distinguished from the other seven ticks by the small size and the color of the head and shield, the so-called head parts, whose lateral borders are straighter and more parallel, as shown in No. 1b. These head parts are short and relatively broad and dark reddish brown or chestnut brown in color, appearing as a convex plate on the median line at the fore end of the

a In figures 3 and 4 various ticks that infest cattle are shown as follows: The natural sized nature female tick, this tick mangnified four times, and the head and shield of the same enlarged ten to fifteen times.

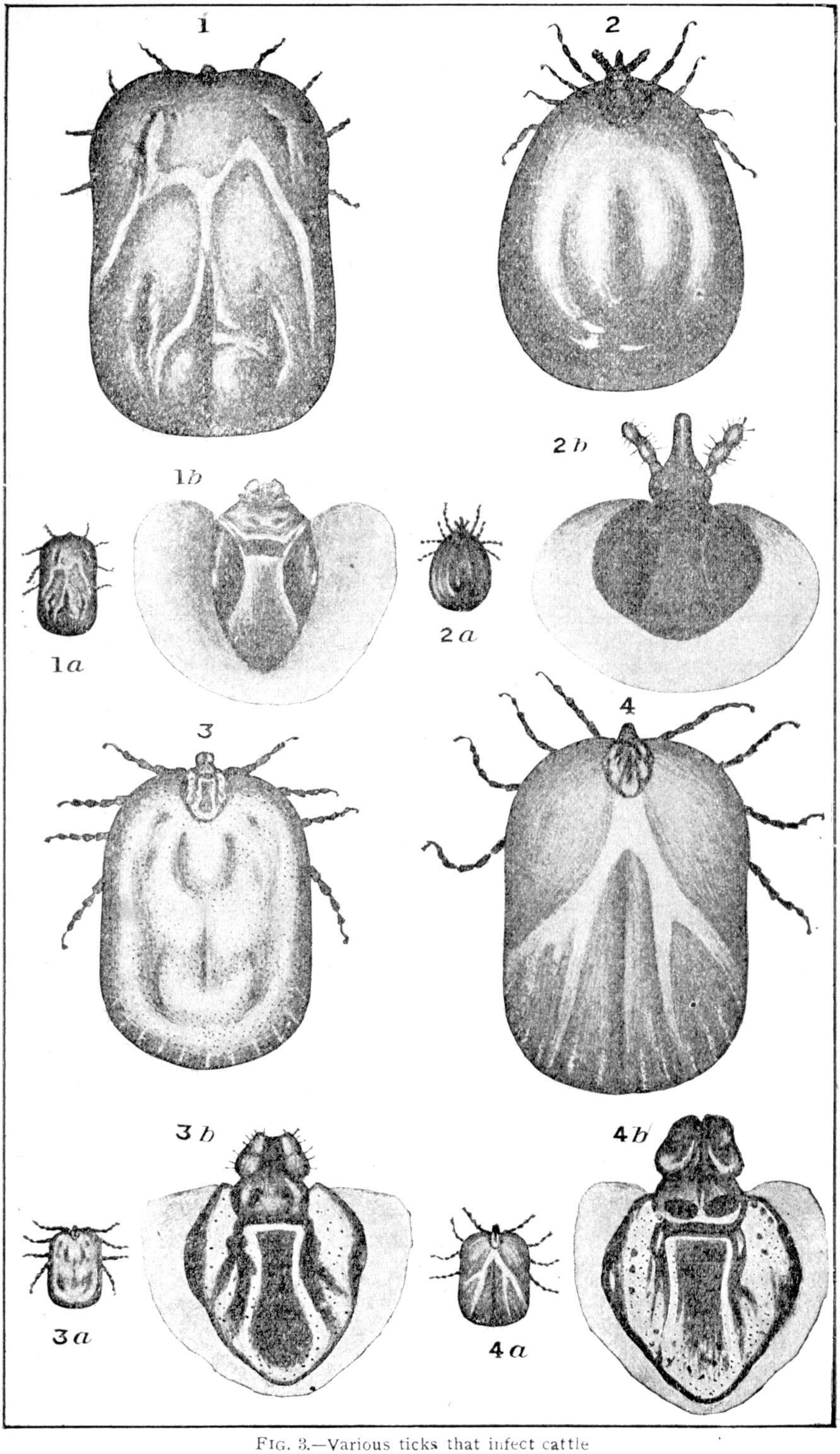


FIG. 3.—Various ticks that infect cattle

tick. The body is oblong oval in shape and may reach one-half inch in length. The color varies from a dull yellow to an olive brown; often it is mottled with irregular areas of yellow and brown or streaked with wavy lines of these colors. Two grooves or indentations are seen running from the front to the rear on the skin of the back, which become almost, if not entirely effaced at about the middle of the body. Another groove is seen between these two grooves in the posterior half of the body. These grooves are caused by the contraction of the muscles of the body and therefore vary considerably, entirely disappearing when the tick is full of blood. They are very distinct when the ticks have been removed from cattle several days. The four pairs of legs are brown, moderately long, and very slender. This tick is found principally on cattle, less frequently on horses, mules, and asses, and in one case it was found on a deer. The Federal quarantine line indicates the northern boundary of the section of the United States infested with fever ticks.

CASTOR-BEAN TICK (*Ixodes ricinus.*)—The body of this tick (fig. 3, Nos. 2 and 2a) resembles in shape that of an eggplant, and it takes its name from its similarity to the bean of the castor-oil plant. It is lead colored, with a variegated mixture of yellowish red, brown, or gray. The body contains two anterior grooves that slightly diverge from each other, and three posterior grooves, the middle one of which is straight, while the other two are curved outward. The mature female is from three-eighths to seven-sixteenths inch long and has four pairs of dark-brown thin legs. The head and adjacent shield are a shiny dark brown or a chestnut brown, the latter portion being five-sided, like a pentagon (No. 2b), with lateral borders prominent and rear angle rounded. Two stout and well-developed feelers (palpi) may be seen extending outward on each side of the head. This tick has been collected from sheep, cattle, goats, horses, deer, dogs, cats, foxes, rabbits, birds, man, and a few other animals.

It was one of the first ticks studied, and has a very wide distribution in the United States.

NET TICK (*Dermacentor reticulatus.*)—The body of the adult female tick is oblong oval, five-eighths inch long, and of a deep brown or slate color (fig. 3, Nos. 3 and 3a). It has four pairs of brown legs of moderate length. The skin of the back and head is covered with fine points, or punctations, which almost disappear at this stage. Besides the grooves that are located like those in the cattle tick, there is a marginal groove extending around the body just inside the border. There are also eleven small indentations (festoons) arranged about the posterior margin of the body. These festoons and grooves become shallow or effaced in the adult stage. The shield portion of the head parts has a silvery white metallic rust extending along the two sides and posterior portion (No. 3b). It may have a rose or greenish tinge. The head is larger than that of the cattle tick. The net tick has been found on man, cattle, horses, sheep, and deer; and in this country it seems to be most common in the West, especially in California, Texas, and New Mexico.

AMERICAN DOG TICK; ALSO CALLED WOOD TICK (*Dermacentor electus*).—This tick (fig. 3, Nos. 4 and 4a), resembles the net tick (*Dermacentor reticulatus*) so closely that a hand lens must be used to distinguish between them. However, it can be readily known from the Texas fever tick by the fact that the so-called head parts are longer and broader (No. 4b). Here there is also a yellowish white rust in the posterior portion which extends anteriorly along each side as two bright, iridescent lines separated by a central brownish area. The body is oblong oval in shape and measures as much as three-fifths inch in length. The skin of the back contains grooves like those found in cattle ticks, and, in addition, another groove extending around just inside the margin, together with eleven smaller grooves (festoons) on the posterior border. These lines, so distinct in the young female, become shallow at maturity. This tick has been found on man, cattle, dogs, horses, rabbits, and panthers, and has been collected in woods and on uncultivated lands in many sections of this country, especially in eastern United States.

LONE STAR TICK (*Amblyomma americanum*).—As indicated by Nos. 5 and 5a of figure 4, the body of this tick is oblong oval and of a yellowish gray or brown color. The skin is rough and puckered unless the body is full of blood. The reddish brown area at the front of the tick is composed of the head and head shield. The latter extends backward a short distance to form a triangle, in the apex of which is a white or metallic-yellow spot from which it derives its name "Lone Star" (No. 5b). The mature female may reach one-half inch in length and has four pairs of long thin legs. This tick has been found on cattle, dogs, horses, sheep, goats, hogs, and man, and is very widely distributed in the United States.

EAR TICK (*Ornithodoros megnini*).—As will be observed from Nos. 6 and 6a, figure 4, the shape of this tick is similar to that of the body of a violin. It is nearly twice as long as broad, rounded at both ends, narrower behind than in front, and slightly constricted in the middle. In color it varies from gray or brown to violet, and has two grooves behind the head, with a middle one in the posterior portion. On the skin of the back are numerous minute spines, or stiff hairs. The adult females are from one-fourth to three-eighths inch in length, and have four pairs of long stout legs. The anterior portion of the tick is curved downward to form a cover for the very small and short head, which can only be seen from the under side of the tick. The feelers (palpi) and beak, however, stick out from under the front part of the body and can be seen from above (No. 6b). This tick is found in the ears of cattle, horses, mules, asses, and other animals in the South and West.

CHICKEN TICK (*Argas miniatus*).—In shape and appearance this tick is like an enlarged bedbug, and is of a uniform reddish brown color, with four pairs of lighter

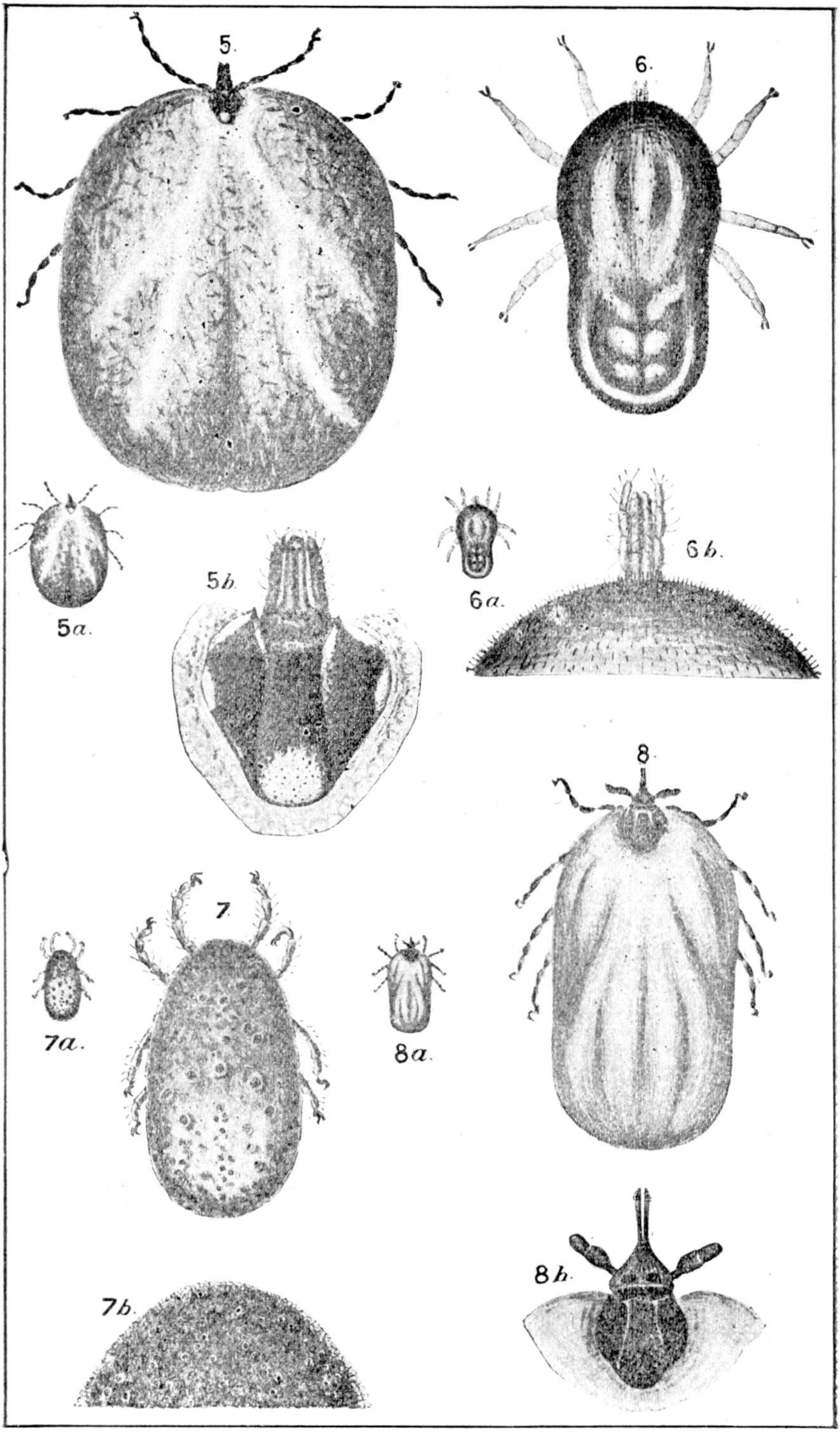


FIG. 4.—Various ticks that infect cattle

colored legs. The skin is wrinkled and contains very short and minute hairs. On the top as well as the bottom of the tick are numerous bright pits or cavities with raised borders (fig. 4, Nos. 7 and 7a). These vary in size, are arranged in rows radiating from the center more or less uniformly, and are usually symmetrical on each side. It is about three-eighths inch in size when mature. The head is so completely covered by the body that it can not be seen from the back (No. 7b). This tick has been observed on cattle once only, but is frequently found on chickens, turkeys, and other birds in the South.

EUROPEAN DOG TICK (*Ixodes hexagonus*).—The body of this tick is oval in shape and of an ashy color (fig. 4, Nos. 8 and 8a). The grooves on the back are united in an arch in front and diverge in the posterior portion of the body. The four pairs of legs are longer, thicker, and stronger than those of the cattle tick. The head and shield are brown-red in color and similar in shape to those of the catsor-bean tick, but less oval and rather more lozenge-shaped, with more acute lateral angles and narrower posterior angle (No. 8a). The palpi, or feelers, are longer and more prominent than in the cattle tick, but not so long as in the castor-bean tick. This dog tick has been collected from dogs, cattle, sheep, foxes, rabbits, squirrels, gophers, cats, birds, man, and other hosts in eastern United States.

LIFE HISTORY AS OBSERVED IN ALABAMA.

The following cattle tick records were made by Mr. W. M. Lewallen, while a student at Auburn, Ala., from August, 1905, to August, 1906. The fall of 1905 was dry, the winter was average with alternate periods of cold and warm weather. The spring of 1906 was early and average in moist and dry spells, and the summer was hot and wet.

Out of 20 ticks that began to lay from August 11 to 19 the number of days between laying and hatching were as follows: 30, 29, 23, 24, 23, 23, 23, 24, 25, 25, 25, 25, 25, 25, 25, 26, 27, 27, 25 days—an average of 25 days.

The ticks were all dead as follows: 35, 35, 35, 35, 35, 35, 35, 36, 35 days, an average of about 35 days and including the progeny of half the ticks. Of the other half after 35 days the progeny of two ticks were all alive and active, and after 35 days the progeny of the remaining ticks were nearly all dead.

In another lot of four ticks that began to lay September 19 to 21, hatching began after 40, 48, 42, and 46 days or an average of about 45 days. After 122 days and 228 days the progency of two ticks were all dead. After 63 days the progeny of one tick were alive, but inactive.

Tick Egg-Laying Record for 1905-1906.

DATES	DAYS	EGGS-LAID
From Oct. 31, 1905 to Feb. 12, 1906	104	3016
From Nov. 27, 1905 to Feb. 12, 1906	97	1632
From Jan. 21, 1906 to Mar. 15, 1906	53	1141
From Jan. 22, 1906 to Apr. 6, 1906	74	1487
From Jan. 22, 1906 to Mar. 19, 1906	56	1694
From Jan. 21, 1906 to Apr. 23, 1906	92	3840
From Jan. 21, 1906 to Apr. 19, 1906	88	3101
From Jan. 21, 1906 to Apr. 23, 1906	92	2840
From Feb. 15, 1906 to Apr. 6, 1906	50	1013
From Mar. 3, 1906 to May 3, 1906	61	2981
From Feb. 12. 1906 to Apr. 26, 1906	73	3586
From Feb. 23, 1906 to Apr. 28, 1906	65	2388
From Apr. 5, 1906 to Apr. 28, 1906	23	3687
From Apr. 7, 1906 to Apr. 26, 1906	19	2987
From Apr. 5, 1906 to Apr. 30, 1906	25	3210
From Apr. 5, 1906 to Apr. 27, 1906	22	1858
From Apr. 6, 1906 to May 1, 1906	25	2724
From Apr. 3, 1906 to May 1, 1906	28	3132
From Apr. 6, 1906 to Apr. 8, 1906	2	137
From Apr. 3, 1906 to May 1. 1906	28	3003
From Apr. 15, 1906 to May 5, 1906	20	1446
From Apr. 3, 1906 to May 2, 1906	29	2175
From Apr. 23, 1906 to May 9, 1906	16	3496
From Apr. 23, 1906 to May 18, 1906	25	2862
From Apr. 25, 1906 to May 7, 1906	12	1372
From Apr. 26, 1906 to May 7, 1906	11	345
From Apr. 26, 1906 to May 2, 1906	6	164
From May 21, 1906 to June 14, 1906	24	2687
From May 21, 1906 to June 4, 1906	14	1940
From June 18, 1906 to July 8, 1906	20	4261
From June 18, 1906 to July 4, 1906	14	4191
From July 16, 1906 to Aug. 8, 1906	23	3475
From July 16, 1906 to Aug. 12, 1906	27	3947

Monthly Average Egg Record for 1905-1906.

First Egg Laid ...	No Ticks ...	Last Egg Laid	Average No. Days......	Average No. Eggs......
From Oct. 31, 1906	2	Feb. 12, 1905	100	2324
From Jan. 21, 1906....	6	Apr. 19, 1906	76	2350
From Feb. 12, 1606....	4	May 3, 1906	62	2492
From Apr. 3, 1905	10	May 2, 1906	22	2435
From Apr. 23, 1906....	5	May 18, 1906	14½	1648
From May 21, 1906....	2	June 14, 1906	19	2313
From June 18, 1906 ...	2	July 8, 1906	17	4176
From June 16, 1906....	2	Aug. 12, 1906............	25	3711

Tick Record on Horned Jersey Calf, Texas Ticks

Oct. 15. 1905	Infested with 15 ticks.
Oct. 19 or 20.	Moulted first time.
Oct. 21 or 22.	Dark brown color; size of pin head
Oct. 28 or 29.	Moulted second time, grew slowly up till this time. Ticks were brushed off (?) calf at this time before maturing.

On Hornless Jersey.

Nov. 15.	Infested with 15 ticks.
Nov. 18.	Ticks found on inside of thigh.
Nov. 20.	Ticks lead white.
Nov. 21.	Ticks darker, nearly brown.
Nov. 24.	(1) Tick has reddish thorax, abdomen color of oxide of lead.
	(2) Other ticks are milk white in color.
Nov. 27.	(2) Tick has yellowishstripe on back.
Nov. 28.	(1) Tick has yellowish specks on back.
Nov. 30.	(2) Tick moulted. (1) Tick has yellowish spots on back.
Dec. 1.	(2) Tick became dislodged leaving his moult on cow
	(1) Tick moulted.
Dec. 5.	(3) Tick found.
Dec. 6.	(3) Tick dislodged. Ticks cannot be found.

Jersey Calf Below Barn.

Nov. 15.	Infested with 15 ticks.
Nov. 20.	Ticks lead white.
Nov. 28.	Ticks grew larger.
Nov. 30.	(1) Tick has yellowish stripe on back.
Dec. 1.	1, 2, 3, 4 appear about ready to moult; (5) tick has moulted.
Dec. 2.	(2) Tick moulted (3) Tick has white speck on belly.
Dec. 3.	1, 3, 4 Ticks moulted

Dec. 6.	(4) Tick has tick beneath it (male?) about ½ its size. (5) Tick missing.
Dec. 9.	One female tick has two small male ticks beneath her; when she was lifted they seemed to be attached to her and on separation a little blood was present at the attachment. Female lead color, males brown.
Dec. 9.	Another female like the above with only one male Males don't increase in size while females. grow rapidly.
Dec. 13.	Dropped off of calf. Total no of days on calf **28** One tick moulted in 15 days (2nd moulting). Others in 16 and 17 days.

Red Spotted Calf

Dec. 15.	Infected calf with 15 ticks. Auburn ticks.
Dec. 19.	(1) Tick found, lead color.
Dec. 21.	1. Moulted and changed position.
Dec. 25.	2. Tick discovered, has white speck on abdomen
Dec. 31.	1. Tick of white cast, about size of pin head. 2. Tick in process of moulting. Seems to have loose skin.
Jan. 1. 06	2. Tick has mark on back. 1. Tick whitish skin on belly.
Jan. 3.	Removed moult from both ticks, about size of tack head, dark brown.
Jan. 5.	2. Tick disappeared, Removed moult from tick 3. Tick 4. getting ready to moult. Tick 5. much smaller.
Jan. 6.	3. Tick moulted again. larger than yesterday.
Jan. 7.	6. Tick has one beneath it when discovered to-day.
Jan. 8.	6. Tick has no tick beneath it
Jan. 10.	4, 6&7, have males beneath them; females 6&7 about four times size of males with partial moult on posterior half of body. 5. Tick moulted.
Jan. 12.	6&7 detached; 7. grown yesterday; 6. removed to-day. 5. Tick has yellowish marking on back, males of 6&7 still attached.
Jan. 13.	5. Tick changed location; 4. Tick removed moult; males of 6&7 have disappeared, leaving bloody seat. Found 2 females on abdomen about grown, removed them. 3. Tick moulted.
Jan. 14.	4. Tick light brown, male left it, not ready for fertilization as she moulted after male sought her.

	3. Tick has 2 males beneath her.
Jan. 16.	4. Tick had a male beneath her. Only one male under tick 3.
Jan. 18.	3. Tick engorged removed for breeding male left on calf.
Jan. 19.	Male of tick 3 gone.
Jan. 23.	4. Tick engorged removed.
Jan. 24.	Found two more engorged females, left them to see how long they remain.
Jan. 25.	Two ticks found yesterday have dropped. Another found but disappeared.
	Tick 4 engorged in 39 days removed by hand.
	Tick 3 engorged in 34 days removed by hand.
	Tick 1 moulted in 6 days.
	Removed moult from 1&2 in 19 days.
	Removed moult from 3 in 21 days.
	Tick 5 moulted in 26 days.

Jersey with Horns.

Jan. 15.	Infested with 15 ticks.
Jan. 16.	1 tick found.
Jan. 19.	1 tick again found, white spot on posterior part, probably moulted 18th.
Jan. 27.	No ticks found from 19 to 27.
Jan. 30.	Found a tick size of pin head, lead color.
Feb. 2.	Tick oval shape, has yellow stripes on back.
Feb. 4.	Tick moulted.
Feb. 9.	Dark brown color.
Feb, 13.	Tick mated.
Feb. 13.	2 ticks found ready to begin 2nd moulting.
Feb. 14.	1. tick dislodged.
Feb. 15.	Male of 1 tick still attached.
Feb. 16.	Male of 1 tick gone, 2 tick moulted.
Feb. 29.	2 tick dislodged.
Mar. 8.	2 tick couldn't be found.

Ticks collected on January 15 began to deposit eggs March 12 and continued during a period on an average of 40 days. Ticks collected on April 15 began to deposit eggs April 25 and continued during a period of an average of 17 days. The average length of life of ticks on cattle for late summer and early autumn was 22 days for three tests. Longevity of larvae during the late fall and winter was six months and during the summer and autum thirteen days. The average length of parasitic period for five ticks during the latter part of summer, autumn, winter and early spring was twenty-nine days, the longer period prevailing in winter.

The following records were made by C. T Butler, while a student assistant in the Veterinary Department, during 1906 and 1907.

Bottle No.	Date Laid	Date Hatched	Percent Hatched (Approximate)	When dead and Remarks
All	Aug. 20-Sept. 20, '06	Began Sept. 19, '06		One bottle dead Oct. 15; another Oct. 20, due to lack of moisture (?). In the other bottles many ticks dead Mar. 20, 1907. Ticks dead in all but one bottle Mar. 28; in this bottle about half dead. Apr. 3, few ticks alive, but dead Apr. 10, 1907.
1	Sept. 20-Oct. 4, '06	Nov. 19-22, 1906	100	All dead but few Mar. 28; dead Apr. 1, 1907.
2	Sept. 20-Oct. 5, '06	Nov. 19-22, 1906	100	Many dead Mar. 28; all dead May 5, 1907.
3	Sept. 20-Oct. 27, '06	Nov. 19-22, 1906	100	All dead Mar. 28, (lack of moisture) (?)
4	Sept. 20-Oct. 29, '06	Nov. 15-22, 1906	100	All dead but few Mar. 28, '07. All dead Apr. 1, 1907.
5	Sept. 20-Oct. 1, '06	Nov. 19-22, 1906	100	All dead Mar. 28; due to lack of moisture (?).
1	Oct. 22-Nov. 22, '06	Began 3-10, 1907	10 to 20	Few ticks dead Apr. 12, '07
2	Oct. 22-Nov. 58, '06	Began 3-10, 1907	10 to 20	Few ticks dead Apr. 12, '07
3	Oct. 23-Nov. 9, '06	Began 3-5, 1907	5 to 10	4 to 10 ticks living Apr. 28, most of ticks died soon after hatching.
4	Oct. 22-Nov. 12, '06	Began 3-5, 1907	10 to 20	4 to 10 ticks living Apr. 29, dead May 22, most died early.
5	Oct. 22-Nov. 12, '06	Began 3-5, 1907	10 to 20	More than half dead Apr. 29, 1907.
1	Nov. 22-Dec. 18, '06	Began 4-3, 1907	1 to 5	Most of Eggs shrivled; few dead Apr. 29.
2	Nov. 21-Dec. 18, ,06	Did not hatch	0	Possibly too much light.
3	Nov 21-Jan. 16, '07	Began 4-3, 1907	not over 5	Few dead May 23.
4	Nov. 22-Dec. 18, '06	Began 4-3, 1907	5 to 10	Few dead Apr. 29.
5	Nov. 24-Dec. 18, '06	Began 4-3, 1907	10 to 15	Nearly all dead May 23.
1	Jan. 7-Feb, 5, '07	2 hatched Apr. 29	0	Egg shriveled.
1	Jan. 18-Mar. 5, '07		0	Eggs shriveled
2	Jan. 19-Mar. 26, '07		0	Probably due to too much light.
3	Jan. 19-Mar. 2, '07	1 tick but dead		
1	Mar. 2-25, 1907	May 10-23	30 to 50	
2	Mar. 3-26, 1907	May 6-23	70 to 90	
3	Mar. 4-30, 1907	May 10-23	30 to 40	
4	Mar. 5-26, 1907	May 10-23	40 to 60	
5	Mar. 5-25, 1907	May 6-23	80 to 90	
1	Mar. 22-Apr. 1, '07	May 22		
2	Mar. 23-Apr. 26, '07			
	Mar. 27-Apr. 9, '07			

Of the ticks that hatched Nov. 1906, bottle 2 lived until May 1907, others died some time before probably due to lack of moisture.

The probable reason for eggs (laid between Oct. and Mar.) being shriveled is too much light. Direct rays of the sun was sometimes on them, for 2 hours per day.

Summary of Butler's Tick Records.

Aug. 20.-Sept. 10. 6 ticks laid from 305-3,456 eggs.......Ave 1,623
Laying period from 18-22 days..................Ave. 20 days
Sept. 20-Oct. 5. 5 ticks laid from 1,056-2,243 eggs......Ave. 1,520
Laying period from 8-10 days..................Ave. 12 days
Oct. 22-Nov. 28. 5 ticks laid from 1,125-2,646 eggs......Ave. 1,703
Laying period from 18-37 days..................Ave. 25 days
Nov. 21-Jan. 16. 5 ticks laid from 2,235-2,937 eggs......Ave. 2,599
Laying period from 27-56......................Ave. 33 days
Jan. 7-Feb. 5. 1 tick laid 1,978 eggs 1,978
Laying period, 29 days................................29 days
Jan. 18-Mar. 5. 3 ticks laid 833-1,721 eggs...............Ave. 1,192
Laying period, from 26-46 days..................Ave. 39 days
Mar. 2-30. 5 ticks laid 1,419-3,413 eggs................Ave. 2,414
Laying period, 23-28 days......................Ave. 24 days
Mar. 22-Apr. 26. 3 ticks laid from 340-3,745 eggs........Ave. 1,371
Laying period from 9-34 days...................Ave. 20 days
N. B.—Tick 3 was only half-grown eggs; did not hatch.
Apr. 25-May 20. 5 ticks laid from 1,143-3,703 eggs.......Ave. 2,656
Laying period from 8-25 days..................Ave. 20 days

Summary of Non-Parasitic Life of Tick

Egg-laying period	Average no days	Hatching period	Longevity of Seed Tick
Aug. 20-Sept. 10	20	30 days	A few lived 190 days
Sept. 20-Oct. 5	12	29 days	Few lived for 129 days
Oct. 21-Nov. 28	25	131 days	Few lived for 50 days
Nov. 21-Jan. 16	33	131 days	All dead in 58 days
Jan. 18 Mch 5	39	no hatching	
Mch. 2-Mch 30	24	64 days	No record
Mch 22-Apr. 26	20	60 days	No record
Apr. 25-May 20	20		

The winter of 1906 and 1907 was exceptionally warm. The mature laying ticks, eggs and seed ticks were kept in a room with window open and no fire in the room. The seed ticks and eggs were kept in test tubes with moist cotton in the lower part of the tubes.

Why Eradicate the Cattle Tick.

The cattle tick lives by drawing the blood from its host, and the host is usually cattle. When undisturbed, the ticks in a pasture get so numerous that they take sufficient blood from the cattle in the pasture, to reduce or retard the growth of the cattle, or check milk or beef production. I have seen cattle go into a tick infested pasture in fairly good condition in the spring and owing to loss of blood by ticks and the tick fever, the cattle came out of the pasture in the fall weighing less and consequently much poorer than when they went into said pasture, and the pasture a good one so far as the grass and water supply were concerned.

Tick fever kills more native cattle in the tick infested areas than all other cattle diseases in the South. Moreover, the cattle tick prevents free trade in the markets of the United States and of the world for the greater part of the year. Consequently, it decreases the market price of southern fed and southern bred cattle from one-fourth to one-half a cent per pound in the cattle markets above the quarantine line.

The losses from death of northern cattle and imported cattle brought into the South have been so great that improvement in the various dairy and beef breeds represented in the South and the introduction of new breeds of cattle have been seriously hindered and checked.

The following tabulated statement will give an approximate idea of the various losses falling upon the tick infested area of the South:

Number and Value of Farm Animals in Alabama Jan. 1, 1906.

Animals	No.	Farm Value	Total Value of Each Kind	Total Value of all Animals in Ala., Jan. 1,1906
Cows	253,132	$ 20 40	$ 5,163,893	
Other cattle	496,762	8 32	4,131,822	
Horses	155,142	93 69	14,535,227	
Mules	185,839	111 66	20,750,794	
Swine	1,137,501	4 65	5,289,380	
Sheep	195,597	2 10	409,776	
				$50,280,892

In the United States Jan. 1, 1906, there were about 67,000,000 cattle. In the entire quarantined area there were about 15,000,000 cattle. In Alabama at the same time there were 749,894 cattle. Losses coming directly and indirectly from the cattle tick:

1. Decrease from milk production in five million milk cows, one million of which is giving milk all the year. Each cow in milk losing one quart of milk per day and rating that at four cents per quart on the farm. 1,000,000 x .04 equals $40,000 per day. $40,000 x 365 gives the loss per year........$14,600,000
2. Loss in the decreased or checked or retarded growth in the other 14,000,000 cattle at $1 per head........ 14,000,000
3. Loss of at least $3 per head on all cattle from the South sold above the quarantine line—700,000 cattle at $3 each........ 2,100,000
4. Loss by death from tick fever of 700,000 native cattle each year, valued at $15 per head 10,500,000
5. Loss by tick fever of breeding cattle shipped from the North into the South........ 50,000
6. Cost of the United States and the various quarantined States in maintaining quarantined lines and eradicating the tick...... 200,000

Total annual loss from the cattle tick in the quarantined area $41,450,000

Alabama loses each year about one-twentieth of this total or about $2,000,000. The total live stock valuation for Alabama is $50,280,892. Hence, the cattle ticks in Alabama produce a loss of 4 per cent. each year on the amount or capital invested in live stock.

METHODS OF ERADICATING CATTLE TICKS.

I. Cleaning Cattle.

1. By applying oils to the cattle. This may be employed by using hand cloths or swabs, by spray pumps or by dipping the cattle in a vat or in a dipping tank. The oils that can be used are more or less variable. Beaumont crude petroleum, West Virginia or Kentucky Black oil, cotton seed oil, lard, machine oil, etc., have been employed. Kerosene oil (20 to 25 per cent.) emulsion or kerosene oil (20 to 25 per cent.) in combination with cotton seed oil or with lard have been used. One to two per cent. of sulphur may be added to any of the above oils except Beaumont oil or black oil. The essential things in the use of oils or grease in killing ticks on cattle is to be certain to apply it all over the cattle. If many cattle are to be treated use a spray pump or a dipping tank. (a) If a few cattle are to be greased, a good piece of sacking burlap or cotton bagging may be employed by hand or on a swab stick. Have the animal put into a specially prepared break or chute. Two men (one working on each side of an animal) can grease five to ten cattle in an hour. (b) A spray pump, costing five to fifteen dollars, is very convenient. The bucket spray pump is the cheapest. But the knapsack and the barrel spray pump are very handy. These pumps are the same as horticulturists use in spraying fruit trees. It is well to have a kerosene mechanical mixer attached to pump. With it you can use water or kerosene with the oil. This pump will mix twenty-five per cent. of Beaumont oil with the water and effectually cover the cattle with very little loss of oil. The water possesses no advantage except to spread the oil in thinner layers, to make it go farther and waste less. A quart of Beaumont oil will effectually cover a 700 pound cow with this mechanical mixer spray pump;

while it will take two to four quarts to cover the same cow in putting it on with a hand rag or swab or by immersing her in a dipping vat filled with oil. Two sprayers, one working on each side of the animal, will spray one to two hundred cattle in a day. (c) Oil in the dipping tank or vat is rather expensive. But is is sometimes employed in that way—especially by the Federal government and by the large ranch owners in Texas. In order to fill a 2,000 gallon dipping tank it would take a half car load of Beaumont oil. Some have tried it by having about six inches of oil floating on water in the tank. This has not in all cases proven successful. The Beaumont oil may be used in the tank in a 25 per cent. soap emulsion.

Oil has some striking advantages. It destroys ticks, it stays on the hair and skin for several days, it keeps off flies. It prevents skin evaporation and consequently may raise the animal's temperature; to avoid this danger have plenty of shade and water for the cattle for one or two days after oiling them.

2. An arsenical dip has been employed successfully in Cuba, Texas and in one instance in Alabama. Dr. N. S. Mayo, chief veterinarian of Cuba, first used this formula and directions for making it are as follows:

Arsenic trioxid, commercial	8 pounds.
Sodium carbonate, crystalized	24 pounds.
Yellow soap	24 pounds.
Pine tar	1 gallon.
Water sufficient to make	500 gallons.

Dissolve the arsenic in 20 to 30 gallons of water by boiling 30 to 40 minutes. Add water to make 100 gallons. Dissolve the soda in 20 to 30 gallons of water; dissolve the soap (shaved) in the soda solution; pour the tar into this in a fine stream, stirring at the same time. Mix the two solutions. Add enough water to make 500 gallons.

Dr. John W. Parker, of Texas, made it by leaving out the soap, according to the following formula:

Arsenic	8 pounds.
Sodium Carbonate	24 pounds.
Tar	1 gallon.
Water sufficient to make	500 gallons.

This is made in the same way as given in the directions for preparing Dr. Mayo's dip except the soap is omitted. It is best to use free-stone or rain water in making this dip, also exercise great care in having the ingredients accurately weighed and measured.

The cattle should not be held over one minute in the tank. In fact, it is best not to hold the animal in the tank but let it pass at once through and out of the tank to the dripping pen. From the dripping pen let the animal pass into a bare lot or place containing shade and no grass or feed and remain there till dry.

To dispose of the waste or unused part of the dip, care must be taken. Dig a deep pit in some out of the way place where it will not seep into a well. Put the old unused or waste dip into this pit and cover it with plenty of soil. Remember this dip is poisonous. When through dipping, mark the height of the dip in the tank, then if some of the water evaporates before the dip is used again sufficient water may be added to fill the tank up to mark. Or cover the tank when not in use with close fitting lids or cloth to prevent evaporation and filling with rain water. As a rule it is uncertain and often unsafe to use old arsenical dip. Better carefully dispose of the old dip and prepare a new lot just before using it.

This arsenical dip may be used with a spray pump or by a hand swab. Keep your hands greased with lard or vasaline to prevent the arsenic from injuring the skin, or keep your hands out of the arsenical dip.

3. Cresol dips or coal tar dips or insecticides may be employed by hand or in spray pump or in vat. But many of them are so inconstant in strength that one can not always depend upon them for efficient work. I have known

some that were said to kill ticks when used at a strength of 5 per cent. and a trial proved that a 10 per cent. solution was required to do effective work.

4. Picking cattle ticks from cattle may be employed where one or even a dozen dairy cows are stabled twice a day. The big ticks may be hand picked, or rubbed off with stiff brush or curry comb. The ticks that are picked or brushed off should be given to chickens or otherwise destroyed to prevent them from laying eggs and producing more seed ticks. This must be done once every day. Chickens about a cow lot or yard will pick up all the ticks that drop off and pick a large number of ticks directly from the cattle. Begin this picking early in the spring, because every tick killed in the spring means the cutting off of the seed that will multiply into the thousands in the summer and fall. Another good time to begin picking ticks is September 1, and keep it up until January 1 or until ticks disappear, then keep a good keen eye for ticks again the next spring. In fact picking off the big ticks when oiling or applying any tickicide is wise because some half grown and some mature ticks may escape the oil or the other material; fall to the ground and lay eggs.

Feeding sulphur to cattle will not kill the ticks on the cattle or prevent seed ticks from getting on the cattle. The United States Bureau of Animal Industry and other investigators have thoroughly tested the feeding of sulphur to cattle and proven it to be of no value.

Cleaning Cattle of Ticks Without the Use of Tickicides by Morgans Feed Lot Method, or the Pasture Rotation Method.

1. The feed lot method was first employed by Morgan. In this the cattle are placed in a feeding pen that has been constructed on tick free ground (plowed ground, cotton or corn or sweet potato ground or any place where cattle have not been penned or left for six months or more, is free of cattle ticks). Keep the ticky cattle in this feed

lot for twenty days—say begin May 1 or any time in spring, summer or fall. At the end of twenty days move move the cattle into another cattle-tight feed pen on tick free ground; pen number two should be at least ten feet away from th first pen; keep the cattle all the time in pen number two, for twenty days, and then move them into pen number three of the same kind. As a rule when the cattle move from pen number two into pen number three, the cattle will be entirely free of ticks, no matter how many they had on them in the beginning or when they went into pen number one. This is explained by the life history of the cattle tick. All female ticks when engorged with blood drop off the cattle, hide and soon begin to lay eggs. The tick eggs can not be deposited by the old female tick and then hatch under twenty days. Hence, before any tick eggs hatch or before the appearance of seed ticks in pen number one, the cattle are moved into pen number two. The same is true in pen number two. By the end of forty days in spring, summer or fall all of the female ticks have developed or become mature and have dropped off the cattle. What becomes of the males? They do not count because they can not lay eggs and will not work for their own living. It is always best to keep the cattle in pen number three for ten to twenty days before moving them into tick free areas. This feed lot method of cleaning cattle of ticks is expensive because three pens must be built, the cattle fed and watered in the pens for fifty or sixty days. The expense could be reduced to a minimum by preparing good forage crops like kaffir corn, sorghum, cowpeas, soja beans, and corn thick in the row. Have the crops come so that the cattle can be fed green soiling forage throughout the fifty days. In order to make the water supply cheap build the first pen on the lower part of a small running branch where there are no ticks, build pen number two ten feet or more above it and pen number three ten or more feet above pen number two.

It will be cheaper to apply Beaumont oil thoroughly and keep the cattle in a tick free pen where they can have good shade and plenty of water and feed for four days, then apply the oil thoroughly again and keep them in shady pen for three or four days more, and they will then be clean or free of cattle ticks, and ready to be turned into a tick free pasture or field.

2. Pastures or fields that are tick free may be used in the same way. Take a hay field of Johnson grass or red clover, or mellilotus, or of crab grass, or of any other forage or grass, divide it into three pastures or move the temporary partition fences every twenty days.

3. Where there are only one to five cattle, they can be staked and cleaned. Always begin at the lower part of the branch and stake the cattle so as to move the stake up the ditch or branch every day. Where the cattle were staked the first twenty to forty days, do not stake there again for three or four months.

When Should the Tick Killing Materials be Used.

If an effective or tick killing material is applied at first in the fall (beginning September or October 1st), and it is thoroughly applied once per week until December 1st or until frost appears; and during the winter as often as ticks are found; then keep up the thorough applications once per week from March until May, June or July 1—all the cattle ticks will be killed in the pasture and on the cattle. One thorough application of a good oil will usually kill all the ticks on the cattle, but as soon as the oil is rubbed or washed off the cattle will pick up other seed ticks in the infected pasture or lots. Applying the oil or other material once per week and sometimes once every two weeks will eradicate the ticks in a pasture because as fast as the ticks mature they are killed. Hence, if the mature ticks are all killed for four months in summer and six to eight months in winter all the tick eggs will have perished or hatched into seed ticks and the seed ticks will all have died from starvation or will have been killed on the cattle. This method admits of beginning in the early spring or early fall,—say from March to December or from September to June. It is most effectual in good pastures where the cattle are confined during the spring, summer and fall in a fixed enclosure. Upon the ranges it is difficult to make it effectual because one or more cattle owners will often fail to regularly and thoroughly apply the tickicide.

II. Cleaning Pastures and Tick Infested Fields or Ranges.

1. Keep all cattle, horses and mules off of a given pasture, field or range four months in summer or six to eight months in winter and all the tick eggs will have perished or hatched and all seed ticks will have starved to death. The seed tick lives only on the blood of cattle, horses or mules.

(a) May 1, divide your pasture into two parts with a cattle tight fence so that cattle can not put their heads through between the wires. If possible put a six inch board on the ground or throw up a ridge with a plow on the fence line before the fence is built. Keep the cattle, horses and mules out of the high part (No. 1) and in the lower part (No. 2) from May 1 to October 1. Then move the cattle to a tick-free pen, oil them thoroughly once and in four days oil them again. Now they can be put into pasture number 1 or allowed to run in the corn or cotton field or other tick-free field. Pasture number 2 must be kept closed from October to May or June. The cattle may go into pasture number 1 any time after October 1, providing they are free of ticks. Sometimes the cattle may be turned out of pasture number 2 October 1 or December 1 into the corn field or cotton field and other cultivated fields—(all of which are tick-free in the fall). The time for turning them out will depend upon when the fields are ready and when frosts have appeared. After frosts and cold weather have come the life cycle of ticks is much prolonged and usually by the middle or last of December cattle are free of ticks, and remain clean all winter providing they are not kept in infected barns, sheds or lots where heating manure hatches out the eggs. Hence, if cattle are turned out of pasture number one October 1 and allowed to run in cultivated fields until March 1 or sometimes until April 1, they may be examined closely for ticks, and if found tick free, can be turned into pasture number two. If not tick free, they should be cleaned by oiling thoroughly before turning them into pasture number two.

(b) September 1 take the cattle, mules and horses out any given pasture, keep them out continuously until the next May 1, and see that the cattle, horses and mules are clean of ticks before returning them to the pasture. This method has been used for several years very successfully by Dr. Butler of North Carolina. When tick free pastures or fields are made, they will remain tick free as long as ticks are not carried into such areas on cattle, horses or mules. In some rare cases, seed ticks or old females may be washed down from higher elevations into a low pasture.

(c) Cultivating land destroys ticks. It is possible that one or two good cultivations of land in summer will make it tick free.

(d) Burning the grass, leaves and weeds in the fall or spring will destroy many ticks, but it will not make a pasture entirely free of ticks. As a rule it should not be advocated because it destroys young timber and burns up vegetable matter.

(e) Heavy, washing rains carry many of the eggs and seed ticks away.

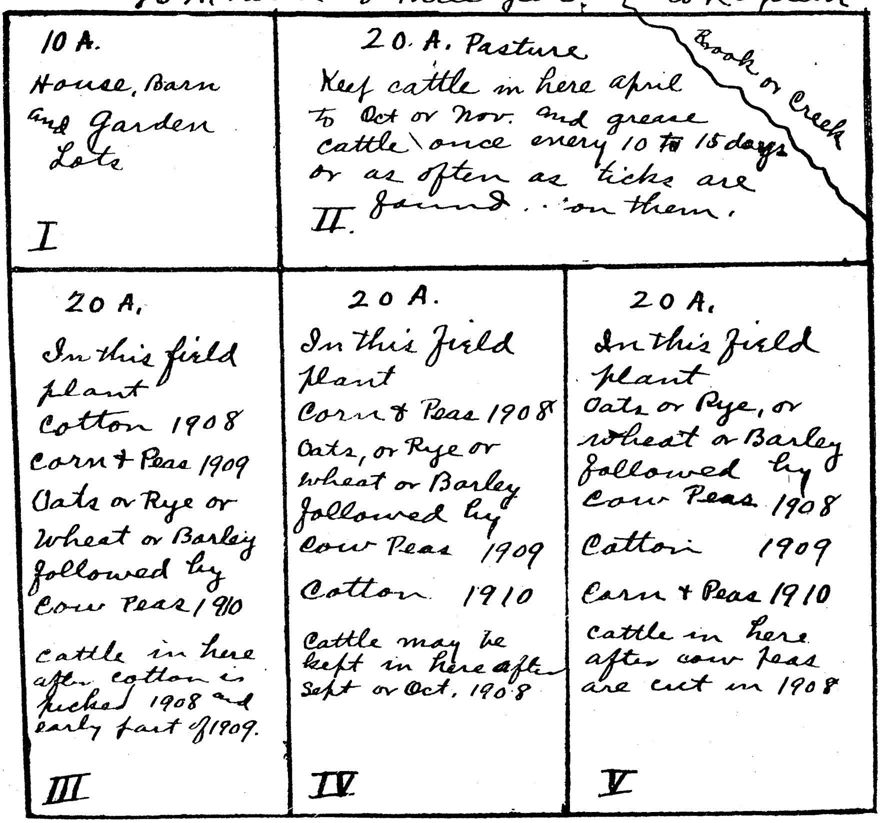
(f) Some insects destroy many of the female ticks and tick eggs.

(g) Dry and hot, sunny places are hard on ticks—in fact seed ticks can not live one month in such places. Shade and a little moisture in hot weather favors the hatching of eggs and the longevity of the seed tick.

ROTATION OF CROPS AND PASTURES HELP ERADICATE THE TICK.

A few systems of rotation of crops are introduced into this bulletin to suggest ways by which concentrated feed, forage and hay can be produced in sufficient quantities on the farm to enable the farmer to handle his cattle and other live stock during the time of tick extermination with the least expense and trouble. The crop rotation systems are great aids to soil improvement and to the eradication or holding in check of cotton wilt or black root and other fungus diseases and insect pests. Moreover, rotation of crops means diversified farming and

90 A. Farm and Three year Rotation System



forces the farmer to feed live stock on his farm or lose soil fertility by selling feed, forage and hay. Again, feeding live stock and growing legumes and other forage crops on the farm increases the vegetable matter or humus in the soil. Humus can not be bought in commercial fertilizers and the old worn lands are almost universally deficient in vegetable matter.

The rotation systems suggested are not iron clad, and may not be suitable to every farm. Yet the tick inspector and the farmer can study these and if they are not suitable as a whole or in part to a special farm, these will suggest others or methods of preparing a system adapted to the special farm.

In the ninety acre farm and three year rotation system, the plan adopted for eradicating the tick is oiling method with the cattle kept in the pasture from April until October or November or until they can be turned into the field where cow peas have been harvested or into the field where corn and peas have been removed, or into the cotton field after it has been picked. On this farm pasture II could be divided May 1, and either plan (a) or (b) of starving out the ticks and greasing the cattle only twice just previous to putting them into tick free areas could be employed. This three year rotation system was first suggested by Director Redding of Georgia.

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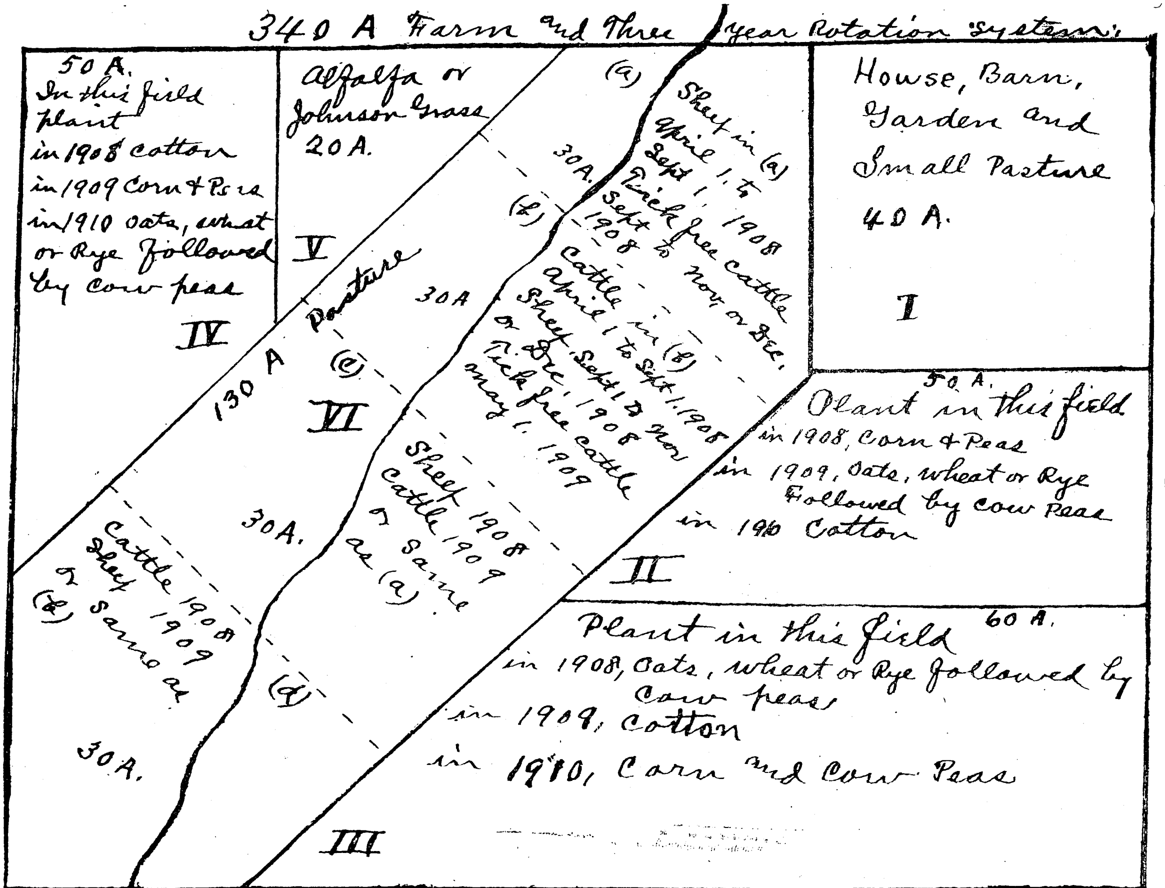

340 A Farm and Three year Rotation system.
50 A.
In this field plant
in 1908 cotton
in 1909 Corn & Peas
in 1910 Oats, wheat or Rye followed by cow peas
IV
Alfalfa or Johnson Grass
20 A.
V
House, Barn, Garden and Small Pasture
40 A.
I
(a)
Sheep in (a) April 1, to Sept 1, 1908
Tick free cattle Sept 1908 to Nov, or Dec.
30 A.
(b)
Cattle in (b) April 1 to Sept 1, 1908
Sheep Sept 1 to Nov or Dec, 1908
Tick free cattle May 1, 1909
30 A
130 A Pasture
(c)
VI
Sheep 1908
Cattle 1909
or Same as (a)
30 A.
Cattle 1908
Sheep 1909
or Same as (b)
(d)
30 A.
50 A.
Plant in this field
in 1908, Corn & Peas
in 1909, Oats, wheat or Rye Followed by cow Peas
in 1910 Cotton
II
60 A.
Plant in this field
in 1908, Oats, wheat or Rye followed by cow peas
in 1909, cotton
in 1910, Corn and Cow Peas
III

Fig 6

The rotation system on the 340 acre farm is the same as on the 90 acre farm. But the methods employed in eradicating the tick are different. The pasture VI is divided into four parts. In (a) the sheep, goats, or hogs are kept from April 1 to September or Oct. 1, then they are removed to (b) and the cattle in (b) are cleaned by thoroughly oiling them twice, with four days between each oiling) or apply any other effective cattle dip twice; then after the cattle are kept for a few days in a tick free lot or pasture, they may be put into (a).

Or, the pasture might be divided into just two parts and the same plan employed. Instead of putting the cattle back into (a) they could go into the corn and pea field or into the cowpea field after those crops have been harvested, and after the cotton is out put the cattle into the cotton field. Keep them in the cultivated fields during the late fall and winter, and put them back into (a) in April. The cattle could not be moved into (b) before May or June 1.

It would not be advisable to try to grow alfalfa in part V unless the land was lime land or made sweet by sowing sufficient air slaked lime or ground lime rock on it. Nor would I advise planting Johnson grass on this land, but if it is already there, make the best of it by cutting it for hay always before it goes to seed.

Recent inevstigations indicate that sheep may be carriers of cattle ticks. Hence, it may be necessary to keep them out f pasture or other places where it is desirable to starve out cattle ticks.

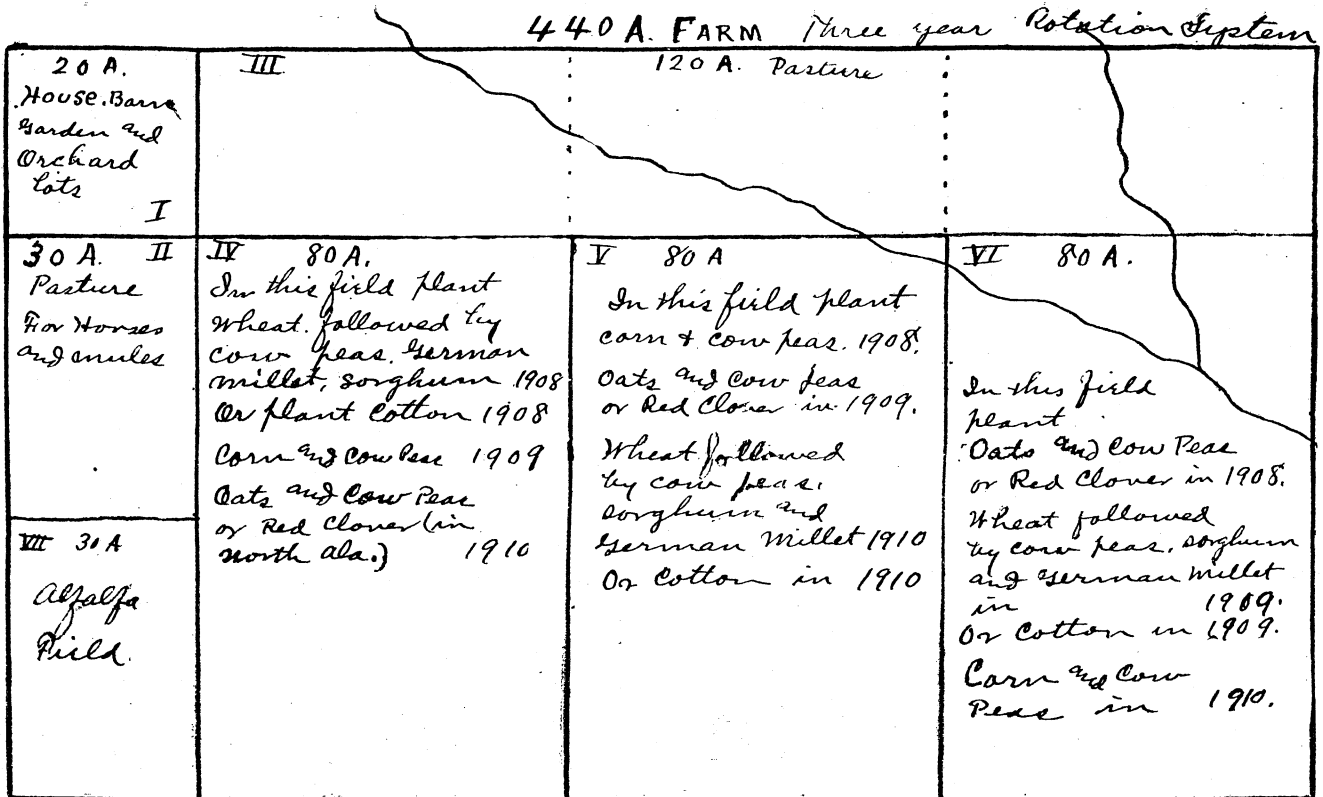
440 A. FARM Three year Rotation System
20 A.
House. Barn
Garden and
Orchard
lots
I
III
120 A. Pasture
30 A. II
Pasture
For Horses
and mules
VII 31 A
Alfalfa
Field
IV 80 A.
In this field plant
Wheat. followed by
cow peas. German
millet, sorghum 1908
Or plant Cotton 1908
Corn and Cow Peas 1909
Oats and Cow Peas
or Red Clover (in
north Ala.) 1910
V 80 A
In this field plant
corn & cow peas. 1908.
Oats and Cow Peas
or Red Clover in 1909.
Wheat followed
by cow peas.
sorghum and
German Millet 1910
Or Cotton in 1910
VI 80 A.
In this field
plant
Oats and Cow Peas
or Red Clover in 1908.
Wheat followed
by cow peas. sorghum
and German millet
in 1909.
Or Cotton in 1909.
Corn and Cow
Peas in 1910.

Fig. 7.

The rotation system on the 440 acre farm is also a three year system and very much like those given for the 90 acre and the 340 acre farms. But in this cotton is replaced, optional or divided with wheat followed by one or more of the following: cow peas, German millet, sorghum or soja beans. The oat crop is to be followed by cow peas, but red clover or alsike clover might be sown with the oats. Red clover, of course, could be used only in North Alabama.

The 120 acre pasture could be used for cattle and the cattle regularly oiled, or the pasture divided into two parts, on May 1 move all cattle, horses and mules into the part next to the house and barn. Keep all cattle, horses and mules out of the other part until October 1, then the clean cattle can be put into it. Or take all cattle, horses and mules out of the pasture about September 1 and keep the entire pasture closed to cattle, horses and mules until May 1 the next year; then put only tick clean cattle into the pasture.

460 A Farm. Four year Rotation system

70 A Pasture	30 A.	70 A. Pasture
Bermuda and Carpet grass Keep cattle in here from April until Sept or Oct Spray. Dip or grease cattle once every 10 days or as often as live ticks are found on them	House. Barn garden. Orchard calf and pig pastures	Bermuda and Carpet Grass. Keep cattle in here from April to Sept. Spray. dip or grease cattle every 10 days or every 5 days if ticks are found on them.

60 A.	60 A	50 A	60 A.	60 A.
Cotton in 1908 Corn + Peas 1909 Red Clover or Hairy Vetch + cow peas in 1910 Oats followed by Cow Peas 1911	Corn + Peas 1908. Red Clover or Hairy Vetch and Cow Peas 1909. Oats followed by cow peas 1910. Cotton in 1911	Pasture or Part of it may be planted in Alfalfa	Red Clover or Hairy Vetch and Cow peas 1908 Oats or Wheat followed by Cow peas 1909 Cotton in 1910 Corn + Peas 1911	Oats or Wheat or Rye or Barley followed by Cow peas in 1908 Cotton in 1909 Corn + Peas 1910 Red Clover or Hairy Vetch and cow peas 1911

Fig. 8.

The four-year rotation system given on the 460 acre farm plan is one that is intended for a farm where large quantities of forage or hay crops are desired for feeding live stock. Notice that the soil improving crops are very prominent. The cow peas after oats could be replaced by soja beans—especially after the land has been improved by the rotation system and the use of stable manure. On this farm are two 70 acre pastures and 150 acre pastures. To clean the cattle and the pastures of ticks, the oiling method may be adopted or either of the other methods can be used. With this number of pastures fenced and all of the separate cultivated fields fenced, it would be relatively easy to clean all the cattle and all the pastures. Keep all of the cattle in one of the 70 acre pastures from April 1 to Sept 1, then move them into the corn and peas or the cow pea field after they have been harvested; later put them into the cotton field, and then shift them about on the cultivated fields until April or May 1. At that time, if the cattle are not clean of ticks thoroughly oil them or dip them twice, with four days between each oiling or dipping and put them into the other 70 acre pacture, out of which they were moved September 1. Thus in one year all of the pastures and cattle can be readily cleaned of cattle ticks.

When a pasture is vacated by cattle May 1, the low, rich, open, bottom lands may be plowed in August or September and sowed in winter rye or barley. These will give green grazing in the winter varying in quantity according to the fertility of the land and the cold or warmth of the winter.

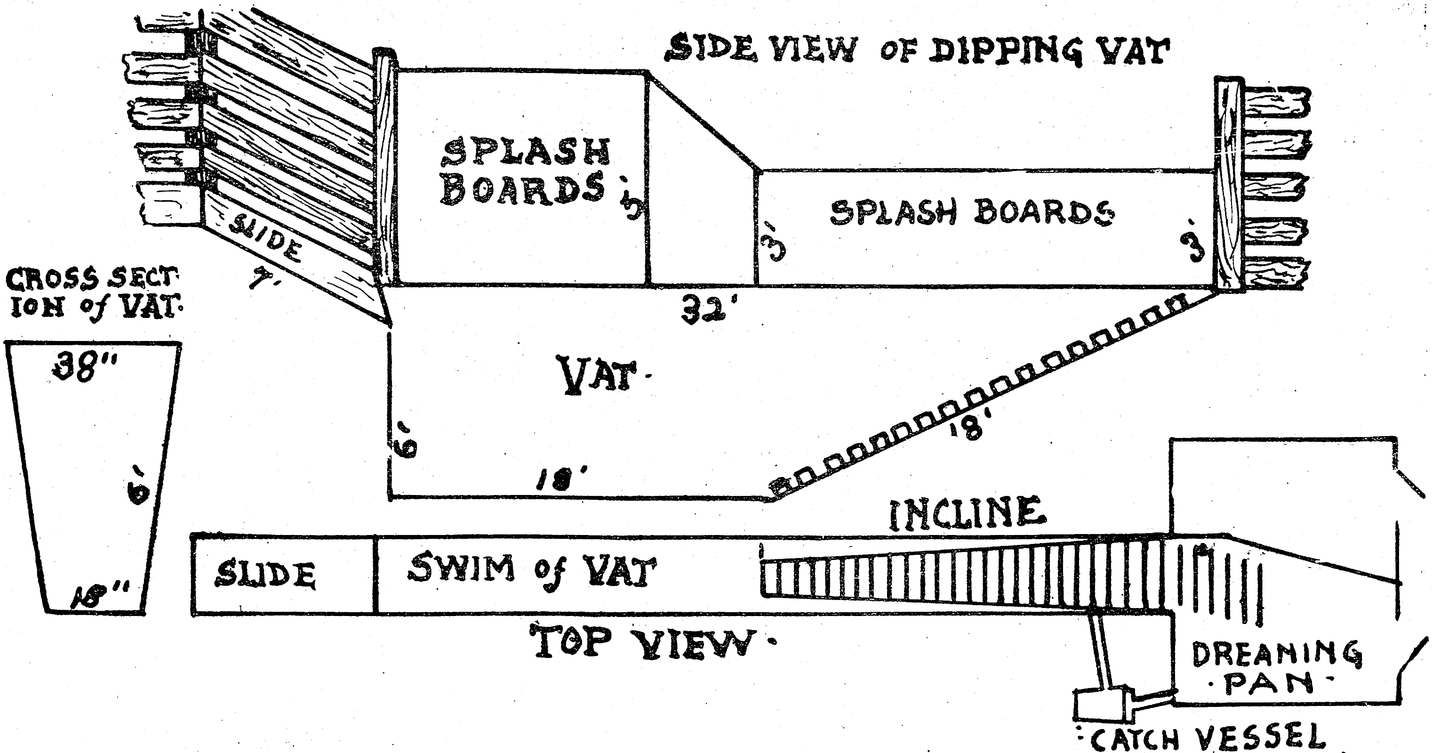
SIDE VIEW OF DIPPING VAT
SPLASH BOARDS
5'
3'
SPLASH BOARDS
3'
SLIDE
7'
32'
VAT.
6'
18'
18'
INCLINE
CROSS SECTION OF VAT.
38"
6'
18"
SLIDE
SWIM OF VAT
TOP VIEW.
DREANING PAN
CATCH VESSEL

Fig. 9.

How to Make the Vat.

Length of swim, 18 feet. Incline, 14 feet 1 in. "Slide," 7 to 8 ft., with drop of 3 ½ to 4 ft. Top width, 38 in. Bottom, 18 in. Depth, 6 ft. Set in ground 5 1-2 feet.

Frame with 2x4, every 16 to 18 inches.

Lay bottom of 2x18x18 ft. cypress. Then lay sides of 1x4 best flooring. Incline of 2x18x16 ft. cypress, cut in two pieces to fit, and dressed. Perpendicular end of same. "Slide" of good straight grained lumber, hardwood dressed, or soft wood covered with sheet-iron. It should be 7 feet long, with about a thirty degree slope. All joinings should be carefully fitted, and laid in coal tar or white lead. Quarter-round may be laid in angles to prevent leakage.

Dripping pen may be single or double. Should not drain into vat, but to one or both sides, where dip should be received into a suitable catch-vessel, through a screen, and allowed to settle before returning to vat, to get rid of filth. "Incline" and floor of dripping pen must be cleated.

A cover should be provided for the vat to prevent evaporation, which would concentrate the dip so that it would be of unknown strength and possibly unsafe to use. When not in use, drainage from dripping pen should be diverted from vat in case of rain, to prevent the dip in vat from being diluted.

Vat of the above measurements will require 2,000 gallons to fill 5½ feet deep. Dr. Parker, of Texas, wrote the specifications for this vat.

Bermuda.

Every permanent pasture in Alabama or the South should be set in Bermuda. All the upland and all the bottom lands that are not too wet are suitable places for it. The hill pasture lands should be terraced and set well in Bermuda. This will stop washing and hold fertility. The greatest mistake is made when one attempts to grow it on very poor, bare or washed land, without the use of fertilizers. A complete commercial fertilizer, or stable manure will make it grow. When possible, it is always best to grow one or more crops of cow peas on the land after it has been terraced (if hill sides) and then plant in Bermuda. It is best to grow wheat, rye, barley, vetch or burr clover on the land in winter, between the times of growing the cow peas. These will act as catch crops, prevent the soil from washing and hold fertility. The best time to plant Bermuda roots or stems is during the wet weather in May, June or July. Dig up the Bermuda from a sodded place and be sure to avoid a place where nut grass or Johnson grass is growing. Also avoid carrying smut grass with the sod. The smut grass can be easily separated from the roots or stems of the Bermuda. Furrows may be opened from one to two feet apart and the Bermuda roots dropped into the furrows and covered with the plow. The Bermuda roots may be run through a corn cutter and then they will be more easily handled and will plant more ground. If the land is in corn, the Bermuda roots may be planted in the middles. This may prevent the corn from making a full crop, but with plenty of rain and fertile soil, it will make a good Bermuda sod. Burr clover or hairy vetch may be planted in the furrow with the Bermuda roots. The combination of Bermuda and burr clover will produce at least 10 months pasture in nearly every year. Bermuda on rich land will produce as much pasture as Kentucky blue grass will produce in Kentucky. Bermuda can be made to grow in the shade providing the soil is sufficiently fertile and the shade is not too dense. I have grown it under cedar trees, producing a solid sod. Its greatest enemies are smut grass and nut grass; and carpet grass will crowd it out of wet places. Japan clover is said to smother it some, but it will not do it only on poor land. In rich bottoms not too wet it will grow high enough to be cut for hay.

CARPET GRASS (PASPALUM PLATYCAULE).

This is also called blanket grass and Louisiana grass. It grows readily on almost any kind of fertile soil. It will grow in the wet places where the Bermuda does not thrive and consequently it is often found covering the wet places in a Bermuda pasture. Grazing animals usually prefer it to Bermuda and will keep it eaten off close to the ground. It is said to crowd out weeds and other grasses, especially in wet places. The seed is expensive and it does not catch well from seed. Yet, when once started, it spreads rapidly—one plant is said to cover 10 to 20 square feet in one season. It is not a hay plant but an excellent pasture plant, ranking next to Bermuda in the South. It can be readily destroyed by plowing and cultivation.

RAPE.

Rape is a pasture plant for hogs and sheep, and may be used for cows and other animals.

It requires a rich loam soil well supplied with humus, or vegetable matter, and a complete fertilizer may be used on the soil to the amount of 300 to 800 pounds per acre. Plow the land well and deep, harrow and thoroughly pulverize by use of roller, clod crushers, and harrow. Sow from 3 to 5 pounds of Dwarf Essex seed per acre in drills or 6 to 8 pounds broadcast and brush over lightly.

It may be sown in summer, fall or spring, when the ground is moist enough to germinate the seed. When sufficiently large, graze it with hogs or sheep by using hurdles or by letting them run on all of it. It will continue to grow for several months, if not eaten down too closely to the ground or allowed to go to seed. It may be sown in between cotton or corn rows in August or September. It will not grow in dry seasons.

ALFALFA.

Alfalfa is a perennial forage plant which may be kept growing for twelve or more years, provided the weeds and its parasites do not kill it. Almost any fertile lime land, with no "hard pan" or rock near the surface, will grow alfalfa. It is necessary to have the bottom land well drained, for alfalfa will not thrive in wet soil. One without any experience should begin with a few acres. Select good lime land, and if it is not lime land, apply, after plowing, on each acre 2,000 pounds of air slaked lime or 4,000 pounds of ground lime rock. It is best to apply the lime a short time before sowing the seed and harrow the plowed land to mix the lime well with the surface soil. It will not be necessary to apply the lime again for 5 to 8 years.

In preparing the land for alfalfa, it is best to begin one to three years before sowing the seed. Add all the stable manure you can each year to the land, and grow cow peas or soja beans in summer in drill and cultivate so as to kill out all the weeds. In winter time grow crimson clover, hairy vetch or wheat, rye or barley. After two or three years apply well rotted stable manure and 500 pounds of 16 per cent. acid phosphate per acre. Plow 10 to 15 inches deep with disc plow or one to two inches deeper than the land has ever been plowed with a three or four horse turn plow, following in each furrow with a long scooter or subsoiler. Harrow and roll until you have a finely pulverized seed bed. After cutting off the oats, wheat, rey, barley, crimson clover, or hairy vetch, the land could be kept cleanly cultivated by shallow plowing once every one or two weeks until the middle of August. Then the manure and phosphate could be applied and the land be plowed deeply, harrowed and rolled. After plowing, apply the lime or lime rock. Always do this previous to harrowing and rolling. Some time from the middle of August to last of September, sow 20 to 25 pounds of good alfalfa seed (free from weed seed). Sow it evenly and broadcast it. In order to inoculate the soil and the seed, secure 100 pounds of rich dirt or soil from any field where alfalfa, mellilotus, or burr clover is growing or has grown within a year of the time you take the soil. Place this soil in a box, wet the alfalfa seed and thoroughly mix it with the pulverized soil in the box. Sow the soil and seed broadcast over the acre of prepared land and brush in lightly.

As a rule the young plants will get sufficiently large to resist the freezing and lifting frosts of winter, and the next spring the young alfalfa will grow so early and rapidly that it will keep down the weeds. But should you fail to get a stand from the fall sowing, the same land may be easily prepared for seeding again in the same way and at any time from March 1 to April 1.

When the little branches begin to start out from near the base of the stem or just about blooming time, the alfalfa should be cut, and after removing the hay, the alfalfa stubble, if weedy, may be harrowed with a tooth harrow to destroy weeds and loosen up the ground. And after the first summer every time it is cut, it may be run over .with a disc harrow having the discs set straight and then run over it in a direction at right angles to the way that the disc harrow ran, with a tooth harrow. This kills and keeps down weeds, loosens up the soil, admits air, and retains moisture.

The essentials for growing alfalfa are lime, manure, fertile soil, and absence of weeds, grass and parasites.

Dodder, or "love vine," is one of the worst parasitic enemies of alfalfa. When once started, it may be kept in check by hoeing it out and all the alfalfa for several feet around it. Pile up the dodder and alfalfa in the center of the cleared space and burn it when dry. Do not allow anything to grow on these bare places for one or more years. As a rule, the only way to kill out dodder in an alfalfa patch is to plow up the alfalfa and put that land in cotton and then in corn. Crab grass and chick weeds are plants that will crowd out or choke out alfalfa.

Crimson Clover.

This clover grows best in the fall, winter and spring, and may be sown in between the cotton or corn rows from latter part of August up to the fifteenth of October. If the ground is rich or has been made fertile by using stable manure on the corn or cotton, 200 to 500 pounds of 16 per cent. acid phosphate and a little potash may be all the fertilizer required. Sow 20 pounds of good seed and cover with small harrow or shallow cultivation. If it is to be sown on freshly plowed land, it is best to run the roller over the ground after harrowing in the seed. When possible, secure 100 pounds of dirt from a field where red, white, or alsike clover or crimson clover has been grown luxuriantly within one year. Wet the 20 pounds of crimson clover seed and then thoroughly mix the 100 pounds of dirt with the seed. Now sow the mixture of dirt and seed on the freshly harrowed land. Harrow again after sewing, and then roll the land, if not in corn or cotton. This is to inoculate the seed and the land. It will not do to sow it in the late fall, in winter, in spring, or in early summer. It will be ready for cutting when it blooms in May or early June. It can be followed by cow peas, sorghum, soja beans, or late corn. In case you can not secure inoculated soil for inoculating the seed as above directed, use plenty of stable manure on a small piece of fertile land, and the next year the soil from this land will do for inoculating more seed and land. To be sure that a given soil is inoculated, examine the rootlets of the young or old clover plants growing on the land, for the bunches of little nodules. When the land does not contain lime, an application of 1,000 to 2,000 pounds of air slaked lime to the land before sowing the seed will help the growth of crimson clover. It should not be planted on wet land, or low undrained wet land.

Hairy Vetch.

One of the best legumes for collecting the nitrogen from the air, for making proteid or nitrogenous forage which is equal to wheat bran in feeding value, and for adding vegetable matter and nitrogen to the soil, is hairy vetch. It does not require lime land but some claim that it will grow best on sweet soil. It may be planted with winter oats, wheat, rye, or barley. But, as a rule, it does best with oats. Yet it is rare that any of these cereals are ready for making the best hay when the hairy vetch is in bloom and ready for cutting. It can be sown on Bermuda sod in June, July or August. If the Bermuda is on rich land and is not pastured too close, the hairy vetch will take hold and grow vigorously after the fall rains. It would be better to cut up or scarify Bermuda sod with a scooter or some other plow and then sow the seed and harrow with a disc harrow. Hairy vetch may be drilled or sown in between the corn, sorghum, or cotton rows in August or September. If sown by hand, cover by shallow cultivation. It is well to use 300 to 500 pounds of 16 per cent. acid phosphate on each acre of land and a little potash. And if not inoculated, use plenty of stable manure. The seed and the land can be inoculated by getting a 100 pounds or more dirt from a field where hairy vetch or some other vetch grew the previous year or season, or from a place in the garden where English peas grew the previous year or season. Wet the seed with water and then mix the seed and dirt. Sow the mixture of dirt and seed over freshly harrowed or plowed land, and harrow again and then roll the land. This plant will stand more freezing than rye. Sow about thirty pounds of seed per acre. If used with oats or wheat, sow 1 to 2 pecks of hairy vetch seed with one to one and a half bushels of oats or wheat. The vetch seed may be sown with the inoculated dirt and then the wheat or oats can be sown broadcast or drilled.

Alsike and Red Clover.

It is doubtful if either of these two clovers can be successfully grown anywhere south of the Tennessee river valley in Alabama. In all places where the land is "clover sick" for red clover, use alsike. Here I can not do better than quote a letter from Director H. A. Morgan of the Tennessee station: "Regarding the preparation of land for alsike clover or red clover, we handle it something this way: In order to rid the land of weeds, which are natural upon most of our lands, put the land in peas, after making an application of lime—three or four thousand pounds to the acre of ground limestone rock and about two thousand pounds of the burnt lime. Disc this into the surface of the plowed ground a week or two before sowing the peas. After the peas are taken off, the land may be sown to a winter cereal, such as rye, wheat or fall oats, and, in early spring, seed to alsike clover, putting in plenty of good seed. We use as much as 10 to 12 pounds to the acre on our poor lands.

I do not believe, from our experience here, that it would be wise for you to recommend red clover until sufficient seed from immunized clover plants can be procured. Red clover is universally affected with a species of Colletotrichum, an anthracnose, and in the Middle Southern States undoubtedly dies from this disease. We have every promise, from our experiments with clover this year, finally to work out immune varieties, and I hope that this will be only a matter of three or four years. In the meantime, we are recommending alsike on well limed land. Alsike, as you remember noticeing when at the station, is exceedingly sensitive to an acid soil, and therefore accepts beautifully a lime application.

Mellilotus or Sweet Clover.

For the redemption of bare, poor lime lands no plant equals mellilotus. It is a bienniel and when once started will readily reseed itself if not kept from going to seed by frequent cutting with the mover.

The land should be well prepared and the seed sown in September or March, at the rate of 15 to 20 pounds per acre. It will do well on lime land where Johnson grass has a good hold. If cut early it will make good hay. It will also stand pasturing, but at first some animals must be kept on it for several days before they will eat it. The seed can be inoculated with dirt from an old mellilotus field or from a field of alfalfa or burr clover.

BURR CLOVER.

This is a close relative of alfalfa and is an excellent winter growing plant. It will grow on almost any kind of fertile soil that is not too wet. But it will grow best on lime land. It may be sown broadcast in between the cotton or corn rows just before the last plowing in June or July, using 2 to 3 bushels in the burr. Do not use the California burr clover seed. It can be sown broadcast, in June, July or August on scarified Bermuda sod, or on disced wheat, rye or barley stubble. If the seed with the burr removed is used, it may be sown as late as September. It is well to roll the land after harrowing in the seed that is sown in September. If not eaten off too close in the spring, it will reseed itself. In South Alabama it will furnish good winter pasture from December to April. Very cold weather may freeze back the top growth, but warm weather will bring it out again. As a rule the seed in the burr is inoculated, but it can be inoculated by using dirt from a mellilotus field, an alfalfa field, or a burr clover field. It is best to inoculate the seed that is cleaned of the burr, or use plenty of stable manure. Do not attempt to grow it on poor soil. Better grow a crop of cow peas on the land and then fertilize well before trying burr clover. This is not a good hay plant. Better plant hairy vetch, crimson clover, or red clover, or alsike clover for hay. Burr clover is a winter and spring plant.

No. 333.) AN ACT. (S. 165.

To establish a State Live Stock Sanitary Board and the office of State Veterinarian in order to further protect live stock from contagious and infectious diseases and provide for eradicating and excluding such diseases from Alabama.

Section 1. Be it enacted by the Legislature of Alabama, That from and after the passage of this act, the commissioner of agriculture and industries of the State of Alabama, the State health officer of Alabama, the professor of animal industry and the professor of veterinary science, of the Alabama Polytechnic Institute shall, ex-officio, constitute a board to be known as the State Live Stock Sanitary Board. The commissioner of agriculture and industries shall be chairman and the veterinarian on the board shall act as secretary of the board. The State Live Stock Sanitary Board shall have full power to make or enact such rules and regulations as they may deem necessary for governing the movements, transportation or disposition of live stock that may be quarantined as hereinafter provided, on account of being affected with, or exposed to, a contagious or communicable disease, or on account of being infected or infested with the carrier or the carriers of the cause or the causes of a contagious infectious or communicable disease of live stock.

Sec. 2. Be it further enacted, That the professor of veterinary science of the Alabama Polytechnic Institute shall act as State Veterinarian of Alabama. The State veterinarian shall nominate, and the State Live Stock Sanitary Board shall elect, as many assistant State veterinarians and State live stock inspectors as they may deem necessary and as the funds at their disposal shall permit.

Sec. 3. Be it further enacted, That the State veterinarian is authorized and directed to quarantine a stall, lot, yard, pasture, field, farm, town, city, township, county, or any part of the State of Alabama when he shall determine the fact that live stock in such place or places are affected with a contagious, infectious, or communicable disease, or when said live stock are infested or infected with the carrier or the carriers of a contagious, infectious or communicable disease. The State Veterinarian or an assistant State Veterinarian shall give written or printed notices of the establishment of said quarantine to the owners or keepers of said live stock, and to the proper officers of railroad, steamboat, or other transportation companies doing business in or through the quarantined part or parts of the State.

Sec. 4. Be it further enacted, That no railroad company, or the owners or masters of any steam or other vessel or boat shall receive for transportation or shall transport live stock from any quarantined part into any other part of Alabama except as hereinafter provided. No person, corporation or company shall deliver live stock for transportation to any railroad company or sailing or steam vessel or boat in a quarantined part of Alabama, except as hereinafter provided. No person, company or corporation shall drive or cause to be driven, live stock on foot, or transport live stock in a private conveyance, or cause live stock to be transported in a private conveyance from a quarantined part to a non-quarantined part of Alabama, except as hereinafter provided.

Sec. 5. Be it further enacted, That live stock may be moved within the limits of a quarantined part or from a quarantined part of Alabama only under, and in compliance with, the rules and regulations of the State Live Stock Sanitary Board. It shall be unlawful to move or allow to be moved, any live stock from one place to another within the limits of a quarantined or from a quarantined part to a non-quarantined part of Alabama, in any other manner or method, or under any conditions other than those prescribed by the rules and regulations of the State Live Stock Sanitary Board.

Sec. 6. Be it further enacted, That all live stock, except such live stock as are to be used for immediate slaughter, when brought into Alabama by a person, company, corporation, railroad or other transportation companies, shall be accompanied by a certificate of health, and said certificate shall state that said animal or animals are free of contagious, infectious or communicable disease and the carrier or the carriers of the cause or the causes of such diseases. This certificate must be made by a qualified veterinarian immediately after he has personally eximined the live stock and before the live stock has been shipped into Alabama. This certificate shall be attached to, and accompany, the shipping bill of the live stock to the place to which the live stock is shipped, and the owner of the live stock or agent of the transportation company shall mail or send said certificate to the State veterinarian, immediately following the arrival of the live stock at its place of destination. The State veterinarian shall furnish qualified veterinarians and transportation companies with blank health certificates at actual cost.

Sec. 7. Be it further enacted, That owners, renters, or parties in possession of quarantined live stock or quarantined places shall follow the directions in the rules and regulations of the State Live Stock Sanitary Board in cleaning and disinfecting infected live stock and infested or infected quarantined places, and in destroying the carriers of the cause of a contagious, infectious or communicable disease, that infest or infect live stock and quarantined places. Said cleaning of said live stock and the disinfecting of said places and destroying of said carriers shall be done by the owners, or the parties in possession of the infected live stock and places, in a reasonable time after receiving a written or printed notice from the State veterinarian, an assistant State veterinarian, or a State live stock inspector. Any person, company or corporation violating the provisions of this section shall be guilty of a misdemeanor and on conviction, shall be punished for each and every violation by a fine not less than ten dollars, nor more than one hundred dollars, or by imprisonment not less than ten days nor more than sixty days, or by both such fine and imprisonment.

Sec. 8. Be it further enacted, That the State veterinarian, the assistant State veterinarian and the State live stock inspectors are hereby empowered to enter upon the premises or into any barns or other buildings where live stock are temporarily or permanently kept in the State of Alabama in the discharge of the duties prescribed in this act. Any person or persons who forcibly assault, resist, oppose, prevent ,impede, or interfere with the State veterinarian, an assistant State veterinarian, or a State live stock inspector in the execution of his or their duties, or on account of the execution of his or their duties, on conviction, shall be punished as provided in Section 11 of this act.

Sec. 9. Be it further enacted, That the work of cattle tick eradication or the suppression or eradication of any other infectious, contagious or communicable disease of live stock shall be taken up under the provisions of this act in any county or any part of a county or any part of the State of Alabama, when the State Live Stock Sanitary Board may deem it best. The county commissioners of any county in which the State or Federal authorities take up the work of tick eradication or the suppression of any infectious, contagious or communicable disease of live stock, may appropriate, for aiding in such work, such sum as the county commissioners may deem adequate and necessary.

Sec. 10. Be it further enacted, That the State Live Stock Sanitary Board may appoint or elect the Federal veterinarians and live stock inspectors, who are doing work in Alabama, as assistant State veterinarians and State live stock inspectors; provided, they consent to act without pay from the State of Alabama.

Sec. 11. Be it further enacted, That any person, persons, company or corporation violating the provisions of Sections 4, 5, 6 or 8, of this act, shall be guilty of a misdemeanor and, on conviction, shall be punished by a fine of not less than fifty dollars, nor more than five hundred dollars, or by imprisonment of not less than one month nor more than six months, or by both fine and imprisonment.

Sec. 12. Be it further enacted, That there is hereby appropriated annually the sum of five thousand dollars to be disbursed under the direction of the State Live Stock Sanitary Board to pay the actual expenses of the Live Stock Sanitary Board in attending meetings; to pay for the printing of the official blanks, the annual reports of the State veterinarian and the rules and regulations of the Live Stock Sanitary Board, to pay the State veterinarian five hundred dollars per year and expenses while on actual duty; each assistant State veterinarian five dollars per day and expenses while on actual duty, and each State live stock inspector one to three dollars per day and expenses while on actual duty; and to pay such other expenses as may be necessary in carrying out the provisions of this act.

Sec. 13. Be it further enacted, That the judges of the circuit and criminal courts shall give this act in special charge to each future grand jury empanelled in this State, and that such grand jury be clothed with, and authorized to exercise inquisitorial power for the carrying out, and the enforcement of, this act.

Sec. 14. Be it further enacted, That the State veterinarian shall make an annual report to the Governor of Alabama, giving a full account of the work done and a detailed report of the money expended.

Sec. 15. Be it further enacted, That all acts not in accord with this act, are hereby repealed.

Approved March 12, 1907.

Official:

Frank N. Julian, Secretary of State.