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Grazing and Feeding Experiments with Pigs.

By J. F. DUGGAR.

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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 sows 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 unthrif 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 3½ 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, stable 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 data 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.
	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
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. <i>net</i> 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 re-

quired 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, meantime 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	<u>\$5.85</u>

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 $3\frac{1}{2}$ 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.
	<i>Square ft.</i>		<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
A }	8,344	Spanish peanuts, grazed	152 }	81	1.88
B }	12,448	Mixed grain, ½ ration..		22	.....
C }	7,937	Spanish peanuts, grazed	152 }	79	1.92
D }	Chufas, grazed		304	70 5	4.31
		Mixed grain, ½ ration..			
		Mixed grain, full ration			

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 growth. 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 76¼

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 $240\frac{1}{2}$ 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.
		<i>Lbs.</i>		<i>Days.</i>
A	Peanuts, and $\frac{1}{2}$ grain ration..	1.50	2.58	850
B	Peanuts, alone. ....	.41	.....	463
C	Chufas and $\frac{1}{2}$ 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 FIRM-
NESS 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.		Increased hardness over lot B Deg. F.
			Deg's C.	Deg's F.	
A	Peanuts, ground cowpeas and corn. }	Sorghum grazed	28.0	83.4	10.8
B		Ground cowp's & corn			
C	Chufas and ground cowpeas and corn. }	Sorg'm graz'd; pean'ts	27.5	81.5	9.9
D		Cowpeas grazed			
	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.
		<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
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	$\left\{ \begin{array}{l} \frac{1}{4} \text{ cotton seed meal..} \\ \frac{3}{4} \text{ corn meal..} \end{array} \right.$	Peanuts, alone	87 4
C		Chufas, &c. $\left\{ \begin{array}{l} \frac{1}{3} \text{ cowpea meal} \\ \frac{2}{3} \text{ corn meal..} \end{array} \right.$	82 8
D	do.....	Full ration $\left\{ \begin{array}{l} \frac{1}{3} \text{ cowpea meal} \\ \frac{2}{3} \text{ corn meal..} \end{array} \right.$	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.		Grain eaten per pig.	Lbs grain per lb. growth	Daily ration per 100 lbs. live weight.	Daily growth per pig.
		Lbs.	Lbs.				
3 (P. C.)	{ $\frac{1}{4}$ cotton s. meal, $\frac{3}{4}$ 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 perceptibly 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
			<i>Degrees F.</i>	<i>Degrees F.</i>
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	$\frac{3}{4}$ corn meal, $\frac{1}{4}$ cotton seed meal....	Peanuts.....	84.2	.....
90	$\frac{3}{4}$ corn meal, $\frac{1}{4}$ cotton seed meal....	Peanuts.....	84	.....
Av. 88 & 90	$\frac{3}{4}$ corn meal, $\frac{1}{4}$ 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 imme-

diately 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 Fahrenheit. 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, (becoming to ripe stage), and a half ration of grain, as below.

Lot II, in dry lot, fed sorghum from same field, cut into lengths 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.	Fig. No.	Weight Sept. 20		Food.	Daily growth per pig.	Total growth.	Grain consumed.	Lbs. gr'n per lb. growth.	
		Each.	Total.						
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.
Lot I.	Sorghum grazed; and grain..	Lbs. 707	Lbs 2768	Lbs. 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 acre of 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 I 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.)
	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
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 dai,y 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; $\frac{1}{2}$ ration of $\left\{ \begin{array}{l} \frac{1}{3} \text{ cotton seed meal..} \\ \frac{2}{3} \text{ corn meal.....} \end{array} \right.$	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 discontinued (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.
Lot III	$\frac{1}{3}$ cowpea meal, $\frac{2}{3}$ corn meal....	Lbs. 95.3	Lbs. 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	{ $\frac{1}{8}$ cowpea meal...	Peanuts.....	81.5	72.0
		{ $\frac{2}{8}$ corn meal.....		79.9	72.5
III.	8	do	do	80.7	72.3
III.	Av.	do	do	88.3	78.8
IV.	10	Corn meal.	do	77.2	72.4
IV.	9	do	do	82.7	75.6
IV.	Av.	do	do	90.0	70.3
V.	7	{ $\frac{1}{8}$ cotton seed meal	do	83.3	64.4
V.	13	{ $\frac{1}{8}$ corn meal.....	do	86.7	67.4
V.	Av.	do (died.)	do		
V.	Av.	do	do		

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:

<i>Food.</i>	<i>Daily growth per pig. Lbs.</i>	<i>Grain, per lb. growth Lbs.</i>
Corn meal.....	1 1.....	5 31
$\frac{1}{4}$ cotton seed meal, $\frac{3}{4}$ 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	{ $\frac{1}{4}$ cotton seed meal, $\frac{3}{4}$ 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 knowl-

edge 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.

<i>Food.</i>	Total growth, lbs.	Food eaten, lbs.	Lbs. food per lt. 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 con-

sisted 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:

<i>Food.</i>	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 { $\frac{1}{2}$ cowpea meal	
{ $\frac{1}{4}$ corn meal	5.0
{ $\frac{1}{4}$ rice polish	
Lot C { $\frac{1}{2}$ corn meal	4.2
{ $\frac{1}{2}$ rice polish	

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	56	3.7
	40% cowpea meal		
	20% wheat bran		
Lot E	40% rice polish	65.5	3.1
	40% cowpea meal		
	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 weight.
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.