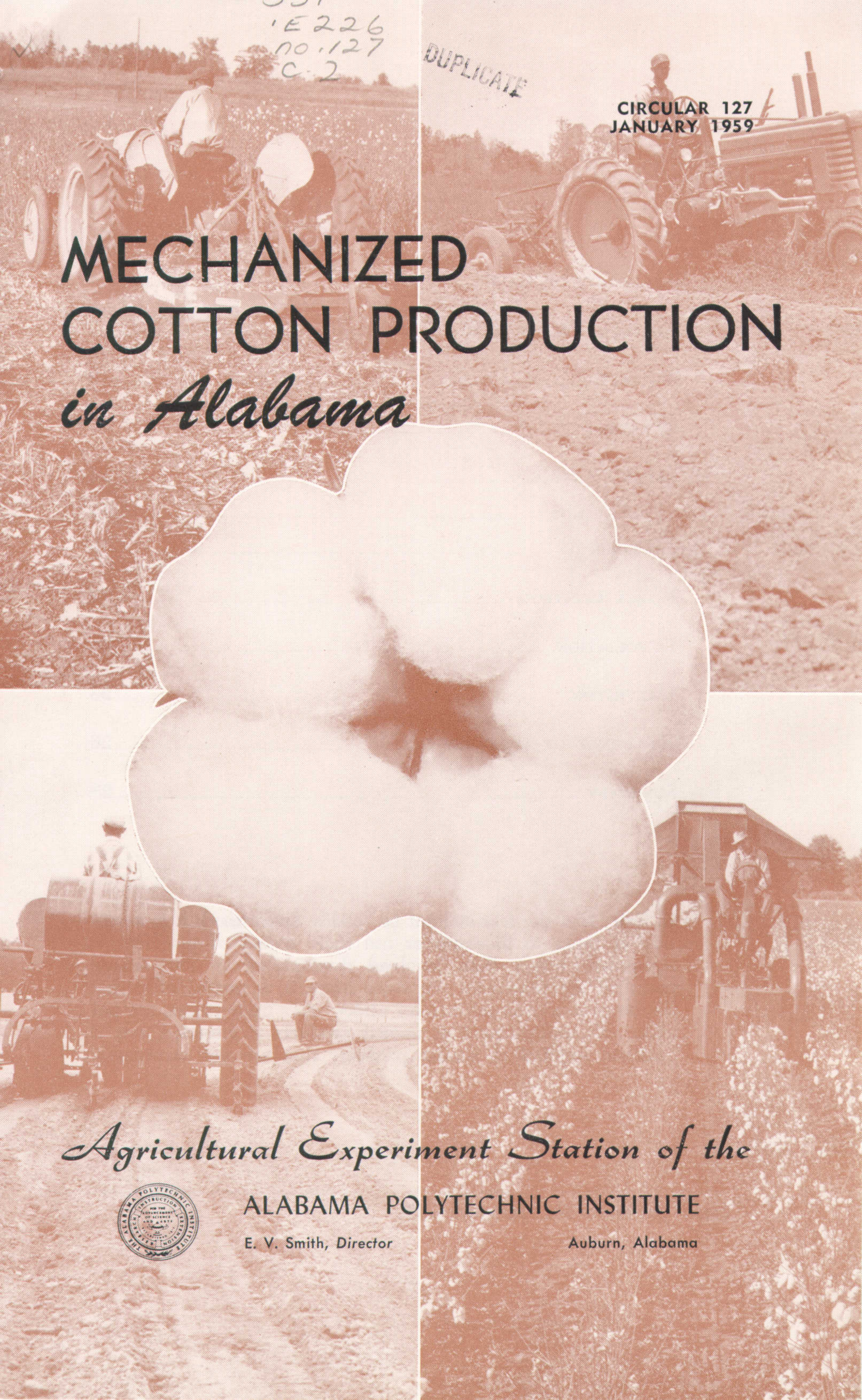

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MECHANIZED COTTON PRODUCTION *in Alabama*

Agricultural Experiment Station of the

ALABAMA POLYTECHNIC INSTITUTE
E. V. Smith, *Director* Auburn, Alabama

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In order that the text content be readily understood, it is necessary at times to illustrate or use trade names of products or equipment rather than involved descriptions or complicated chemical identifications. In some cases it is unavoidable that similar products on the market under other trade names are not cited. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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MECHANIZED COTTON PRODUCTION *in Alabama*

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MAKING MORE PROFIT is the aim of every cotton farmer. To do this, ways must be found to produce the crop as cheaply as possible.

Of course there are problems other than high production costs. For example, acreage reduction and lowered prices are serious. But, there is little that individual farmers can do about such matters. Government programs determine acreage and, to a large extent, price.

This leaves one important factor—production costs—that is controlled by individual farmers.

High labor requirements are the main reason for high production costs. About 100 man-hours are required with present production and hand-harvesting practices for an acre of cotton yielding 1 bale. With labor scarce and becoming costlier, reduction in labor requirements offers the greatest opportunity for cutting production costs.

Test results show that labor requirements for cotton production and harvesting can be greatly reduced by use of machinery. However, a reduction in labor will not necessarily mean a reduction in production costs unless the machinery is used efficiently and yields are high enough to justify the investment. Machinery is costly and its use must justify the investment. Many individu-

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* Cooperative Agricultural Experiment Station of the Alabama Polytechnic Institute and Agricultural Engineering Research Division, ARS, USDA.

The authors acknowledge the assistance of C. A. Brogden, superintendent, Wiregrass Substation; John Boseck, superintendent, Tennessee Valley Substation; S. E. Gissendanner, superintendent, Sand Mountain Substation; and J. O. Helms, superintendent, Agricultural Engineering Farm Unit.

ally operated small farms cannot be completely and economically mechanized with machines now available. This is especially true of mechanical cotton harvesters. Most production equipment can be used for producing other crops usually included in a diversified farming program, but the cotton harvester can be used for cotton only. A farmer planning to buy a picker needs adequate cotton acreage (at least 50 acres for the smaller pickers) or arrange to do custom work. A farming program that permits multiple use of machines can justify purchase of equipment in some cases. For example, a farmer with 10 acres of cotton might find it economical to purchase a sprayer for applying chemicals for weed control in cotton if the sprayer were also used for applying cotton insecticides and for spraying livestock and orchards or for custom spraying.

This publication reports results from tests over a period of years and from field experience in mechanized production and harvest. It deals only with machines, methods, and practices for reducing labor and increasing machine efficiency. The latest recommended agronomic and insect control practices for producing high yields are essential in a mechanized cotton program. Good yields of sound bolls contribute to high mechanical harvesting efficiency and economical machinery use.

Proper planning is essential for successful production and harvest of cotton with mechanical equipment. Every phase of mechanized cotton production from land selection to harvesting has a direct effect on the successful performance of each succeeding operation. Consequently, it is important to make a good start by carefully selecting land and properly preparing the seedbed.

SELECTION *of* LAND

In addition to choosing good soil capable of producing high yields, it is important to select land that is suitable for efficient operation of machinery. Since adjustment and operation of planting, cultivating, and harvesting equipment are more critical for cotton than for most other crops, cotton rates the best available land.

Large fields with long rows are desirable. Fields can often be made larger by eliminating hedge rows and ditches and by changing fencing and road systems.

Rocks and stumps that cause machinery breakdowns and interfere with planting, cultivating, and harvesting must be removed. Savings from fewer machine repairs and increased efficiency of the machinery will soon pay for removing rocks and stumps.

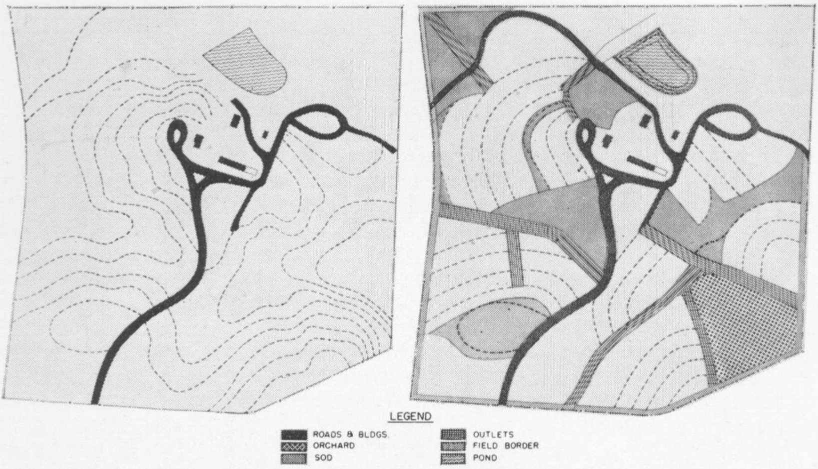
Planting on well-drained land is essential for mechanized cotton production. Wet spot in this field prevented timely use of rotary hoe.

Drainage is an important factor in mechanized cotton production. A few wet spots will often delay timely production operations for an entire field and hinder mechanical harvesting because of non-uniform maturity.

Flat fields are desirable for machinery operations, but they often present difficult drainage problems. Many times it is necessary to provide drainage ditches, then adapt tillage operations to the system. Turning the soil toward the outer edges of a field forms elevated field borders that prevent proper field drainage. After several years of such practice, many areas cannot drain and wet spots develop. Also, turning terraced land with conventional plows often forms high ridges just above the terrace channel and dead furrows between them that prevent proper land drainage.

Two-way turning plows can be used to great advantage in eliminating elevated field borders and dead furrows between terraces. The absence of elevated field borders makes it possible for the rows to drain into drainage ditches and terrace outlets.

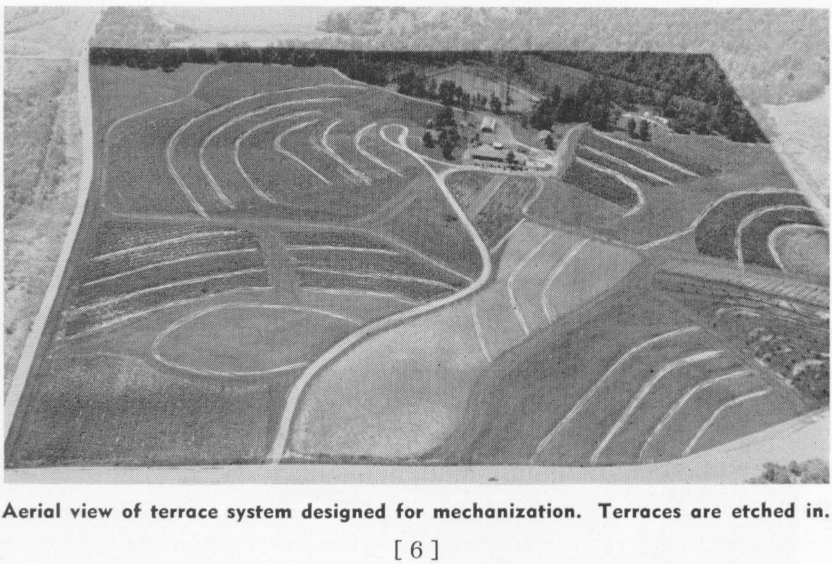
Sloping or contoured land can be used for mechanized cotton production provided suitable drainage and terracing systems are used. Many present-day terracing systems hinder efficient operation of tractor equipment, especially multiple row equipment. Sharp turns in terraces make it difficult to maneuver tractors even at slow speeds. Unevenly spaced terraces result in numerous point rows that are undesirable for mechanized operations. Ter-



Contoured land with suitable terrace and drainage system can be used for complete mechanization. Conventional terrace system at left is contrasted with system at right that is designed for mechanized production.

races with narrow bases have sides too steep to accommodate tractors and equipment.

In recent years, terracing systems that lend themselves to mechanization and conservation have been developed. These systems are designed to include water disposal outlets in the major draws, which permit straighter and more evenly spaced terraces. In many fields it is often possible to lay out all or most of the terraces parallel. Where parallel terraces are not possible,



Aerial view of terrace system designed for mechanization. Terraces are etched in.

This four-row cultivator is being used on a broad terrace built for mechanization. Line in foreground shows cross section of broad terrace channel.

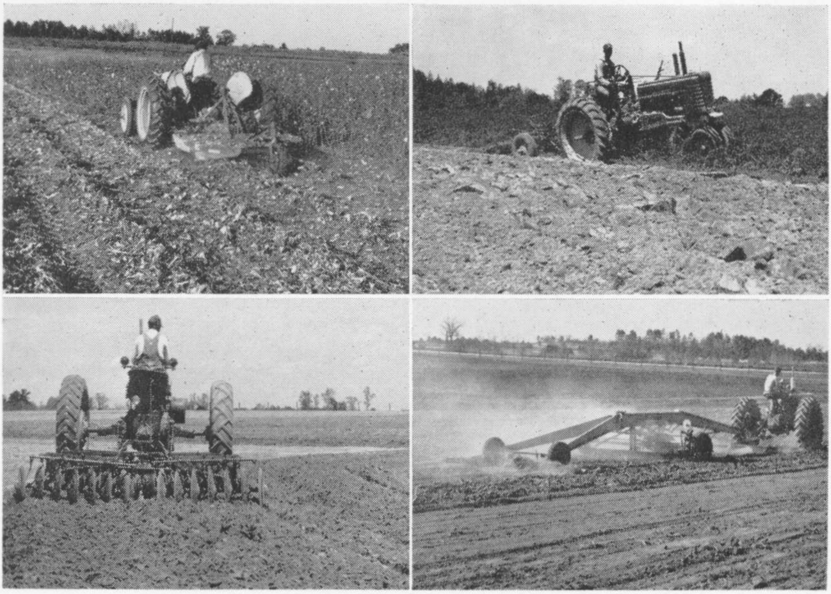
rows are made parallel to one terrace and areas where point rows occur may be sodded and used for turning the equipment without damaging crops. These areas taken out of row crops can be used for production of seed and hay crops.

The most desirable type of terrace for mechanical production is the channel type terrace with sufficient width to permit four rows between channel and ridge. Flat and shallow water disposal outlets are essential to permit crossing them with machinery.

Fields heavily infested with Johnsongrass, Bermudagrass, perennial vines, and other hard-to-control weeds are unfit for mechanized cotton production until weeds are controlled. Such weeds can be controlled usually by fallowing and/or treating with chemical herbicides, by pasturing and/or mowing, or by planting a crop that will not be damaged by chemical herbicides.

SEEDBED PREPARATION

Main objectives of seedbed preparation are to turn under plant residue, pulverize and firm the soil, and smooth the soil surface. Results from seedbed preparation studies in Alabama show that areas where the soil surface was most completely turned had fewest weeds at harvest. Results from these same studies on two soils, Greenville fine sandy loam and Decatur clay, show that deep till-



Shown above are four steps in good seedbed preparation—shredding stalks, turning under residue, disking to firm soil and eliminate clods, and smoothing.

age had no noticeable effect on cotton yields. Results throughout the Cotton Belt do not agree on effect of tillage depth on yield and plant growth. The greatest benefits of deep tillage have been obtained on some soils of the Delta, whereas there were no apparent effects on heavier soils of other areas.

Although it is possible to increase cotton yields on some land by subsoiling or deep tillage, such benefits are limited to soils with a compacted zone (hard pan or plow sole) that interferes with plant root development. Power requirements and cost for subsoiling are higher than for normal preparation methods. Therefore, subsoiling is not warranted unless there is a definite need for this type of tillage. Use of chisel plows or subsoilers, however, will often result in better penetration of turning plows on some of the hard-to-turn clay soils.

Results of tests have shown that moldboard and disk plows are about equally effective for turning land. Soil type will determine to a large extent which type to use. Turning to a uniform depth of at least 6 inches is needed to improve penetration of planting and cultivating equipment and anhydrous ammonia applicators.

Proper disposal of crop residue will reduce clogging of machinery when plowing, planting, cultivating, and harvesting. As soon as the crop is harvested, stalks should be cut close to the ground and into small pieces. Power-driven rotary cutters have proved very effective in shredding stalks. Such machines also can be used for clipping pastures.

One phase of seedbed preparation that greatly improves planting and weed control is smoothing the soil surface. This eliminates unevenness of the soil surface caused by tillage tools, making it easier to plant at a uniform depth throughout the field for more uniform emergence. A smooth seedbed improves the performance of rotary hoes, mechanical cotton choppers, sweep cultivators, and equipment for applying chemicals for weed control. Homemade drags pulled behind harrows will eliminate many soil irregularities and are the most widely used smoothing tools. Although any kind of drag will help, land levelers are excellent tools for smoothing the seedbed. While the use of land levelers in other areas is usually confined to land leveling operations, their use in Alabama is intended primarily for smoothing land and improving drainage.

VARIETY

For machine harvesting, the same varieties are recommended as for hand harvesting. Storm resistance appears to be one of

TABLE 1. RESULTS OF COTTON VARIETY SPINDLE PICKER TESTS

Location and dates	Variety	Weather or pre-harvest loss[1]	Spindle picker efficiency[2]	Overall efficiency[3]
		Per cent	*Per cent*	*Per cent*
Sand Mountain	Empire	2.3	97.0	94.8
1955 and 1956	Coker 100 W.	4.3	96.5	92.3
One picking 1955	Plains	4.1	95.4	91.5
Two pickings 1956	Stone. 3202	2.2	95.8	93.8
Tennessee Valley	Empire	0.8	91.0	90.3
1955 and 1956	Coker 100 W.	1.7	90.2	88.6
One picking when	Plains	1.5	88.0	86.7
all open	Hale 33	0.7	84.8	84.2
Wiregrass	Auburn 56	4.1	91.0	87.2
1954	Coker 100 W.	16.9	91.3	75.8
One picking when	Plains	16.5	88.7	74.1
all open	All-in-One	12.0	90.9	80.0
Wiregrass 1955	Auburn 56	3.5	95.8	92.4
Two pickings—	Coker 100 W.	5.1	96.3	91.4
first when	Plains	5.9	95.0	89.4
55 per cent open	All-in-one	4.0	95.8	92.0

[1] Percentage of total yield on the ground at harvest time.
[2] Percentage of cotton on the plant harvested by the machine.
[3] Percentage of total yield harvested by the machine.

the most important characteristics to consider in choosing one of the recommended varieties for machine harvesting. Cotton intended for machine harvest is often left in the field until most or all of the bolls are fully open. Thus it is exposed to wind and rain longer than hand picked cotton. Varieties showing storm resistance have less weather or pre-harvest loss and still give high machine efficiency. Given in Table 1 are the results from 3 locations in Alabama of the cotton variety spindle picker test. There were no great differences among varieties in the overall harvesting efficiency, but the most storm resistant varieties, Empire and Auburn 56, were slightly better than the other varieties tested.

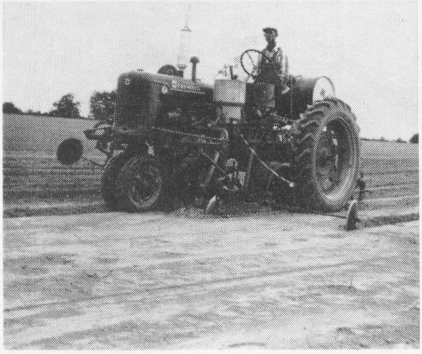
PLANTING

The common practice in Alabama is to plant cotton thick and hand chop to the desired stand. However, cotton can be planted to a stand just like corn, peanuts, soybeans, grain sorghum, and most other crops to eliminate hand thinning. Tests in Alabama and throughout the Cotton Belt show that plant spacing in the drill can vary considerably without materially affecting yield, provided the plants are uniformly distributed. In Table 2 are results of spacing tests conducted at three locations in Alabama. These data show that a stand can vary from 20,000 to 60,000 plants per acre. Based on these results, it is recommended to plant for a stand of about 3 plants per foot or 40,000 plants per acre. If good weather prevails during emergence, a stand of

TABLE 2. RESULTS OF COTTON SPACING SPINDLE PICKER TESTS

Location and dates	Spacing		Per acre yield	Bolls per pound	Spindle picker efficiency
	Plants per acre	Plants per foot			
	No.	*No.*	*Lb.*	*No.*	*Per cent*
Sand Mountain	14,700	1.1	1,574	56*	94.9
Substation	21,700	1.7	1,611	58	94.6
1954, 1955,	40,100	3.1	1,697	60	95.1
1956	56,600	4.3	1,705	62	94.7
Tennessee Valley	14,000	1.1	1,025	72	90.7
Substation	20,300	1.6	1,080	72	91.3
1954, 1955,	41,200	3.2	1,104	79	90.5
1956	59,700	4.6	1,045	81	90.3
Wiregrass	15,300	1.2	2,178	76	91.8
Substation	18,300	1.4	2,196	76	92.5
1954, 1955	35,100	2.7	2,112	78	92.9
	56,700	4.3	2,130	79	92.5

* Average for 1955 and 1956 at Sand Mountain Substation.



Cotton can be planted and pre-emergence weed control chemical applied in same operation with sprayer mounted as shown above. Note the well-prepared seedbed and use of row marker and wide press wheel.

60,000 plants per acre or more may result. However, if bad weather occurs, a stand of at least 20,000 plants per acre can be expected. In either case, yields will not be affected materially. Although 20,000 plants per acre may be just as good as thicker stands, it is not advisable to plant to a stand of 20,000 plants because poor emergence could result in an unsatisfactory stand. When planting to a stand, it is important to remember that too many plants are better than too few.

Skips like the one shown reduce yield and promote growth of grass and weeds that interfere with harvesting.

Thickness of stand affects growth and fruiting of cotton. In photos at left is stand of 1 plant every 12 inches. Note long limbs and low fruiting. Plants at right are spaced 1 every 2.7 inches and have short limbs and high fruiting.

Close spacing in the drill tends to produce uniform plants with short and high fruiting limbs. Although thicker spacings had but little effect on spindle picker efficiency, higher fruiting in the thicker stands made it possible to operate the picker higher above the ground. This made it easier to keep the picking drum from gouging into the dirt. There are no serious objections to thick stands for hand picking, except that smaller bolls result from the thicker stands, Table 2. However, the slight difference in boll size is less than variation among the recommended varieties.

Determining how many seed to plant to get a desirable stand without thinning is a problem. It is difficult to predict accurately the percentage of emergence of cottonseed. Germination percentage is not always a good measure of emergence.

A good rule of thumb is to plant about twice as many good seed (80 per cent germination or better) as you wish to emerge. When planting to a stand and planning to use chemicals for weed control, about 7 seed per foot are needed. This seeding rate is approximately 3 pecks of machine delinted seed per acre. When using a rotary hoe for weed control, the planting rate is about 10 seed per foot or a bushel per acre. In most cases, several rotary hoe cultivations will eliminate enough plants for a

Weeds and grass collected with cotton are difficult to remove in ginning and result in lower grades.

Clean culture year after year is important in good weed control. The use of hand labor to remove late growing weeds before they go to seed will pay dividends. In a rotation, it is best that the crop preceding cotton be a clean culture crop. From the standpoint of weed control, cotton should not be in a rotation with corn. Where cotton is rotated with corn, weed control is more difficult because weeds are usually allowed to go to seed in the corn.

Clean culture of cotton in fields infested with hard-to-kill perennials requires much hand labor the first year or two. However, it should result in relatively clean fields after several years of operation.

Seedbed preparation influences weed control practices. A smooth, firm seedbed free of clods and debris is needed for most effective use of the rotary hoe and sweeps and chemical weed control equipment.

Rotary Hoe

Use of the rotary hoe and chemicals will eliminate much of the hoe labor for cotton production. Table 3 gives results of five tests comparing mechanical and chemical weed control with conventional hand chopping and hoeing at the Sand Mountain Substation. In these tests, the conventional or check plots were seeded in a continuous drill at the rate of 1 bushel of seed per acre, barred-off, and hand-chopped to a stand. The rotary hoe

TABLE 3. RESULTS OF 5 TESTS COMPARING 3 CULTURAL TREATMENTS, SAND MOUNTAIN SUBSTATION, 1954-56

Item	Results from three cultural treatments		
	Check[1]	Rotary hoe[2]	Chemicals[3]
Seeding rate, *seed per foot*	11	11	7
Stand at harvest time, *plants per foot*	1.8	4.1	3.0
Grass and weeds 30 days after planting, *number per 100 row-foot*	525	163	2
Hoe labor, *man hours per acre*	17.1	9.5	1.8
Yield, *pounds per acre*	1,540	1,480	1,517
Spindle picker efficiency, *per cent*	94.6	95.1	94.4

[1] Hand chopped and hoed.
[2] Broadcast-type rotary hoe used and hand hoed but not chopped.
[3] Pre-emergence chemical (C.I.P.C.), 1 to 2 post-emergence treatings, and hand hoed but not chopped.
Note: All treatments received sweep cultivation.

desirable stand. (Note: Test results of planting to a stand are discussed under Weed Control.)

When planting to a stand, the seed may be hill-dropped or drilled. Hill-dropped cotton is easier than drilled to hand-hoe when weeds are numerous.

Fuzzy seed and machine delinted or acid delinted seed can be used to get a stand. However, delinted seed can be planted with greater accuracy than fuzzy seed.

Flat planting is desirable in mechanized cotton production. It leaves the row more accessible for effective rotary hoe cultivation, especially with a broadcast type rotary hoe. Flat or low bed planting is best where chemicals are used for weed control, because water will not collect and leach the chemicals into the soil and damage the cotton seed. Flat planting provides a desirable row profile for efficient application of post-emergence chemicals. Flat planting reduces the hazard of soil silting in from beating rains and sand storms. Furrow planting offers some protection from cold wind and sand storms as experienced in southeastern Alabama. However, sand will often fill the furrow and kill the emerged cotton or cover the seed too deeply for emergence.

Fertilizer can be applied at planting time if put in narrow bands about 2½ inches to either or both sides of the seed and 2 to 2½ inches below the seed. Placement of fertilizer should be accomplished with minimum disturbance of the seedbed.

For best machine use, uniformly spaced long rows are needed. Rows of uniform width are needed in obtaining good coverage when poisoning and defoliating with multiple-row sprayers and dusters. They also reduce damage by tractor wheels during cultivating, poisoning, defoliating, and harvesting. A row marker aids in planting rows of uniform width.

For most efficient harvesting, mechanical harvesters must enter the row straight and continue past the end before beginning the turn, maintaining a normal speed. For this reason, it is important to have about 20 feet of turning area at ends of rows.

WEED CONTROL

Fields free of grass and weeds at harvest time are important for efficient use of mechanical harvesters and for obtaining high grades of cotton. Weeds, vines, and grass in the row sometimes clog mechanical harvesters, causing stops and high harvest losses.

Here, young cotton is being cultivated with a broadcast rotary hoe.

plots were also drilled at the rate of 1 bushel per acre (about 11 seed per foot) but received no hand thinning. The rotary hoe was used 1 to 4 times depending upon weed growth and stand and hand hoeing was done as needed. The chemical plots were drilled at the rate of 3 pecks per acre (about 7 seed per foot) but were not hand-thinned. They received a pre-emergence chemical (C.I.P.C.) application at planting time, 1 to 2 post-emergence applications of oil, and were hand-hoed as needed. The seed in this test were planted in a continuous drill, but tests in other states have shown that the seed may be hill-dropped.

These results show that using the rotary hoe eliminated about 40 per cent of the hoe labor. Where timely and frequent use of the rotary hoe were possible, hoe labor was reduced about 50 per cent. Because of a thin stand caused by poorly treated seed in one test, the rotary hoe was used only once. In this test, hoe labor was only 20 per cent less than that for the check plots.

These tests are good examples of the importance of getting a good stand. The rotary hoe should be used just as weeds begin to emerge. If weeds are allowed to establish a deep root system, the rotary hoe will not be effective.

The greatest limitation of the rotary hoe is the inability to use it when the ground is wet. A long wet period will allow weeds to establish a good root system and become too large for control with a rotary hoe. The destructive power of the rotary hoe on weeds increases as speed increases. In most cases it is desirable to run the hoe at speeds of 4 to 6 miles per hour. The rotary hoe also aids greatly in obtaining a stand by breaking hard crusts caused by rains.

Chemicals

Results in Table 3 show that the use of chemicals reduced hoe labor about 90 per cent. The chemicals were applied as recommended in API Agricultural Experiment Station Progress Report No. 51. A 12-inch flat steel roller was used to press the row, leaving a smooth clod-free band on which to apply the pre-emergence chemical. Recommended depth of planting is the same as for planting without chemicals (¾ to 1¼ inches).

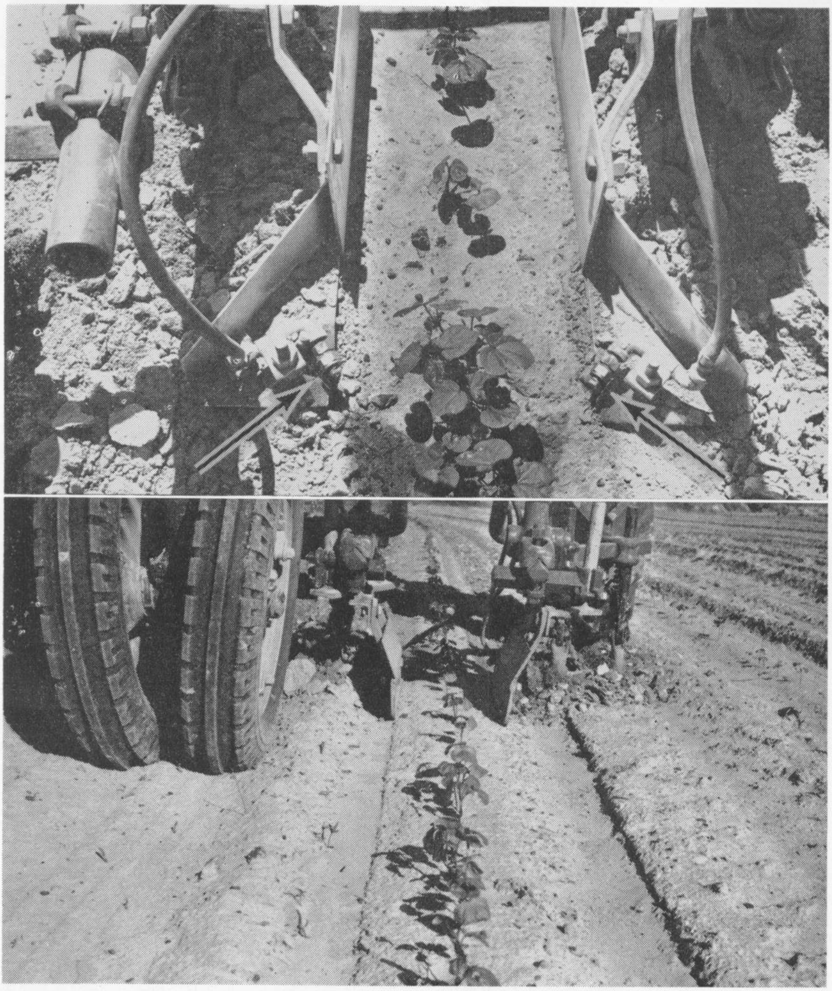
Post-emergence oils were applied with fan-type nozzles mounted on parallel-action spray shields. Nozzles mounted on these shields are relatively easy to adjust for effective spraying of small weeds without spraying the cotton leaves provided cotton is planted flat or on a low bed and a flat roller is used at planting time. Success of this operation depends to a large extent upon a well-prepared and smooth seedbed. If cotton plants are large enough, the post-emergence oil is applied just as soon as the weeds begin to emerge. This is important because large weeds cannot be sprayed without spraying the cotton. For more information concerning spray equipment for weed control see API Agricultural Experiment Station Circular No. 126.

The reduction in hoe labor by using a rotary hoe and chemicals was not only the result of reduction in weeds but also the elimination of chopping or thinning. To realize the greatest benefit from mechanical and chemical weed control, cotton must be planted to a stand. Not only does thinning require considerable time but disturbance of the soil by thinning reduces the effectiveness of the chemicals. However, there is no advantage to planting to a stand to eliminate hand thinning unless mechanical or chemical means are used to control weeds. If weeds are numerous, it takes as much or more labor to get the weeds without thinning as it does to get the weeds and thin the cotton.

Sweep cultivation is the best method for controlling weeds in middles. When properly used it controls many weeds in the row. Sweeps must be set properly for effective, fast, and precise work. When set to run flat and shallow, sweep cultivation does not

Above are results from chemical weed control for 3 years at the Sand Mountain Substation. Top photo shows treated field in 1954. Center (1955) and bottom (1956) photos show chemical treated plots, right, and nontreated, left.

ridge the row but leaves the middle slightly lower than the row, which is desirable for mechanical harvesting. Cotton to be harvested mechanically is cultivated late in the season to reduce weeds at harvest time.



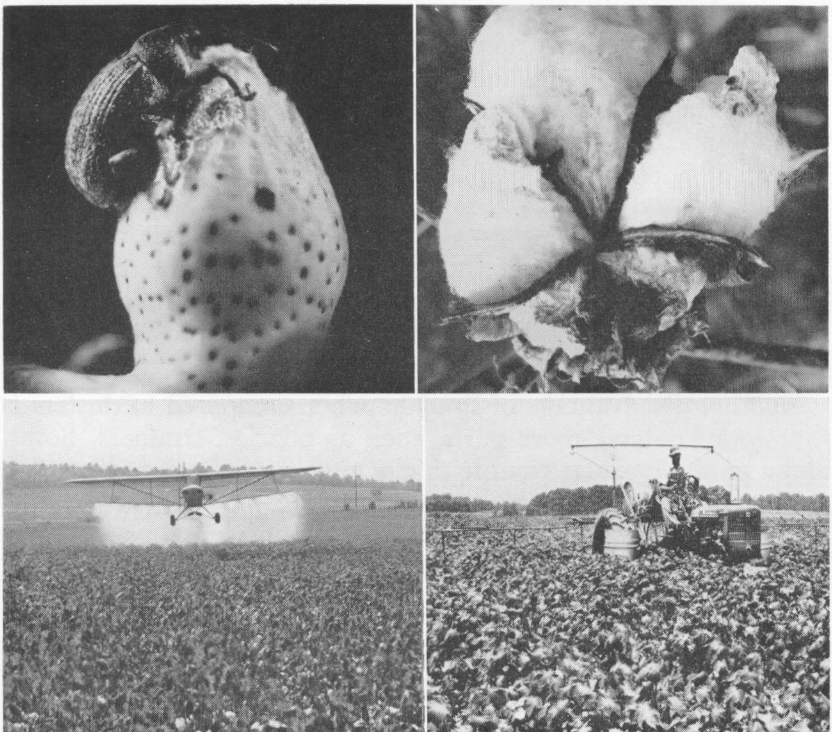
Spraying post-emergence oils for weed control is shown above. Overhead view at top shows nozzles (arrows) mounted on parallel action shields and set for spraying weeds in row without spraying cotton leaves. At bottom is a front view showing sweeps cultivating middles and shields keeping dirt off treated row.

INSECT CONTROL

Cotton insecticides may be applied as a dust or a spray. Tests by the Agricultural Experiment Station have shown that dusts and sprays are equally effective in controlling cotton insects.

Spraying insecticides has several advantages over dust application. Sprays usually can be applied throughout the day, whereas dust application is restricted to early morning, late evening, or night hours when there is little or no wind. In some areas there are days during the growing season when dust cannot be applied at any time because of wind or air currents. This often prevents farmers from following a poisoning schedule which is so important for effective insect control. Using sprays increases chances of being able to poison on schedule.

Sprays can be applied while cultivating. In seasons when early season insect control is important, effective control can be ob-



Insect-damaged boll like one at top reduces yield and picker efficiency. Either ground or air spraying or dusting with insecticides can prevent damage.

tained with sprayers mounted on regular cultivating equipment. Such application is economical from the standpoint of application costs. The same spray rig can be used throughout the growing season.

Spray application is less objectionable to the operator than dust application. Dust applied during calm weather may stay suspended in the air to bother the tractor driver throughout the dusting operation, whereas spray will settle quickly on the plants.

Spraying equipment has much wider use than dusting equipment. In addition to applying insecticides to growing crops, sprayers can be used for spraying livestock, chicken houses, and other insect-infested areas. They can also be used for applying herbicides. **Warning—do not use 2,4-D in the same equipment that is to be used for spraying cotton or other broadleaf plants.**

While spray application has several advantages, it also has some disadvantages. One is that the farmer must mix his own spray solution in correct proportions. The amount of diluted spray for effective control may vary considerably (from 1 to 10 gallons per acre for cotton) so long as the correct amount of technical (active) material is applied. If the strength of the concentrate and the amount of solution the sprayer is applying are known, it is relatively simple to mix concentrate with water in correct proportions. Concentration of the solution is marked on the container and is usually expressed in pounds of technical material per gallon of concentrate. The amount of solution the sprayer is applying must be determined by calibrating the sprayer. (See API Agricultural Experiment Station Circular No. 126 for information on calibrating sprayer.)

Another disadvantage of sprayers when compared to dusters is that sprayers have more parts, such as nozzles, strainers, hoses, and a pump, to cause trouble in clogging, corroding, and rusting.

In Alabama, tractor-mounted dusters are used most widely for insecticide application. Dusters are relatively simple and are easy to operate and maintain. With introduction of the new organic insecticides, improvements were made in the metering and blowing systems to give more uniform distribution of insecticides. Multiple-row dusters have been designed for operating efficiently at high tractor speeds.

Plane sprayers and dusters are now being used for applying cotton insecticides and defoliants. They have advantages over ground equipment in that they (1) do not damage the crop, (2) can be used when the ground is too wet for ground equipment, and (3) can apply the insecticides much faster.

Considerable progress has been made in reducing mechanical damage to crops caused by ground applicators of insecticides. This damage may be quite serious, especially from late season applications in tall crops. Because of this mechanical damage, many farmers stop poisoning before the crop is mature. Test results show that late applications are often the most important. Progress in reducing this mechanical damage has included development of tractor wheel shields, design of sprayers and dusters with high-clearance mounting frames without low braces, and use of multiple row units. Several companies make tractor wheel shields and some farmers have improvised shields that work satisfactorily.

Other progress in reducing mechanical damage to crops includes the development of high-clearance sprayers and the use of "stilts" (high clearance kits) for elevating row crop tractors. The special-purpose, high-clearance sprayers are relatively costly and have been used mostly on large farms and by custom operators. Stilts for tractors have proved to be quite satisfactory. Since the tractor can be removed from the stilts and used for regular tractor work, these rigs are relatively economical for insect control work.

DEFOLIATION

The benefits derived from applying a chemical to defoliate cotton will vary with plant condition and method of harvesting. Tests have shown that defoliation is not always economical or necessary for harvesting by hand or by spindle picker. However, the same tests show that defoliation either by nature or with chemicals is a must for harvesting with a mechanical stripper. Results from defoliation harvesting tests at two locations are given in Table 4. These results show that defoliation had no effect on harvesting efficiency of the spindle picker and trash content of the harvested cotton. However, defoliation gave a slight increase in lint grades. The cotton plants in this test were less than 3 feet tall and some natural defoliation occurred each year. Defoliation should prove more beneficial in rank cotton, especially during wet conditions. Although defoliation did not increase picker efficiency, removal of leaves made it easier for the operator to see and keep the picker on the row. Defoliation

TABLE 4. RESULTS OF SIX HARVESTING TESTS COMPARING DEFOLIATED AND UNDEFOLIATED COTTON, 1954-56

Item	Defoliated	Undefoliated
Yield, *pounds per acre*	1,395	1,360
Spindle picker efficiency, *per cent*	92.1	91.9
Trash content of harvested cotton, *per cent*	7.5	7.8
Grades	1-SM 2-M 6-SLM 2-LM 1-MLt. Sp.	2-M 4-SLM 4-LM 1-MLt. Sp. 1-SLMLt. Sp.

also allowed the cotton to dry quicker for earlier harvesting each morning.

In three tests in 1954, undefoliated cotton harvested with a mechanical stripper contained a high percentage of green leaves and was difficult to gin. It required 2,500 pounds of seed cotton and trash to make a 500-pound bale. These results show that cotton must be defoliated for harvesting with a mechanical stripper.

Defoliants can be applied with equipment used for applying insecticides. Larger volumes of dust and spray are needed for defoliation than for insect control. For insect control, good coverage of the terminal growth is usually adequate. However, for

Defoliated (left) and undefoliated rows of cotton 1 week after defoliant was applied show results from using the chemical.

defoliation each leaf must receive an application of the defoliant. About 20 to 40 pounds of dust defoliant per acre or 15 to 25 gallons of spray solution per acre must be used. See API Agricultural Experiment Station Circular No. 126 for more information about equipment for applying defoliants.

In droughty cotton and when there is no dew, tests results show that it is best to use a spray defoliant. For normal cotton and when dew is present, dusts and sprays are about equally effective.

It normally takes about a week after applying the defoliant for the leaves to fall. Thus the chemical is applied about 7 to 10 days before machine picking. Staggered applications can be timed so that harvesting can be done soon after the leaves fall.

HARVESTING

Based on the principle of operation, there are two types of mechanical cotton harvesters—pickers and strippers. Pickers pick the cotton from the bur, whereas strippers strip the cotton, bur and all, from the plants. Pickers have rotating fingers or spindles that pick the open cotton and leave the green bolls for a later picking. Most strippers have stripping rolls somewhat similar to a corn picker, while others have stripping fingers or tines. It is necessary to wait until all bolls are open before harvesting with a mechanical stripper. Strippers are considerably lower in cost than pickers.

Pickers and strippers were tested for several years in Alabama. Although many problems were encountered with both types of machines, there were more problems associated with the stripper. Results of these tests show that conditions for stripper harvesting are much more exacting than for picker harvesting. Poor defoliation, new growth, vine infestation, uneven plant size, and nonuniform maturity often made it impossible to use mechanical strippers. These same conditions, although unfavorable, did not necessarily prevent picking with spindle pickers. While waiting for all bolls to open as required for stripper harvesting, much cotton fell to the ground, especially during rainy and windy weather. This high weather loss occurred every year at the Wiregrass Substation, whereas only small losses were experienced in northern Alabama. The stripped cotton contained 30 to 40 per cent foreign matter (burs, limbs, and leaves), which usually caused trouble in ginning. Considerable clogging was often encountered

Harvesting cotton with machines like the stripper (top) and spindle picker (bottom) requires only 2 to 3 man-hours per acre.

during ginning. Green limbs seemed to cause the most trouble. The cotton graded Low Middling in most tests.

Results from some of the mechanical stripper tests are given in Table 5. These show that the stripper is an efficient harvester, averaging slightly above the picker. The stripper used in these tests was a 2-row machine with a single steel stripping roll and a stripping bar for each row (John Deere No. 15). In fields with moist sandy soil, the stripper uprooted many plants and sometimes clogged several times before advancing 100 feet. Morning glory and other vines wrapped around the beaters of the conveying system and clogged the machine. Cotton stripped in fields with poor defoliation or with abundant new growth contained

TABLE 5. SPINDLE PICKER AND STRIPPER PERFORMANCE IN HARVESTING ALL VARIETY AND SPACING PLOTS AT THREE LOCATIONS, 1954-56

Location and year		Picker			Stripper		
		Machine efficiency	Overall efficiency	Trash content	Machine efficiency	Overall efficiency	Trash content
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Sand	1954*	91.7	86.6	9.6	92.1	87.4	33.8
Mountain	1955	96.0	93.8	7.8	97.8	95.4	33.6
Substation	1956	96.6	93.4	6.3	97.6	95.8	31.5
Tennessee	1954*	88.2	76.2	6.1	88.6	76.6	38.6
Valley	1955	95.8	95.0	7.6	97.6	96.6	31.9
Substation	1956*	84.2	83.4	7.6	97.8	97.0	33.7
Wiregrass	1954	90.6	77.8	8.1	93.2	80.8	35.0
Substation	1955	95.0	91.4	7.2	94.7	83.2	33.6
Average of 256 trials		92.3	87.2	7.5	94.9	89.1	34.0

* Cotton in these tests was severely drought stressed.

many green leaves; about 2,500 pounds of harvested cotton and trash were required for each 500-pound bale.

There were some years when conditions were good for mechanical stripping and good results were obtained. While stripping is not ruled out for Alabama, these test results point up problems that can be expected with this method of harvesting.

The picker used in these tests was a one-row, low drum machine with barbed spindles (IHC H-14 and C-14). As shown in Table 5, the efficiency of the spindle picker was greatly affected by plant or boll conditions that were determined by weather. Small and knotty bolls resulting from dry weather contributed to low efficiency. Where ample rainfall occurred during the growing season to produce good yields of sound bolls, picker efficiency was usually high. However, long period of wet weather, such as occurred in 1957, caused hard locks that contributed to low picker efficiency. Many of the hard locks that the picker failed to get would have been poor quality cotton even if they had been harvested.

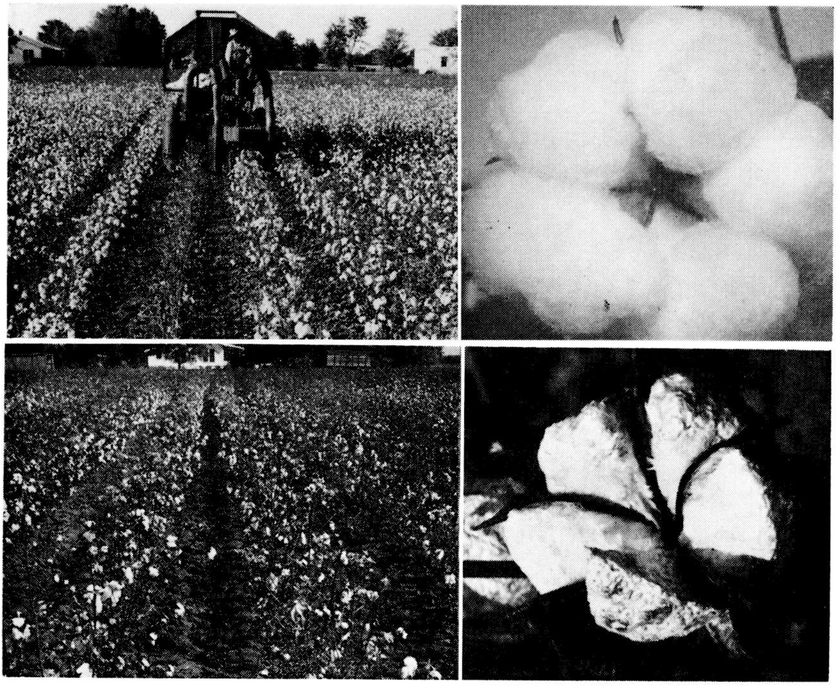
Unlike strippers, pickers can be used to harvest before all bolls are open. A test was conducted comparing twice-over picking (starting when the cotton was 60 to 85 per cent open and picking again when the remaining bolls were open) with once-over picking when all bolls were open. In this test, twice-over picking reduced weather loss and increased overall harvesting efficiency 2 out of 3 years of the tests. No measure was made of quality, but twice-over picking should result in higher quality cotton because of less weathering. However, when yields are low, it might pay to take a chance on weather losses and make one picking when all cotton is open. The additional amount and quality of cotton obtained from two pickings might not offset the cost of the second picking.

The plant compressor sheets of the picker used in this study can be equipped with a rib plate attachment that forces the cotton around the spindles and increases their effectiveness. Data from five tests show that machine efficiency was 89.5 per cent without the plates and 93.0 per cent with the plates. However, the attachment increased the foreign matter content of the harvested cotton from 6.3 to 8.1 per cent. This attachment causes the spindles to puncture green bolls; hence, it should not be used until the last picking.

The grade of machine-picked cotton varies with weather and plant conditions and the ginning equipment used. Table 4 shows the grades obtained in the defoliant test. In comparing machine-picked and hand-picked cotton, field conditions and quality of hand pickers must be known. In early season harvesting, hand-picked cotton will usually average about one grade better than machine-picked cotton. As the season progresses and cotton becomes weathered, the difference in grade between hand-picked and machine-picked cotton becomes less.

INFLUENCE *of* WEATHER

Weather conditions determine to a large extent the success of cotton production. Results of several years of testing have shown that efficiency of the spindle picker is affected more by plant and boll conditions that are determined by weather than by any other factor. Cold weather delays planting, hinders emergence, weakens the plants, and makes the plants more susceptible to diseases. Wet weather prevents timely field operations, makes mechanical grass and weed control more difficult, prevents emergence of deep planted seed, increases insect control problems, promotes rank growth, and causes boll rot. Dry weather prevents shallow planted seed from emerging, reduces the effectiveness of pre-emergence chemicals for weed control, reduces yield, and causes small and hardlock bolls. Weather is especially important in a mechanized cotton program where timely machinery operations, good yields, and high machine efficiency are essential for economical machinery use.



Effect of weather on picker efficiency at the Tennessee Valley Substation is shown above. In 1955 (top photos) there was ample moisture for good yields and sound bolls, resulting in 96 per cent picker efficiency. Severe drought in 1956 caused low yields and the hard-lock cotton shown at bottom. Picker efficiency for this cotton was 86 per cent.

There are many things that can be done to reduce weather hazards. The most important thing in a mechanized operation is to have equipment and land prepared for efficient and continuous operation when soil and weather conditions are favorable. Continuous operation when the time is right contributes greatly to economical machinery use. Machine performance depends almost entirely on skill of the operator. Good operators will help in reducing repair costs and result in more efficient and continuous operation.

SUMMARY

Cutting production costs by use of machinery can help solve problems facing cotton farmers. To do this, machines must be used efficiently. Results from experiments reported show that the following steps will permit efficient and profitable use of mechanized farming practices:

(1) Select and prepare cotton land early.

(2) Use best land for cotton and prepare it for using all types of machines.

(3) Remove rocks and stumps that cause machinery breakdowns.

(4) Keep terrace outlets open and drain low spots to permit earlier seedbed preparation following winter rains.

(5) Prepare smooth, clod-free seedbed well in advance of planting time to reduce chances of late planting on poorly prepared seedbed.

(6) Have tractor and planting equipment in good operating condition.

(7) Adjust all units of multiple row equipment to plant alike. A difference of one-half inch in planting depth may mean the difference between a good and poor stand, especially in bad weather.

(8) Plant to a uniform stand to eliminate hand thinning and reduce hoe labor.

(9) Use chemical or mechanical means to control weeds instead of hoe labor.

(10) Have dusting and spraying equipment adjusted to obtain good plant coverage.

(11) Defoliate rank and leafy cotton.

(12) Begin picking before all cotton is open. With mechanical picker, begin when 60 to 75 per cent is open.

(13) Keep picker drum clean and serviced.

(14) Adjust picker properly for efficient and clean picking.

(15) Do not pick wet cotton.

(16) Gin cotton soon after harvesting or make sure that only dry cotton is stored overnight in trailers.

(17) Don't give up new machines or methods because of poor results during one year of unusually bad weather.