MECHANIZING COTTON

for low-cost production

Bulletin No. B-382
March 1952

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
Oklahoma A. & M. College, Stillwater
in cooperation with
UNITED STATES DEPARTMENT OF AGRICULTURE

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UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration

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Mechanizing Cotton

for

Low-cost Production

By Rex T. Humphreys, John M. Green, and Edward S. Oswalt*

Cotton mechanization is often thought of as something for the future. But in southwestern Oklahoma and adjacent portions of Texas, cotton production is already partially mechanized.

Mechanical methods of cotton production can be adopted as fast as practical ones are found. It is not necessary to wait until the whole job from

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THE INFORMATION REPORTED HEREIN is based on a state-wide cotton research program which is a joint undertaking of the Oklahoma Agricultural Experiment Station and the United States Department of Agriculture, and which is supported in part by the Oklahoma Cotton Research Foundation. Close cooperation is maintained with experiment stations in other cotton-growing states, and especially with the Texas Agricultural Experiment Station. Through this cooperation, unnecessary duplication of effort is avoided, and results obtained by research in any state are quickly available for use of cotton growers in Oklahoma. (Interstate and U.S.D.A. cooperation are organized under Regional Project S-2.)

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planting to harvest can be done with machines. *The real question is not mechanization as such, but finding low-cost production methods*. Use of machines is just one way of cutting costs.

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Practices which increase per-acre yields are just as important as use of machines in reducing cost of producing cotton. Information about how to increase yields is available in other publications, therefore this bulletin puts emphasis on use of machinery. Other publications about cotton production in Oklahoma are listed on page 20.

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Preparing the Seedbed

Good seedbed preparation is especially important when machines are used in cotton production. A well-prepared seedbed helps get more uniform stands, which are needed for proper operation of machinery. It also reduces the number of weeds, thus reducing hand hoeing; and it leaves less trash on the surface to interfere with the use of machinery.

Where cotton follows corn, cotton, sorghums, or other crops with heavy stalks, the first step is to chop these stalks into small lengths with a stalk cutter. Unchopped stalks left in the field make it difficult or impossible to use cotton machinery the following season. Also, the chopped stalks decay more rapidly, thus helping maintain the organic matter content of the soil.

Other steps in seedbed preparation are about the same for mechanized cotton as for cotton grown by older methods, but pre-planting tillage especially must be done carefully. A firm, uniform seedbed is necessary for machine planting to eliminate the labor and expense of chopping to a stand; and pre-planting weed control eliminates much of the usual hand hoeing. These savings are both important in reducing production costs.

The disk harrow or field cultivator, or both, are perhaps the best implements for surface tillage to control weeds, conserve moisture, and prepare a good seedbed.

Precision Planting

Precision planting has an important role in cotton mechanization and in reducing the cost of cotton production. The purpose is two-fold: First, "planting to a stand" to reduce the amount of seed used, and especially the amount of labor needed for chopping; and, second, planting to the proper spacing for mechanical harvesting.

Rows for mechanical harvesting should be as long and straight as possible. If planted on the contour, sharp turns are to be avoided as much as possible.

PLANTING TO A STAND

Planting to a stand is already a common practice in Oklahoma, especially in the southwestern counties. A survey made in that area in 1949 showed that about one-third the acreage was never thinned.

Successful precision planting requires use of acid-delinted seed having a high germination test. It is difficult, or almost impossible, to get uniform spacing in the row when using fuzzy seed, because such seed is not uniform either in size or in the amount of lint on each seed.

Corn or pea plates work satisfactorily with delinted cotton seed. The cells in the plant should be large enough to allow from one to three seeds to pass through the hopper mechanism.

Experiments at the Oklahoma Agricultural Experiment Station suggest that before entirely satisfactory precision planting is possible, seed must be

Two of several types of stalk choppers now on the market. When mechanized cotton is to follow cotton, corn, sorghum or other crop with heavy stalks, a chopper should be used before plowing. Unchopped stalks interfere with planting, cutivating, and harvesting, thus reducing the benefit gained from precision planting and mechanical harvesting.

graded for size as well as acid delinted; but seed graded for size is not yet commercially available.

Figuring Seeding Rate

The seeding rate needed to get plants the desired distance apart can be figured by allowing for the germination percentage of the seed and the expected percentage of emergency of live seed. Appendix Table I, page 19, shows the number of seeds needed in each two feet of row to get a stand of plants at various spacings. This table is based on seed testing 80 percent germination and an expected emergence of 80 percent. Other percentages of germination or emergence can be figured by the method described in the appendix, page 18.

The appendix table also shows the pounds of seed needed per acre at various seeding rates for three different storm-proof varieties of cotton.

The belief that several seeds planted close together will develop a better

Sideways scattering of seed in the row must be avoided as much as possible when cotton is to be harvested by existing types of mechanical strippers. The strings show the desirable maximum scatter—not more than one inch. Arrows point to stubs of cotton plants which are too far outside the row for best results in mechanical stripping.

stand has not proved out in research at Chickasha. It made little difference whether one or 10 seeds were planted at the same spot; all emerged if conditions were right. Hill drop has been compared with drill planting at the Chickasha station for the past three years. Hill drop has been little if any better than drilling in producing a stand.

Adjusting Planter to Desired Rate

To find out how many seeds the planter is dropping in each two feet of row, merely run it a short distance in gear, dropping the seed on the surface of the ground. Then measure off several two-foot portions of the seed row, count the number of seeds in each two-foot section, and figure the average.

If the planter is not dropping seeds at the average rate desired, it can be adjusted by changing the plate size or the drive sprockets ratio.

PLANTING FOR MECHANICAL HARVESTING

Distance between rows, and distance between plants in the row, must both be accurate to permit clean mechanical harvesting. Furthermore, the "scatter" of plants sideways in the row must be held to a minimum.

The entrance or throat of most mechanical harvesters is narrow. If there is much variation in distance between rows, or if the plants scatter sideways in the row, the amount of lint lost is greatly increased. Irregularities in these distances also cause the machine to pull plants and break limbs, which then choke up the harvester.

An important feature of the brush-roller type cotton stripper developed at the Oklahoma Agricultural Experiment Station is a flexibility which adapts the machine to greater irregularities in plant size. This machine is not yet on the market, but is being tested by several manufacturers with a view to producing it commercially.

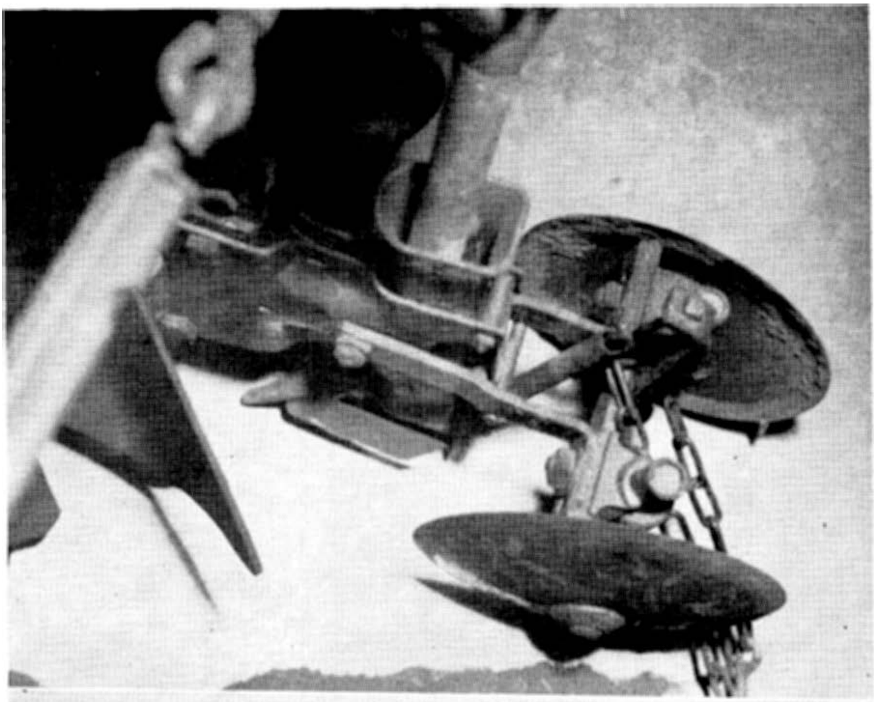
Row Spacing

Cotton for mechanical harvesting should be planted in rows 40 inches apart, because most commercially-manufactured strippers are built for this row width. Row width is adjustable on all planting devices, and it should be double-checked for accuracy before the planter goes to the field. Row markers should be used, and they should also be checked for accuracy.

Reducing Scatter of Seed in Row

The scatter of seed sideways in the row can be held to a minimum by using a planter with a narrow boot or furrow-opener.

If planting is done with a lister, a narrow stinger should be used to keep the drill row narrow and eliminate side splatter of seed (see picture, page 10). Scattering of seed beyond the stinger furrow cannot be entirely avoided, but it should be held to a minimum. The stinger should be set below the lister shear the depth you wish to plant.



The lister used in planting cotton for mechanical stripping should have a narrow stinger of the types shown here. This helps put the seed in a narrow band so the plants will be lined up to enter the throat of the stripper. Only one man is required to operate the entire mechanism.

Use of a narrow stinger has another advantage in dry areas or dry seasons: It places the seed in a firm, narrow crevice that does not dry out readily.

Plant Spacing in the Row

Studies of mechanical harvesting show that plant pulling and limb breakage are considerably affected by the distance between plants in the row. Uneven planting and skips in the row cause the cotton plants at each end of the skip to grow considerably larger than the other plants in the row. These plants often develop lateral branches and heavy central stems too large to pass through most harvesters, thus causing clogging of the machines.

Apparently a distance of from 6 to 12 inches between plants is best on tight land; and for sandy soils it is about 3 to 6 inches. The best distance depends in part on the fertility of the soil, the amount of rainfall, and the variety of cotton grown. Research now underway is aimed at determining the most desirable spacing in the row under various conditions.

FURROW PLANTING PREFERABLE

Comparison of flat and furrow plantings at Chickasha shows two definite advantages for the furrow method.

First, weeds are more easily controlled by mechanical cultivation. Most weed seeds are at or near the soil surface; and furrow planting throws them to the row middles where the weeds are easily reached by cultivator. In trials at Chickasha, about two to four times as much hand hoeing of weeds was required on flat plantings.

Second, furrow plantings produce a deeper root system. The plants are well anchored in the soil, and therefore less likely to be pulled up and clog the stripper.

Furrow plantings can be made with either a planter with a furrow-opener attachment, or a lister seeder.

Cultivation

Weeding and chopping normally account for about a third of the total hand labor involved in cotton production. Chopping can be eliminated by precision planting. Most or all hand hoeing can be eliminated by good seedbed preparation and early and frequent mechanical cultivation after planting.

Weed control is always important. It is even more important when cotton is to be harvested mechanically. Weedy fields tend to clog the machine, and also produce trashier cotton.

Early cultivation may be deep if necessary to control weeds and loosen the soil, but all following cultivations should be shallow.

During the final cultivation the row should be slightly ridged. This helps accumulate trash in the middles, out of the way of the harvesting machine.

The disk cultivator equipped with knives ("go-devil") is an effective implement for early cultivation of cotton planted in the furrow. However, the rotary hoe is probably the most efficient and economical implement for early cultivation of cotton, research of the Texas Agricultural Experiment Station indicates.

Advantages of the rotary hoe include:

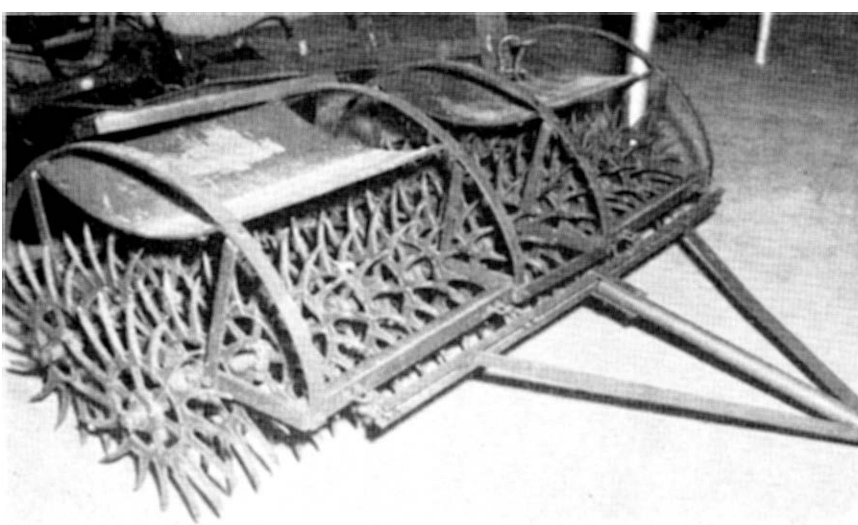
1. It has been the best tool found for breaking the soil crust that forms when hot sunshine follows a heavy rain.

2. It can be used directly over the cotton row to pulverize the soil and prevent growth of grass and weeds.

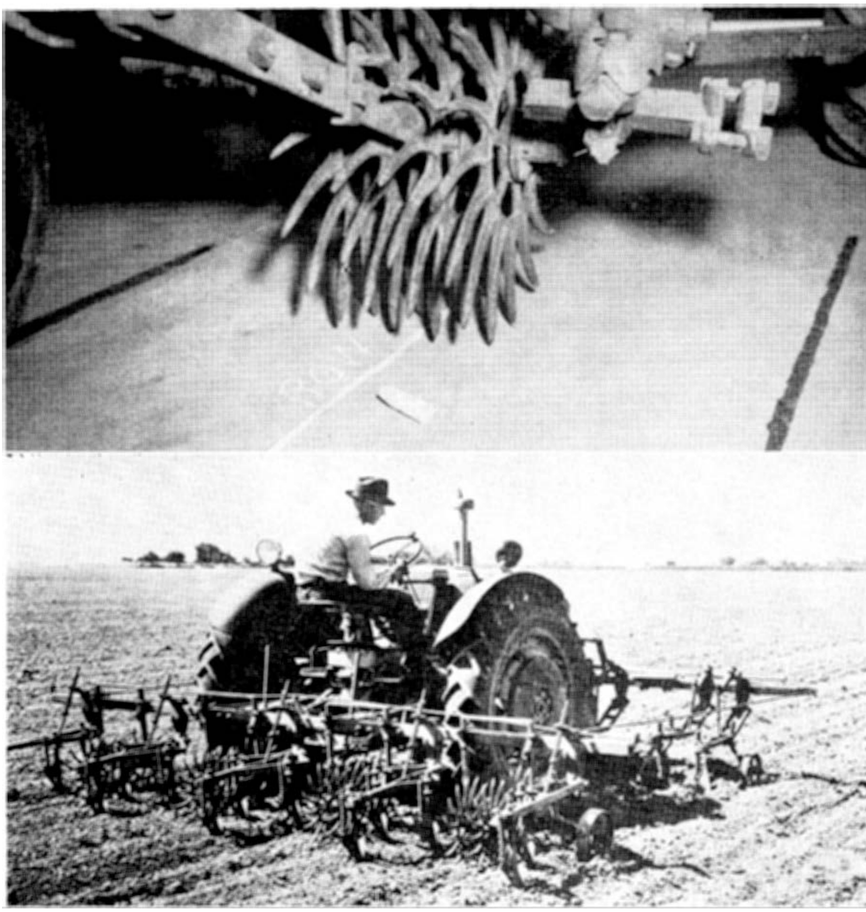
3. It operates at high speeds, 6 to 8 miles per hour for best results. This feature is especially desirable, since timeliness of cultivation is an important factor in weed control.

4. It is a fast shallow cultivator, which kills weeds and grass just after they germinate. Most of the troublesome weeds and grasses are annuals which germinate in the upper quarter-inch of soil; therefore they can be controlled by the rotary hoe if not allowed to make much growth.

There are two types of rotary hoe. One is an attachment which replaces the front sweeps of a cultivator. The other is a gang rotary which is pulled behind the tractor. Either type is effective on cotton planted flat or on the



The rotary hoe is probably the most efficient and economical implement now available for early cultivation of cotton to reduce the amount of hand-hoeing needed. Elimination of chopping and hand-hoeing offers a major possibility for reducing the cost of growing cotton. The gang rotary shown here is effective on cotton planted flat or on the ridge. The cultivator attachment shown on page 13 is more effective when cotton is planted in the furrow.



Rotary hoe attachment for cultivator, showing how it is operated on the row during early cultivation (top picture). This tool is especially effective when cotton is planted in the furrow. Furrow planting is generally recommended when cotton is to be harvested mechanically. Lower picture shows the four-row rotary hoe and cultivator.

ridge. For cotton planted in the furrow, the cultivator attachment is more effective in working the row. Furrow-planted cotton must be gone over several times with the gang-type rotary hoe to get the middles low enough to work the soil over or around the plants.

The rotary hoe is more effective when used as soon as possible after a rain. If the soil is allowed to bake, the fingers will not penetrate or else they will dig out large pieces of soil and thereby damage seedlings.

Rotary hoes for use over young seedlings should have slender, round points. The broad, shovel-type point is made for use on fallow land, and will damage a good many seedings if used on young cotton.

If the surface soil contains many old roots from a previous crop, the rotary hoe wheels should be run backward. When run in the normal direction they become clogged with roots and begin to drag, thus causing damage to plants.

The rotary hoe attachment for cultivators can also be used as a shield in later cultivations, after the cotton plants are well established. This is done by removing the two inside sprockets, leaving the two outside sprockets next to the row. This arrangement is superior to the usual cultivator fender for high-speed work, because it eliminates the dragging action of the usual type of fender.

Chemical Defoliation

Earlier, more uniform boll opening can sometimes be attained through use of a chemical defoliant. Action of chemicals used for defoliation is similar to the action of frost on the plants. Severity of the effect can range from almost no effect to strong tissue destruction, resulting in death of the entire plants. Results obtained will depend on the condition of the plants and kind and quantity of defoliant used.

Actively growing cotton can be successfully defoliated with any of a number of chemicals. A perfect job of defoliation is seldom achieved, and the appearance of new leaves (second growth) may prevent stripping of defoliated cotton. Application of defoliants two weeks before frost is expected will hasten boll opening and drying, and make possible once-over stripper harvest soon after frost has killed any remaining leaves and second growth. This type of treatment will appreciably reduce trash in stripped cotton.

On drought stressed cotton true defoliation is difficult, but killing and drying of the leaves can be achieved by treatment with a strong weed killer. While this treatment will make possible earlier harvest, it may also result in failure of unopened bolls to open properly.

Advice on choice and application of chemical defoliants should be sought from someone experienced in their use before large-scale defoliation is attempted.

Harvesting

All of the various types of cotton harvesters now on the market have been observed in actual operation at the Oklahoma Cotton Research Station near Chickasha. Among the stripper types of machines, the roller-type strippers worked best in tall cotton. In small cotton, the finger-type stripper worked well and turned out a better-than-average sample.

The principal objection to existing roller-type strippers is their inflexibility. This calls for extreme accuracy in planting; and, even under ideal conditions, these machines gather a good deal of trash along with the lint.

Nevertheless, the presently available types of strippers are rapidly replacing hand harvesting in Oklahoma, especially in the southwestern counties.

These strippers work best on cotton plants from 10 to 36 inches in height.

COST OF STRIPPER OPERATION

Station agricultural economists have interviewed many farmers who have operated the stripper-type harvesters or hired custom-operated machines.* They report that, on the average, it takes about 16 man-hours of labor to hand snap an acre of western Oklahoma cotton yielding about one-third bale an acre. Two men with a tractor and stripper can harvest that amount in approximately half an hour; that it, with about one man-hour of labor. Cost per bale under these conditions was estimated at about $40 for hand snapping and slightly over $15 for stripper harvesting, for the 1950 season.

EFFICIENCY OF STRIPPERS

Skill of the operator is one of the chief factors in determining how much cotton is wasted by strippers during harvesting. An experienced operator, harvesting a storm-resistant variety, should not waste more than two or three percent. This is no more than the loss from hand harvesting after frost, comparisons of the two methods at Chickasha have shown.

The cotton wasted is very apparent immediately behind the stripper, but in very few cases will it pay to pick up the lost cotton by hand.

Loss from an improperly operated stripper may run as high as 50 percent. This usually can be remedied by finding and correcting the source of the trouble.

SUGGESTIONS FOR OPERATION

It is usually two weeks after the first killing frost before the cotton plant is cured out enough for machine harvesting. Harvesting should be started just as soon as the plants are ready, in order to get a higher grade lint and to avoid weather hazards. Bolls which are immature at frost will delay harvesting, since they cure out slowly.

Proper adjustment of the stripper is important to permit gathering the lower bolls without picking up rocks, clods and trash.

An important adjustment on roll-type strippers is the clearance between the roll and the stripper bar. It should be set close for small plants and opened up for larger ones. Proper clearance is necessary to get as much as possible of the lint without also getting an unnecessarily large amount of limbs and trash.

THE OKLAHOMA BRUSH-ROLLER STRIPPER

The brush-roller type stripper recently developed at the Oklahoma Agri-

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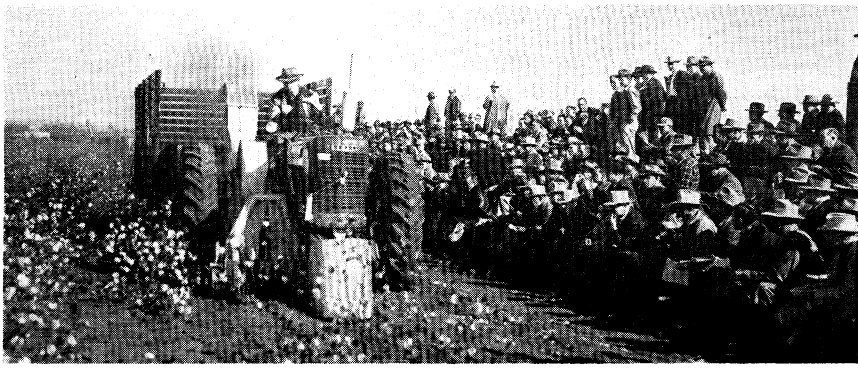
* See Okla. Agri. Exp. Sta. Bul. B-364, "Economic Aspects of Machine Harvesting Cotton in Oklahoma," by John D. Campbell (April, 1951).



An experimental version of the brush-roller type cotton harvester developed by the Oklahoma Agricultural Experiment Station and the U. S. Department of Agriculture. The brush-roller principle, if finally successful commercially, is expected to make extreme precision of planting somewhat less important in mechanical cotton harvesting.

cultural Experiment Station, in cooperation with the U. S. Department of Agriculture, has given some very promising results. When properly adjusted, it pulls very few plants and harvests very few green bolls. Experimental results at Chickasha show that this harvester reduces the amount of trash per bale by from 300 to 500 pounds, as compared to conventional strippers using metal rollers.

Several commercial companies are working with experimental models of brush-type strippers based on the Oklahoma machine. Production models are not yet available.

Varieties for Mechanical Stripping

To be well adapted for stripper harvesting, cotton plants should be small, free of vegetative branches, bear bolls no lower than 4 to 6 inches above ground level, and be storm resistant. Storm resistance, or the tendency for locks to remain in the bolls after opening, appears to be the most important consideration in selecting one of the present varieties for once-over stripper harvesting.

Under conditions usually prevailing in Southwestern Oklahoma, any of the recommended varieties listed in Table I can be stripped if plants are spaced closely in the row, since the plants do not become large when closely spaced. However, only three of these varieties—Lankart 57, Stormproof No. 1 and Northern Star—are sufficiently storm resistant for once-over stripper harvesting. Macha, although not recommended in Oklahoma, is highly storm resistant and can be used if seed of the other stormproof varieties is not available.

Mebane 6801 and Lockett 140 are less "limby" than the other varieties

TABLE 1.—Storm Resistance of Cotton Varieties Compared at Chickasha, Oklahoma, in 1950.*

Recommended varieties	Percent of total locks lost through weathering: Dec. 21	Jan. 26	Feb. 12
Lankart	0.00	0.00	0.44
Stormproof #1	0.00	1.95	1.95
Northern Star	0.00	0.41	2.05
Lockett 140	1.74	1.74	3.47
Mebane 6801	0.45	4.54	6.36
Stoneville 62	0.87	7.51	9.53
Deltapine 15	0.39	8.11	9.65

* Losses in 1950 were not as great as in most years. Losses in the non-stormproof varieties would ordinarily be much higher.

listed in Table I, but do not have enough storm-resistance for once-over stripping.

APPENDIX

How to Figure Plant Spacing in Precision Planting

The goal in precision planting is to get plants spaced a uniform distance apart in the row, as explained on page 6.

To get the desired stand of plants, enough seed must be put into the ground to provide for: (1) The number of plants wanted; (2) seeds which will not germinate; and (3) seeds which may germinate but will not come up to a stand.

Germination—the percentage of live seed—can be obtained by a fairly simple home test; or a sample of the seed can be sent to a laboratory for testing. Seed purchased through regular channels will have the results of a recent germination test on the tag.

Emergence—the number of live seed which will come up to a stand—can be figured at 85 percent of the number of live seed as shown by a germination test. That is, if the seed tests 80 percent germination, the emergence probably will be around 85 percent of the 80, or 68 plants from every 100 seed planted.

Emergence of course varies a great deal, depending on soil moisture, soil temperature, soil texture, depth of coverage, and amount and type of rainfall following planting. But 85 percent can be used as an average figure in calculating seeding rate. A lower percentage should be used if unfavorable conditions are expected.

CALCULATING NUMBER OF SEED PER UNIT OF ROW

The number of seeds which should be laid down in a given length of row to get the desired plant spacing can be figured out as soon as the results of the germination test are known and the expected emergence is decided upon.

Two feet of row makes an easy unit to use, but any other would do as well. The number of seeds to be planted in each two feet of row can be figured as follows:

$$\text{Number of Seeds Needed (per unit of row)} = \frac{\text{Number of Plants Wanted per Unit Row x 10,000}}{\text{Germination Percentage x Expected Percentage of Emergence}}$$

The following examples show how this is worked out:

Example 1

Assume plants are to average six inches apart in the row. That will be four plants in each two feet of row. The seed germinates 80 percent, and an emergence of 85 percent is expected. Then

$$\text{Number of Seeds Needed} = \frac{4 \text{x} 10{,}000}{80 \text{x} 85} = \frac{40{,}000}{6{,}800} = 5.9 \text{ (approximately)}$$

Therefore, about 6 seed must be planted in each two feet of row.

Example 2

Assume poorer emergence is expected—for example, 70 percent—and that the seed tests only 65 percent germination. Then the number of seeds needed in two feet of row to give a stand of four plants per two feet of row would be

$$\frac{4 \text{x} 10{,}000}{65 \text{x} 70} = \frac{40{,}000}{4{,}550} = 8.8 \text{ (approximately)}$$

so about 9 seed should be planted in each two feet of row.

Example 3

Assume a different plant spacing is wanted; for example, plants four inches apart in the row. That would be six plants in each two feet of row. Using the same germination and expected emergence as in Example 2, the figures would be

$$\frac{6 \text{x} 10{,}000}{65 \text{x} 70} = \frac{60{,}000}{4{,}550} = 13.2 \text{ (approximately)}$$

FIGURING AMOUNT OF SEED NEEDED

After the amount of seed per unit of row has been figured, it is also possible to calculate the quantity of seed needed to plant an acre of land. Appendix Table I shows this calculation for three storm-resistant varieties of cotton at various row spacings. This table is based on use of delinted seed.

APPENDIX TABLE 1.—Pounds of Delinted Seed Needed Per Acre for Three Varieties of Storm-resistant Cotton, at Various Spacings in the Row.*

Plant spacing		No. of seed to be planted in each 2 ft. of row**	Amount of seed needed per acre† (pounds)		
Distance apart in row (inches)	No. plants in each 2 ft. of row		Stormproof No. 1	Lankart 57	Macha
3	8	12.5	15¾	21−	16⅔
4	6	9.4	11¾	15¾	12½
5	4.8	7.5	9½−	12½	10
6	4	6.25	7¾+	10½	8⅓
8	3	4.7	6−	7⅓	6¼
10	2.4	3.75	4¾	6¼	5
12	2	3.125	4−	5¼	4¼−
15	1.6	2.5	3+	4¼−	3⅓
18	1.3	1.8	2¼	3	2½−
21	1.14	1.8	2¼	3	2⅓+
24	1	1.6	2−	2⅔−	2¾

* Based on rows 40 inches apart, to fit cotton harvesting machinery.

** Includes allowance for seed testing 80 percent germination and an expected emergence of 80 percent.

† The number of seed per pound for the three varieties was: Stormproof No. 1, 5,200; Lankart 57, 3,900; and Macha, 4,900.

OTHER PUBLICATIONS

About Cotton Production in Oklahoma

Most of the following publications are available free of charge at the offices of county agents in counties where cotton is grown. They may also be obtained by writing: Agriculture Mailing Room, Oklahoma A. & M. College, Stillwater, Okla.

E-504.	Cotton production. Variety and fertilizer recommendations.
E-500.	Stripper harvesting of cotton.
E-499.	Controlling cotton insects.
E-435.	Marketing cotton in Oklahoma.
E-349.	4-H Cotton Manual.
B-381.	Oklahoma cotton varieties; varietal descriptions and performance test results, 1945-1951.
B-364.	Economic aspects of machine harvesting cotton in Oklahoma; the present costs, and future prospects.
B-358.	Cotton growing in southeastern Oklahoma; a comparison of present methods and recommended practices.
B-357.	Effects of auxiliary gin equipment on grades of cotton, western Oklahoma, 1947 and 1948.
B-343.	Cotton varieties for Oklahoma.
B-303.	The cotton flea hopper in Oklahoma.
T-37.	Oklahoma cotton variety tests, 1944 to 1948.

Maintenance and improvement of soil fertility is one method of increasing acre yields and thereby reducing the cost of production per bale. Following are some Oklahoma publications on soil conservation and fertility maintenance:

E-553.	The use of fertilizers in Oklahoma.
E-518.	Soil and water conservation.
E-513.	Taking soil samples.
E-510.	Land judging.
E-509.	Know your soil.
E-476.	Your three acres.
E-412.	Soil improvement program in Oklahoma.
E-408.	Lime for Oklahoma soils.
E-249.	Irrigation in Oklahoma.
OP-26.	Phosphorus.
OP-5.	Stop grass fires.
B-368.	A graphic method of finding the depth of irrigation water applied.
B-362.	Deep plowing to improve sandy land.
B-360.	Salt accumulation in irrigated soils; the prospect for Oklahoma.
B-316.	Crop adaptation to soils of varying acidity or alkalinity.
B-312.	Effect of fertilizers on soil acidity and alkalinity.

3-52—7M.