4-1-1954

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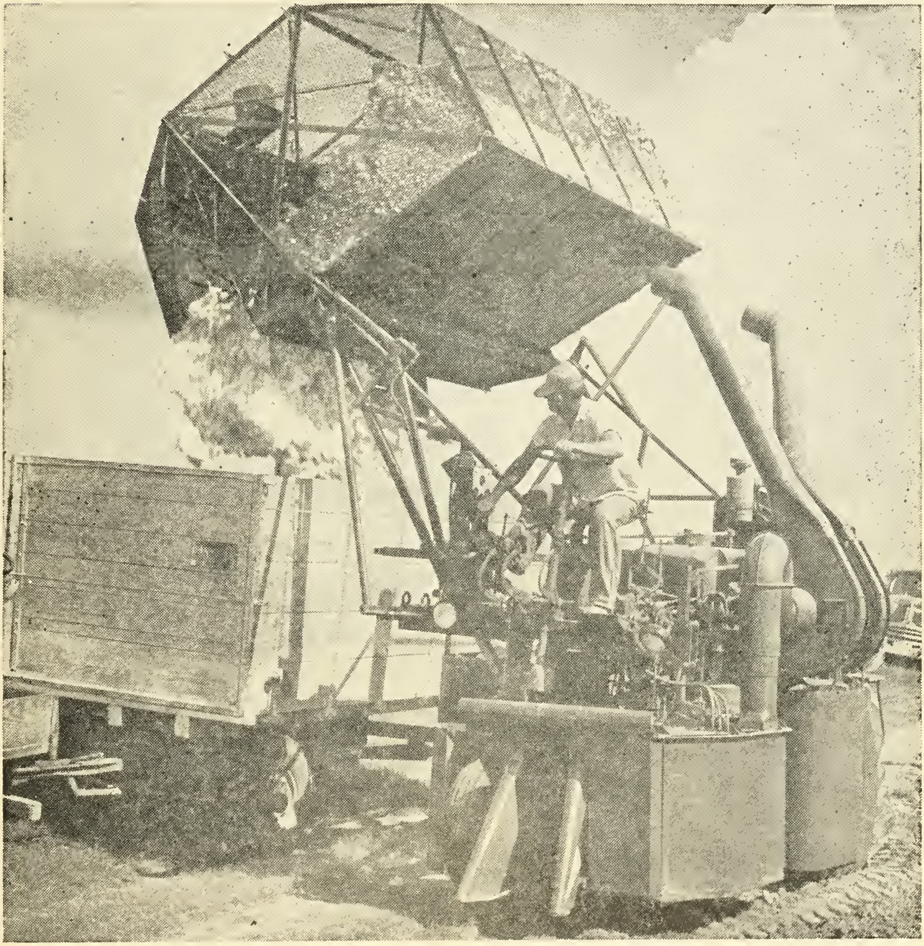

MISSISSIPPI STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

CLAY LYLE, Director

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ON COVER: Unloading the hydraulically operated picker basket into a two-bale trailer. The basket has a capacity of approximately 1,000 pounds of seed cotton.

# FACTORS AFFECTING THE EFFICIENCY OF MECHANICAL COTTON PICKERS IN THE YAZOO-MISSISSIPPI DELTA

By E. B. Williamson, O. B. Wooten, Jr., and F. E. Fulgham[1]

The advent of cotton-harvesting machines has brought new problems to the producer as well as to the processor and user of raw cotton. While the ginner has been busy with the excessive moisture, increased trash content, and tangled fibers in machine-picked cotton, the farmer has worked toward better management of pre-harvest practices, which together with machine performance, ultimately determine the amount and quality of cotton that will be harvested. The most serious charges against machine picking have been (1) excessive field losses and (2) reduction in quality.

Cotton-production practices changed very little as long as hand methods were used exclusively in harvesting. It was often said that a family could produce more cotton than it could pick. Since the efficiency of the hand picker was rarely affected by row length, plant spacing, grassy fields, uniform opening, and certain other factors, there was little incentive for pre-harvest improvements. With the inception of mechanical pickers, however, it has been necessary to reconsider various production and harvesting techniques.

## Early Investigations

Certain production methods have received attention from investigators for many years. It was quite obvious that problems such as breeding cotton varieties adaptable to mechanical harvesting could not be solved overnight. Farmers, research specialists, and industry have all been working vigorously, however, to improve the various practices that affect mechanical picking.

## Factors Affecting Performance

The influence of the following factors on picker performance will be discussed: Varieties, field layout and water control, stalk disposal and seedbed preparation, seed preparation and planting, weed and grass control, insect control, defoliation, and machine performance. Yield is a vital factor in good machine performance.

## Varieties

When the plant breeder was confronted with the problem of breeding a variety of cotton suitable for mechanical picking, there were no well defined specifications available to assist him in the assignment. He also was aware that if an ideal cotton for mechanical harvesting were developed, that environmental factors, such as soil type, rainfall, and climate, would alter the characteristics of the plant when grown in different areas. He realized, too, that early commercial machines would be modified and that new types of pickers with entirely different picking principles might eventually be perfected. Therefore, the cotton breeder has proceeded cautiously before going "all out" for "tailor-made" varieties. Intensive breeding for desirable harvesting traits will be practicable only when machine development becomes stabilized.

Field tests have been conducted in several locations across the Cotton Belt to determine the varietal characteristics that are desirable for mechanical production and harvesting. Early tests conducted at the Delta Branch Experiment Station were modified after the introduction of defoliants and other modern production practices. Further investigations revealed

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[1] Agricultural Engineers, Farm Machinery Section, Agricultural Research Branch, Agricultural Research Service, United States Department of Agriculture, and the Delta Branch of the Mississippi Agricultural Experiment Station cooperating.

This report was prepared as a portion of a study supported in part by funds appropriated under authorization of the Research and Marketing Act.

that plant characteristics, such as height of first fruiting branch, length of limb, and maturity date, could be controlled to a limited extent by factors such as spacing, plants per acre, and flaming.

Additional studies conducted in the Mississippi Delta showed that the picking efficiency of varieties differed significantly between tests and between years. The differences apparently resulted from such things as machine operation, field location, and weather. No decided advantages in pickability or cleanability were determined for any of the commercial varieties adapted to the Delta area (Table 1).[2]

In developing a cotton for mechanical harvesting, many factors have been considered. An ideal plant would be of medium size with relatively short limbs, short fruiting nodes, medium-light foliage, and lower branches well off the ground. It would include, in addition, such desirable features as reduced foliage pubescence, or leaf hairiness; modified boll bracts; medium size, well-opened "straight bur" bolls; and a plant of medium early maturity that tends to shed its leaves when fruiting is complete. Plant breeders are continually working to select strains that have good seedling vigor, since these lines get off to better starts and give better yields. Good yield is a prerequisite for high picking efficiency.

[2]"Cotton Varieties Compared Under Mechanical Practices." **Mississippi Farm Research, pp. 2,** April 1952.

### Field Layout and Water Control

The importance of field layout should not be overlooked in planning for mechanical cotton harvesting. Fields should be arranged so that short rows will be eliminated at every opportunity so that "turning time" will be reduced to a minimum.

Turn alleys should be wide enough to facilitate rapid turning of the machines, and road or alley ditches should be smooth and shallow to reduce the vertical movement of the picking unit as it enters the row. Unless ample turning space is provided, it will be necessary to pick the ends of the rows by hand to get maximum recovery of the cotton.

In some fields it will be advantageous to relocate roads, ditches, fences, and possibly buildings. Careful planning and preparation of land adaptable to cotton production will usually pay big dividends. Row direction is also a vital factor in designing drainage or water-control systems where mechanical farming will be practiced.

**Table 1. Picking efficiency of 11 commercial varieties of cotton in mechanized cotton variety trials conducted at the Delta Branch Experiment Station, 1948-1951.**

| Variety | Picking efficiency | | | | | |
|---|---|---|---|---|---|---|
| | 1948 | | 1949 | | 1950 | 1951 |
| | Test A | B | A | K | A | K |
| | Pct. | Pct. | Pct. | Pct. | Pct. | Pct. |
| Bobshaw 1[1] | 93 | 96 | 94 | 87 | 90 | 90 |
| Coker 100 Staple | 89 | 96 | 93 | 87 | | |
| Coker 100 Wilt | 90 | 95 | 92 | 90 | 88 | 92 |
| Delfos 651 DES | 91 | 95 | 93 | 86 | — | 90 |
| Delfos 9169 | 89 | 96 | 94 | 88 | 85 | 94 |
| Deltapine 15 | 89 | 93 | 92 | 85 | 87 | 90 |
| D & P L-Fox | — | — | — | 90 | 90 | 91 |
| Empire | 86 | 93 | 91 | 86 | 87 | 88 |
| Stoneville 2B | 92 | 94 | 93 | 87 | 86 | 88 |
| Miller | 80 | 91 | 90 | 88 | — | — |
| Wilds | 89 | 95 | 94 | 86 | — | — |

[1]Bobshaw in 1948 and 1949, Bobshaw 1A in 1950 and 1951.

**Figure 1. A power-driven horizontal blade type stalk shredder operating in rank cotton stalks.**

The elimination of low spots, pockets, and other surface irregularities will improve the efficiency of all production practices, including the operation of the mechanical picker. When available, dirt-moving equipment such as scrapers, dozers, and land levelers will facilitate the removal of many of these trouble spots, although occasionally they can be corrected by careful plowing in the affected area. Underground outlets may also be feasible occasionally in eliminating a serious drainage problem. In addition to providing better picking conditions during the harvesting season, improved drainage promotes uniform plant growth and boll maturity.

### Stalk Disposal and Seedbed Preparation

Although mechanical harvesting is rarely affected directly by old crop residues, it is imperative to effectively destroy all vegetative material before using mechanical production techniques. Poor stalk disposal may seriously interfere with planting and cultivation, especially when pre- and post-emergence chemicals are applied. The introduction of modern power-driven stalk shredders has greatly improved methods of crop-residue disposal (Figure 1). By shredding stalks into small pieces immediately after harvesting, better coverage is possible in plowing operations, and more thorough disintegration is obtained before the next crop is planted. Chokage of planters and cultivators from undecayed stalks and other vegetative debris usually results in broken stands, which in turn reduces harvesting efficiency.

Tests have shown that seedbed preparation often plays a prominent role in the kind of stand obtained and the quantity of cotton harvested. In recent studies at the Delta Branch Station, both stand and yield were improved by deep tillage (Table 2).

When land is prepared by bedding, it is especially important to maintain uniform row spacing as well as proper bed shape (Figure 2). Since the picking unit of a mechanical picker is gauged by the large tractor vehicle wheels, it is easy to

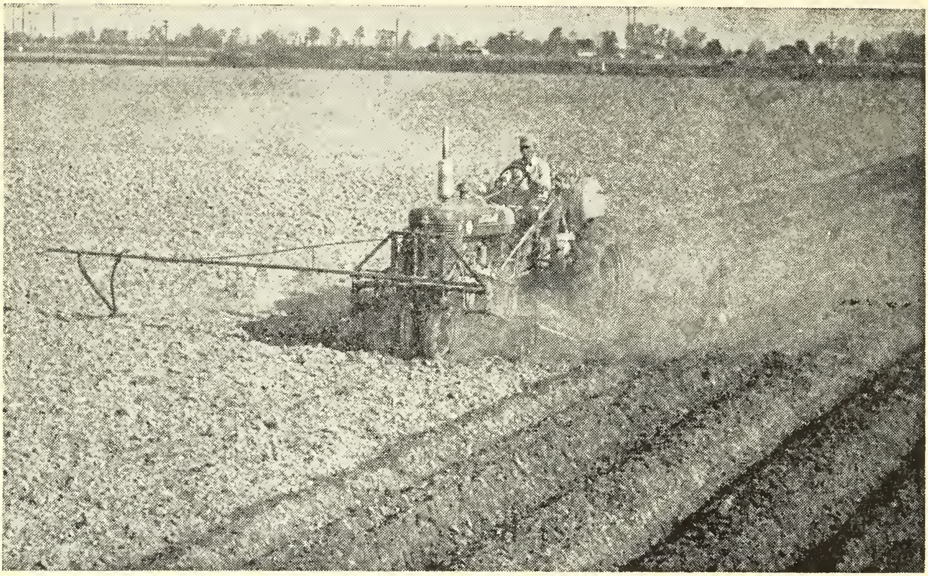

**Figure 2. Applying anhydrous ammonia and bedding four complete rows in one trip across the field. Note the uniform, evenly spaced beds and the balanced arrangement of equipment on the tractor.**

see the uneven effects of alternately low and high middles as the picker moves from one row to another. The use of a carefully adjusted marker on the bedding implement will also facilitate the forming of evenly-spaced beds. The elimina tion of "guess" rows is also important, especially when runner-wing equipped planters are used. For maximum uni formity, it is essential for the soil in the top of the beds to be swept evenly to each row middle.

## Seed Preparation and Planting

Most farmers recognize the advantages of properly delinting and treating cotton-seed. Delinted seed germinate quicker and are better adapted to precision planting. On the other hand, a fuzzy-coated seed is better prepared to withstand ad verse soil conditions when germination is delayed. It is therefore desirable to re tain at least a part of the fiber coat on seed planted in the Mississippi Delta area. Seed treatment is especially important, since it often saves valuable seed and time and may possibly prevent later field epidemics of certain diseases.

The planting operation is of primary importance in cotton production. Uni form stands of healthy plants are invalu able in minimizing grass and weed prob lems, attaining high yields, and provid

**Table 2. The effect of four tillage treatments on stand and yield on Dundee silt loam at the Delta Branch Experiment Station, 1953.**

| Tillage treatment[1] | Plants per acre | Seed cotton per acre |
|---|---|---|
| | Number | Pounds |
| Middlebreaker | 25,973 | 1949 |
| Chisel, 12-inch centers | 28,918 | 2799 |
| Disc plow | 31,962 | 2853 |
| Moldboard subsoil plow | 31,745 | 2931 |

[1]The preparation of all plots except the middlebreaker were approximately 12 inches deep.

ing an even flow of cotton in the picking operation.

A cultivator-planter method of planting developed and first employed at the Delta Branch Experiment Station in 1946 has been adopted by farmers throughout the area. Advantages of the system include (1) the saving of labor and equipment by eliminating many of the usual disking and harrowing operations prior to planting and (2) the preservation of soil moisture, which is a vital factor in obtaining stands during dry periods. Best results are obtained when the soil has been bedded or broken a few weeks ahead of planting and allowed to settle. This method of planting has not been highly adaptable to the heavy clay or "buckshot" soils of the Delta.

The equipment necessary for this operation consists of a tractor equipped with a front-mounted cultivator and a rear-mounted planter, complete with sword openers and runner wings. The regular cultivator sweeps, operating ahead of the planting equipment, loosen the beds or soil sufficiently to permit the planter wing blades to sweep the remaining soil layer to the middles. Under favorable conditions, many partially germinated

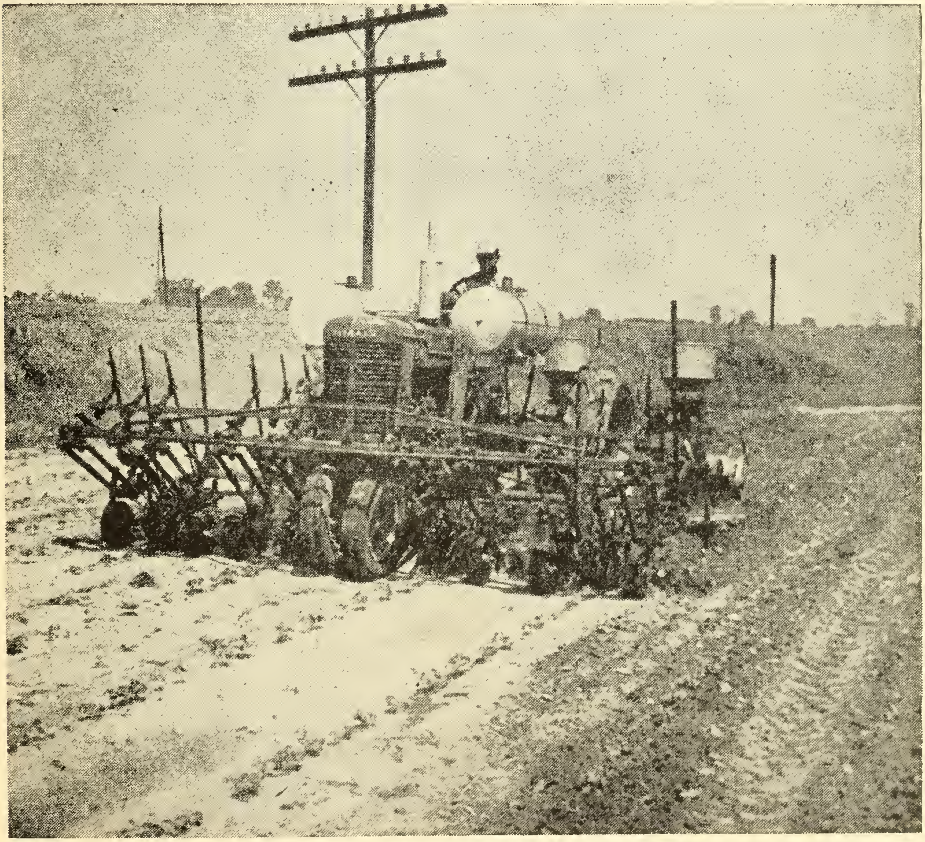

Figure 3. Cultivating young cotton plants with a front-mounted cultivator equipped with rotary hoe attachments. The rear-mounted planter may be used for late planting or for planting skips in the field without changes in the equipment.

weed and grass seed in the warm top layer of the soil are swept out of the drill area into the middles. Another beneficial feature of the planter-cultivator combination is the balanced arrangement of equipment on the tractor, which eases the steering operation for the driver. Still another advantage is the ability to perform both planting and early cultivation operations with the same tractor (Figure 3).

Early investigations indicated that plant spacing and population directly affected mechanical harvester performance. Studies at the Delta Station have shown that under certain conditions closely spaced, uniform stands are more favorable to the efficient operation of cotton pickers than plants in widely spaced hills (Table 3). It should be pointed out that stands in the 40-inch, cross-plowed cotton averaged approximately 20,000 plants per acre for the 4-year period. These relatively low plant populations were instrumental in producing large stalks with long spreading limbs that unfavorably affected picking efficiencies in this treatment.

Results of a stand and harvesting study initiated at the Delta Station in 1952 show that high picking efficiency is also closely associated with high yield (Table 4). Dry weather wilted cotton severely in the first year of the test and both yield and picking efficiency were adversely affected. It is interesting to note that the yield and picking efficiency of the widely spaced, 40-inch cross-plowed cotton compared favorably with the other five spacing treatments for both years. These data also revealed that thick stands of heavily drilled, unthinned cotton produced a greater percentage of small bolls. which tended to open prematurely. Although a long dry period was experienced again the second year, deep breaking practices in the test area stimulated higher yields and resultingly better picking efficiencies.

### Weed and Grass Control

Although weed control has consistently been one of the most expensive operations in cotton production, the problem has been emphasized even more since the introduction of the mechanical picker. It is particularly essential to rid fields of weeds and grass before cotton is picked mechanically.

Various methods of cultivation are employed by farmers, often within the same general area. In working toward ideal harvesting conditions, however, certain desirable production techniques should be followed as closely as possible. When uniform beds or rows are maintained through planting and emergence, cultivation methods should thereafter continue to preserve uniformity until harvest time (Figure 4).

The standard practice of continually piling soil around the cotton plants to cover grass and weeds is incompatible with modern weed control methods. It also raises the tops of rows nearer to bottom limbs of the cotton plants, which brings the mechanical picker in closer contact with the soil. Excessive wear is then experienced on the lower spindles of the picking unit, and additional trash or

**Table 3. The effect of four methods of thinning cotton on the picking efficiency of a high-drum International Harvester picker at the Delta Branch Experiment Station, 1948-1950 and 1953.[1]**

| Thinning method | Spacing | Percent picking efficiency | | | | |
|---|---|---|---|---|---|---|
| | | 1948 | 1949 | 1950 | 1953 | Avg. |
| Hand chopped | 12-inch centers | 91.1 | 94.1 | 94.7 | ----- | 93.3 |
| Hill dropped | 16-inch centers | 89.9 | 93.3 | 94.5 | ---- | 92.5 |
| Cross-plowed | 24-inch centers | ---- | ---- | 93.8 | 92.7 | 93.3 |
| Cross-plowed | 40-inch centers | 86.1 | 89.6 | 89.3 | 92.2 | 89.3 |

[1]The 24-inch cross-plowed treatment was added to the experiment in 1950. Poor stands in 1951 and 1952 resulted in insufficient data for these 2 years.

**Table 4. The effect of six spacing treatments on stand, pounds of seed cotton, and percent picking efficiency at the Delta Branch Experiment Station 1952-1953.**

| Thinning method | Spacing | 1952 Plants per acre | 1952 Yield | 1952 Picking efficiency[1] | 1953 Plants per acre | 1953 Yield | 1953 Picking efficiency |
|---|---|---|---|---|---|---|---|
| | | Number | Pounds | Percent | Number | Pounds | Percent |
| No thinning | Heavy drill[2] | 84,824 | 958 | 77.1 | 68,607 | 2615 | 88.0 |
| No thinning | Light drill[3] | 54,110 | 1341 | 81.7 | 41,622 | 2854 | 91.5 |
| Hill dropped | 14-inch centers | 46,660 | 1227 | 76.7 | 50,578 | 3093 | 92.0 |
| Hill dropped | 20-inch centers | 42,869 | 1178 | 79.0 | 45,869 | 2856 | 91.5 |
| Cross-plowed | 24-inch centers | 45,092 | 1649 | 84.2 | 51,423 | 2986 | 92.7 |
| Cross-plowed | 40-inch centers | 32,283 | 1510 | 80.1 | 39,858 | 3100 | 92.2 |

[1]International Harvester, high-drum picker. [2]Drilled 40 pounds seed per acre. [3]Drilled 20 pounds seed per acre.

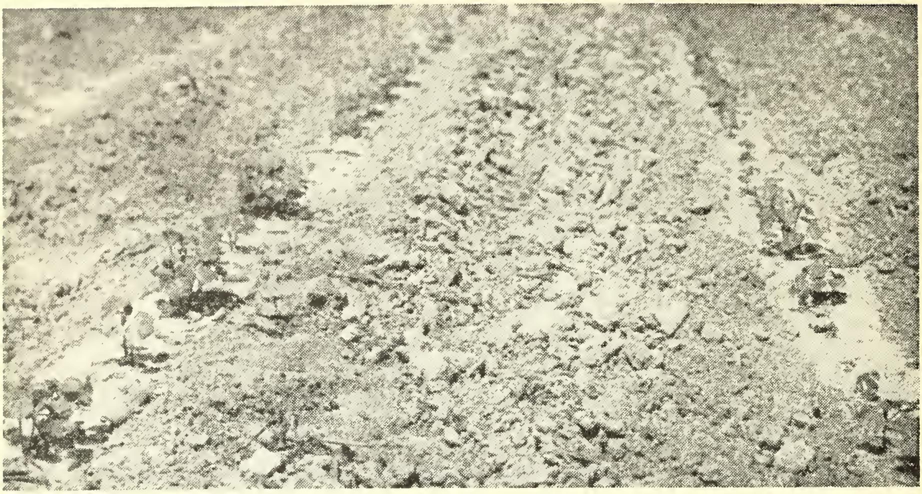

**Figure 4. A stand of hill dropped cotton after the first cultivation with high speed sweeps. Note the low row profile, which is highly desirable for the application of herbicides and flames.**

other debris is picked up and mixed with the cotton.

The use of flat, properly set high-speed sweeps and crop shields will greatly reduce the problem of high bed formation. Rotary hoe attachments have proved highly effective as shielding devices and under early soil crusting conditions have continued to aid in obtaining stands and eradication of small grass and weeds. Both herbicides and flame cultivation are used to a limited extent in weed control programs in the Delta area (Figure 5). Flaming, which has proved feasible for midseason control, has also been used effectively in eradicating weeds and grasses late in the season. Cross-plowing has proved to be one of the most economical methods of weed control in the area, although slightly lower picking efficiencies have been obtained under certain conditions. This disadvantage can virtually be eliminated by leaving wider hills and a greater number of plants.

### Insect Control

The introduction of new insecticides and early control methods has greatly contributed to increased yields. Early insect control materially assists young plants in "getting off" to a better start and assures the productiion of an early crop. Insects invading cotton fields late in the season often cause trouble for the mechanical picker in the form of honeydew, faulty bolls and shredding foliage.

The increased use of insecticides has been stimulated by the development and widespread use of ground spraying and dusting methods. The practice of applying insecticides simultaneously with cultivation generally reduces the cost of application (Figure 6). Farmers who have wholeheartedly followed a well planned insect control program have found that it usually pays large dividends.

Methods of application have included the use of various types of airborne and ground equipment. In early studies at the Delta Station a high clearance vehicle was provided for dusting and spraying in rank cotton by removing the picking unit and storage basket from a cotton picker tractor and properly shielding each wheel (Figure 7).

### Defoliation

The effect of chemical defoliation on mechanical harvesting has been investigated since the first pickers began operating. Results have not conclusively shown that defoliation is economically feasible under all conditions. There have been numerous benefits derived from defoliation however, and several million acres of cotton are defoliated annually.

Tests determining the effect of defoliation on quality and picking efficiency have been conducted at the Delta Station since 1944 (Table 5). Although slight increases have been indicated for both quality and picking efficiency, modern cleaning and ginning methods have largely solved the problem of high trash content. Since green leaves tend to leave objectionable stains in the cotton lint, the

**Table 5. Foreign matter content, grade and picking efficiency of defoliated and undefoliated cotton, Stoneville, Mississippi, 1944-1953.**

| Year | Seed cotton Foreign matter content | | Lint grade | | Picking efficiency | |
|---|---|---|---|---|---|---|
| | Defoliated | Undefoliated | Defoliated | Undefoliated | Defoliated | Undefoliated |
| | Percent | Percent | Index | Index | Percent | Percent |
| 1944 | 5.9 | 6.5 | 77.5 | 73.0 | 78.6 | 76.8 |
| 1945 | 4.6 | 4.7 | 88.0 | 85.0 | | |
| 1946 | 5.4 | 8.8 | 89.5 | 86.5 | 91.8 | 91.8 |
| 1947 | 6.2 | 8.5 | 86.2 | 83.3 | | |
| 1948 | | | 89.7 | 88.0 | 90.2 | 87.4 |
| 1949 | | | 86.3 | 86.7 | 92.8 | 93.3 |
| 1950 | 8.1 | 7.5 | 91.2 | 88.4 | 93.4 | 92.7 |
| 1952 | 6.1 | 6.3 | 100.0 | 97.0 | 81.7 | 77.9 |
| 1953 | 7.0 | 8.4 | 99.3 | 100.7 | 91.5 | 91.2 |
| Mean | 6.2 | 7.2 | 89.7 | 87.6 | 88.6 | 87.3 |

Defoliated with Aero Cynamid, special grade 1944-50; Magnesium Chlorate, 1952-53.

Grade index: 104 Strict Middling, 100 Middling, 94 Strict Low Middling, 85 Low Middling, 78 Strict Good Ordinary, 70 Good Ordinary.

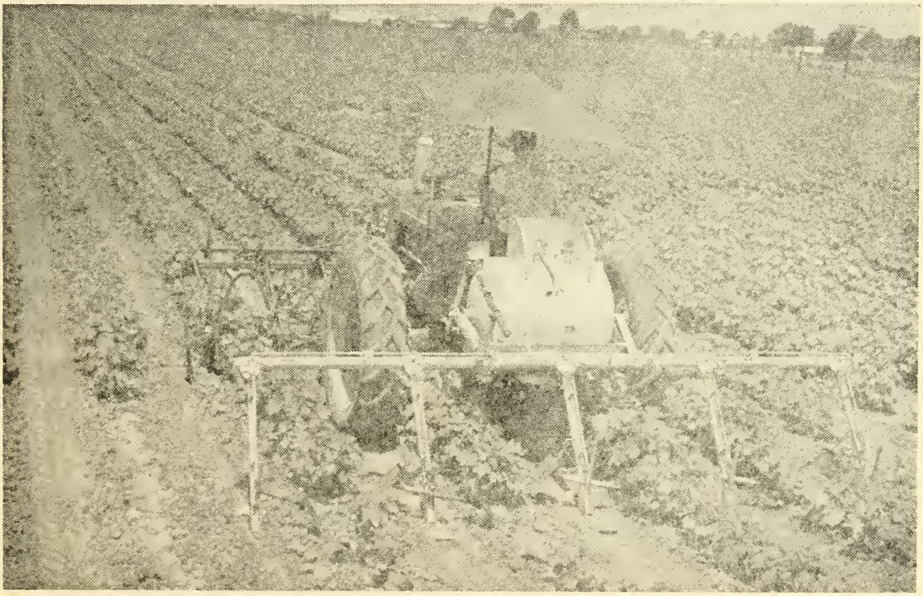

**Figure 5. Mid-season cultivation of cotton with high-speed sweeps and flat type flame burners. The beds are kept flat to improve flame and mechanical picker performance.**

Figure 6. Cultivating and spraying cotton in one operation to reduce the number of trips through the field. Good insect control favors high yield and picking efficiency.

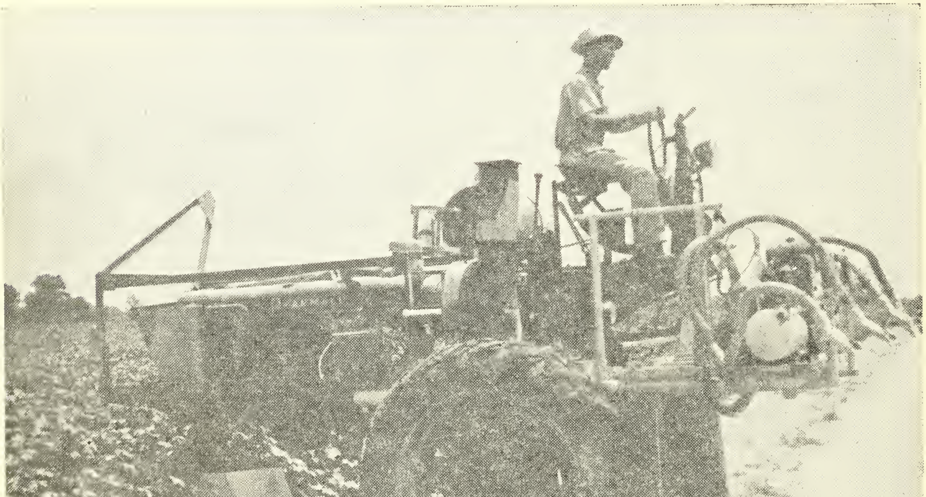

Figure 7. A cotton picker tractor equipped with a duster and wheel shields for the application of insecticides in rank cotton.

Figure 8. Applying a liquid defoliant with an eight-row tractor-mounted sprayer. Wide booms and tractor shields are essential to reduce plant damage by the machine.

Figure 9. Two types of mechanical pickers operating in a field of well defoliated cotton. Tests have shown that picking efficiency is improved by high yields.

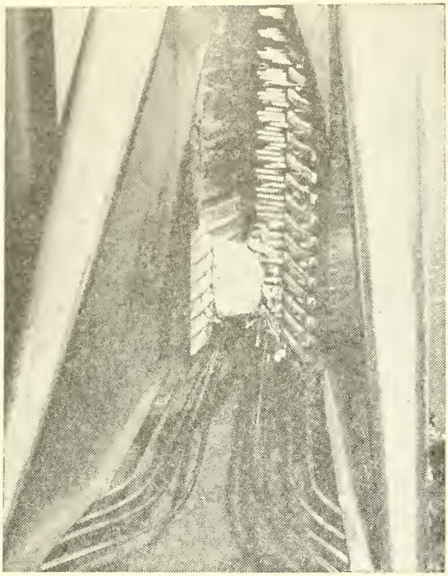

Figure 10. This small chunk of concrete, which lodged between the spindles and the pressure plates of the machine, resulted in the loss of 12 spindles, 3 doffers and ½ day's picking time.

practice of defoliating will no doubt continue to be a vital factor in mechanical picker performance.

Airplanes have been used extensively for applying defoliants, but recent improvements in ground machines indicate that airplane application can be duplicated in many areas (Figure 8).

### Machine Performance

There are several machines on the market that will pick cotton. Although there are certain differences in design they are all relatively expensive machinery, containing many precision parts. To function properly they must be adjusted, operated and maintained with the same care that any complex piece of equipment should receive.

The importance of understanding thoroughly the operation of your machine cannot be overemphasized. A poor job of picking can often be traced to improper care and adjustment. Before entering the field the operator should be sure that the picking mechanism of his machine is in the best possible condition. It costs no more to pick all of the cotton in the field than to pick only a part of it.

All manufacturers of cotton pickers furnish operators manuals that show proper adjustments, lubrication and other service information. Following the service instuctions outlined in these manuals will pay big dividends in better quality picking and less time charged to repairs. After the machine is set to do the best picking job for a particular field, it is then up to the operator to keep the picker performing at top efficiency. Remember, however, that the operator's job can be made easier by employing good production practices that result in high yields of clean open cotton (Figure 9).

Special attention should be given to the condition of the fields that will be harvested mechanically. The time used in removing bricks, scrap iron, stumps and other debris from fields will pay large profits. Even after fiields have been checked and cleaned the picker operator must be alert to the constant danger of ground obstructions and other foreign materials. The passage of a hard object through the picking unit usually results in considerable damage to vital parts, as well as loss of valuable time (Figure 10).

Tests that have been conducted to determine the value of adding wetting agents to water for moistening picker spindles have not conclusively shown increase in picking efficiencies, especially when naturally soft water was available. On the other hand, it has been found that agents often assist in preventing a buildup of "honeydew" and plant juices on the spindles, which therefore warrants their use in certain areas.

Good pre-harvest practices coupled with intelligent use of the mechanical picker produce results that will be profitable.

ACKNOWLEDGEMENT

Acknowledgement is made to J. B. Dick and H. R. Carns and staffs, Section of Cotton and Other Fiber Crops, Field Crops Research Branch, USDA, and Delta Branch of the Mississippi Agricultural Experiment Station, who cooperated in the work on varieties and defoliation, respectively. Acknowledgement is also made to P. H. Grissom, Department of Soil Fertility, Delta Branch of the Mississippi Agricultural Experiment Station, and Dr. William A. Raney, of the Experiment Station at State College, who cooperated in the deep tillage studies. The authors also express appreciation to Dr. W. L. Giles, Superintendent of the Delta Branch Experiment Station for assistance given in the mechanization studies and acknowledge that the late W. E. Meek, formerly head of cotton mechanization research for the Cotton Belt, played a prominent role in the development of the cultivator-planter planting method mentioned in this publication.