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COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 511 SEPTEMBER, 1935

DIVISION OF AGRICULTURAL ENGINEERING

# Progress in the Study of the Mechanical Harvesting of Cotton

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†As of September 1, 1935

This Bulletin reports results of harvesting trials with a roll-type stripper sled, using different kinds and sizes of stripping rolls operated at different angles and speeds. Stripping rolls made of steel and wood having a slightly roughened surface gave a high efficiency in harvesting cotton. Rolls 56 inches in length, operated at an angle between 25 and 30 degrees with the ground, and having a peripheral travel faster than that of the forward travel of the tractor, were the most efficient of the different combinations of roll angles and speeds. Stripping rolls 2-3/16 inches in diameter were more satisfactory than rolls 3 inches in diameter.

The results of tests with the Texas Station Harvester show that the highest percentage of the cotton was harvested when a high roll speed was used. In harvesting Ducona cotton the rubber rolls harvested 96.8 per cent of the cotton, while wood harvested 92.0 per cent, steel 95.3 per cent, and knurled surfaced steel 96.2 per cent. Wood and steel rolls were not as efficient in harvesting as rubber rolls and knurled steel rolls.

In cleaning mechanically harvested cotton in 1934 the Texas Station Bur Extractor and the Texas Station Cylinder Cleaner removed foreign material amounting to approximately 50 per cent of the weight of the harvested cotton. This foreign material consisted of burs, green bolls, dirt, and trash.

Ducona cotton cleaned on the Texas Station Bur Extractor and on the Texas Station Cylinder Cleaner, classed two grades higher than when extracted and cleaned with available commercial bur extracting and cleaning equipment.

The highest efficiency of the Texas Station Harvester was obtained in harvesting varieties with short fruiting branches, short vegetative branches, and storm-resistant bolls.

Satisfactory progress has been made in developing through hybridization and selection higher yielding strains of cotton adapted to mechanical harvesting. A number of promising hybrid strains which are being inbred to fix the type desired gave good results in harvesting trials. Ducona was one of the better strains. The types sought should possess storm-resistant bolls, a relatively high percentage of lint of good staple, a minimum of vegetative growth, a more determinate fruiting habit, and earliness of maturity, characters which most of the commercial varieties do not possess.

## CONTENTS

BULLETIN NO. 511 SEPTEMBER, 1935

# PROGRESS IN THE STUDY OF THE MECHANICAL HARVESTING OF COTTON

H. P. SMITH, D. T. KILLOUGH, D. L. JONES AND M. H. BYROM

The results of previous studies on the mechanical harvesting of cotton, to determine some of the essential principles involved in the construction and operation of a successful cotton harvester of the stripper type, and the relationship of the type of cotton best suited to mechanical harvesting, were published in Texas Station Bulletin 452. This bulletin also gives a rather complete description of the construction and operation of several types of home-made cotton harvesters, and of the Texas Station Cotton Harvester. Tests conducted with the various types of machines during the period 1927-1931 inclusive show that the Texas Station Harvester was the most efficient and harvested a higher percentage of the cotton than the other types studied.

When the Texas Station Cotton Harvester was constructed in 1930, the stripping rolls were made up of various sizes of radiator hose. These rolls when completed were 2-7/8 inches in diameter. In 1931 certain parts of the machine were changed and the size of the rolls was reduced to 2-3/8 inches in diameter. Harvesting tests during these two years showed that a higher percentage of cotton was harvested from the plants with the 2-3/8 inch rolls, than with the 2-7/8 inch rolls*

These tests with the different size rolls, and tests with the tractor operated in low, second, and high gears, indicated that as the size of the roll and the rate of peripheral travel of the roll changed, there was a corresponding change in the operating efficiency of the machine. Consequently, several questions arose which could not be answered satisfactorily from the data obtained in these tests and further investigation of this phase of the problem therefore became necessary. The questions involved may be enumerated as follows:

1. What diameter of stripping rolls would give the highest efficiency in harvesting cotton?
2. What should the peripheral speed of the rolls be in relation to the forward travel of the machine?
3. What influence would the angle of the rolls with the ground have on their efficiency in harvesting cotton?
4. Could a more durable material, such as steel or wood, be used instead of the rubber radiator hose?

Experiments conducted during the three years 1932, 1933, and 1934 with the Texas Station Harvester and a specially constructed Roll Type Sled have satisfactorily answered the above questions, and the results of these and other tests are reported in this bulletin.

The Texas Station Harvester was changed in construction to facilitate better operation, resulting in a more efficient machine.

Special attention was also given to the problem of properly cleaning

*Texas Station Bulletin 452, pages 48 and 51, tables 8 and 10.

mechanically harvested cotton. As a result of these studies the Texas Agricultural Experiment Station has invented, constructed, and tested a cotton bur extractor, and a cotton cleaner, both of which do satisfactory work in cleaning the cotton. The bur extractor removes from the harvested cotton the burs, the green bolls, and a high percentage of the green as well as the dry leaves. The cleaner removes practically all the remaining fine trash and dirt in the seed cotton. These machines, hereafter called the Texas Station Bur Extractor and the Texas Station Cylinder Cleaner, are described and results of tests with them are given.

Breeding work was continued during 1932, 1933, and 1934 in an attempt to develop higher yielding strains of cotton of a type that may be mechanically harvested and cleaned more satisfactorily than ordinary varieties, thereby resulting in a higher grade of lint.

## CONSTRUCTION OF EQUIPMENT

**Improvements in Texas Station Harvester:** Many improvements have been made in the construction of the Texas Station Harvester (Figs. 1

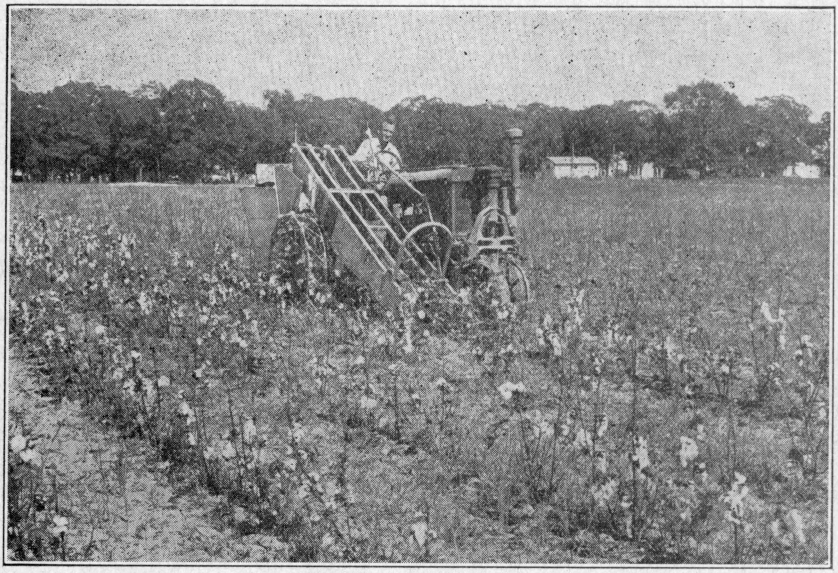

Fig. 1. Texas Station Cotton Harvester harvesting Ducona cotton at College Station, October 1934. Note the type of plant and that the leaves had been eaten off by leaf-worms. Dry weather caused a rather poor yield.

and 2) since it was described in Texas Station Bulletin 452. They may be summarized as follows:

(1) Both the upper and lower bearing supports for the right stripping roll were constructed to permit both ends of the roll to move freely in and out as the volume of vegetative material varies (Fig. 3).

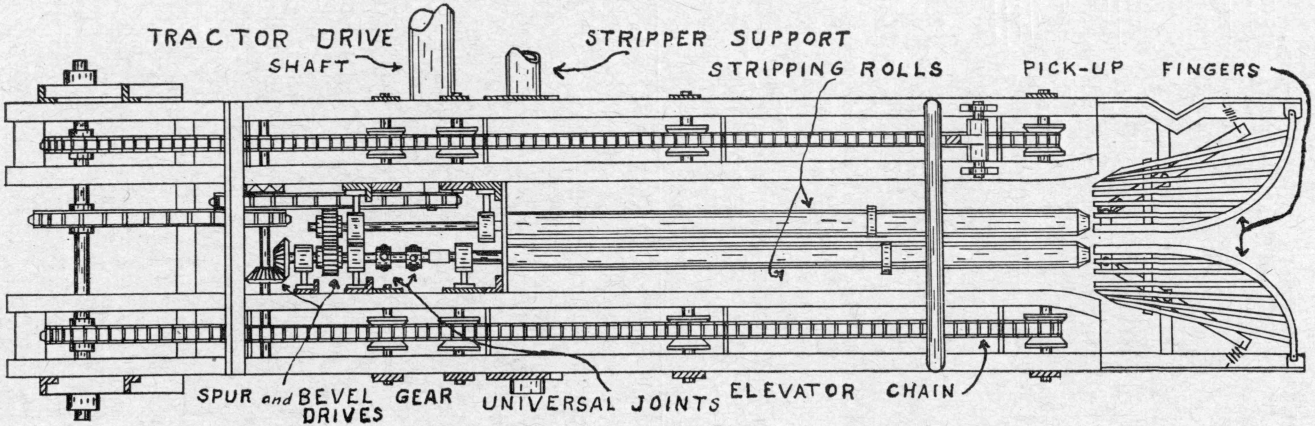


Fig. 2. Over-head sketch showing working parts of the Texas Station Cotton Harvester as used in 1934.

(2) Power was transmitted to the movable roll through a double universal joint, thus permitting the upper end of the roll to move easily under a light tension (Figs. 2 and 3).

(3) Sets of knurled surfaced steel, smooth surfaced steel, and wood rolls interchangeable with the smooth surfaced rubber rolls, were made and tested.

(4) The pick-up fingers were re-designed so as to be adjustable both vertically and horizontally. The front ends of the framework of the stripper were curved so that the rods on the pick-up fingers would easily guide the cotton plants in between the stripping rolls (Fig. 2).

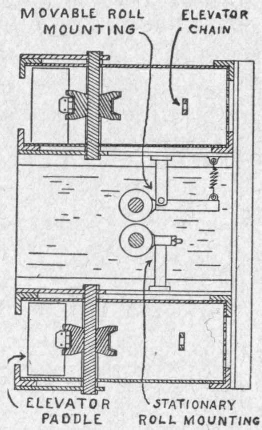


Fig. 3. Cross-section of Texas Station Cotton Harvester, showing rear or upper bearings for both the movable and stationary stripping roll.

**Construction of Roll-Type Sled:** Pick-up fingers and stripping rolls similar to those used on the Texas Station Harvester were installed in a box mounted on four wheels and built 8 feet long, 3 feet wide, and 3 feet deep (Fig. 4). The rolls were fitted in a 7-inch space extending back through the center of the box. The rolls one of which was yielding, were constructed so they could be easily removed and another size put in.

A Fairfield 4½ horse power engine mounted on the rear end of the box

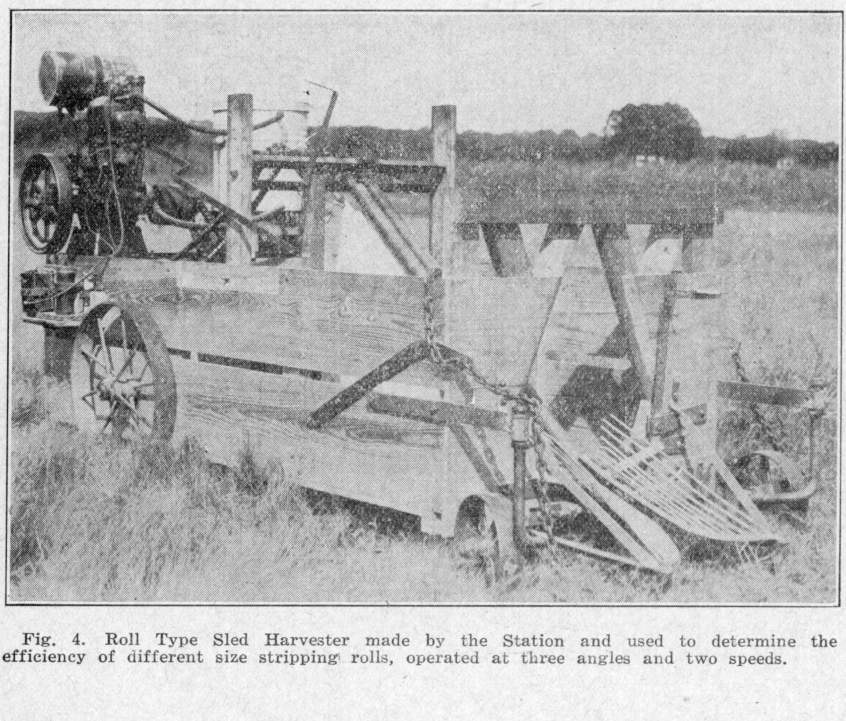

Fig. 4. Roll Type Sled Harvester made by the Station and used to determine the efficiency of different size stripping rolls, operated at three angles and two speeds.

furnished the power for driving the stripping rolls, the power being transmitted by means of sprockets, chains, and gears.

Provision was made to permit setting the rolls at five different angles, 18, 24, 31, 38, and 45 degrees with the ground. Canvas was installed under the rolls to prevent the cotton from falling through the opening under the stripping rolls.

**Construction of Texas Station Bur Extractor:** By referring to Fig. 5 it can be seen that the bur extractor consists of a cylindrical saw drum around which are located a doffer to remove the seed cotton from the saw

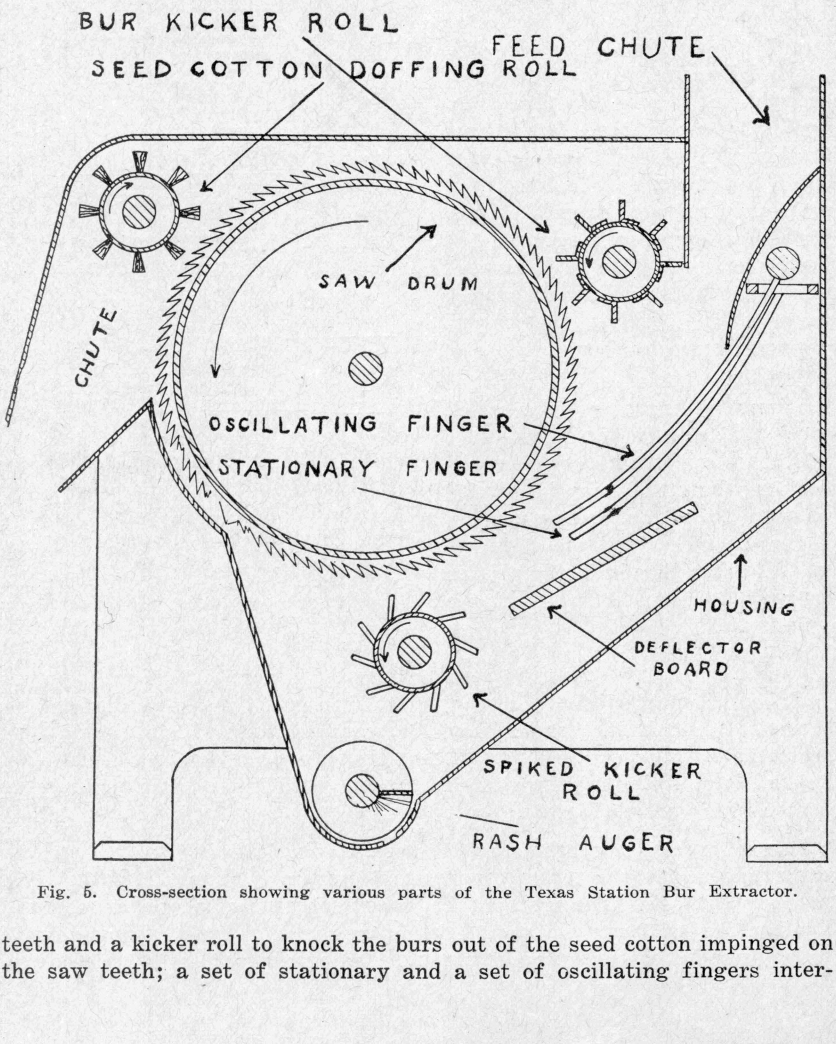


Fig. 5. Cross-section showing various parts of the Texas Station Bur Extractor.

teeth and a kicker roll to knock the burs out of the seed cotton impinged on the saw teeth; a set of stationary and a set of oscillating fingers intermeshing with each other; a deflector board located under the fingers; and a spiked roll located beneath the saw drum and slightly under the lower edge of the deflector board.

In the operation of the extractor the harvested cotton is fed in upon the fingers, thus permitting the saw teeth to pick the seed cotton out of the burs. The burs are then worked through the fingers by the action of the oscillating set, which opens and closes a space large enough for burs and green bolls to pass through. As the burs and bolls drop down upon the deflector board they slide off upon the spiked roll which is revolving fast enough to throw the burs up against the saw teeth. This action permits the saw teeth to catch again the cotton that had not been previously removed from the burs, as well as any stray locks, and at the same time strike the burs and any green bolls present in such a way that they will be thrown out over the deflector board.

The seed cotton is picked out of the burs by the saw teeth which carry the cotton upward and under the kicker roll which in turn knocks back any burs that may be carried up with the cotton. After passing under the kicker roll the cotton is carried around to the doffer, which removes the seed cotton from the saw teeth.

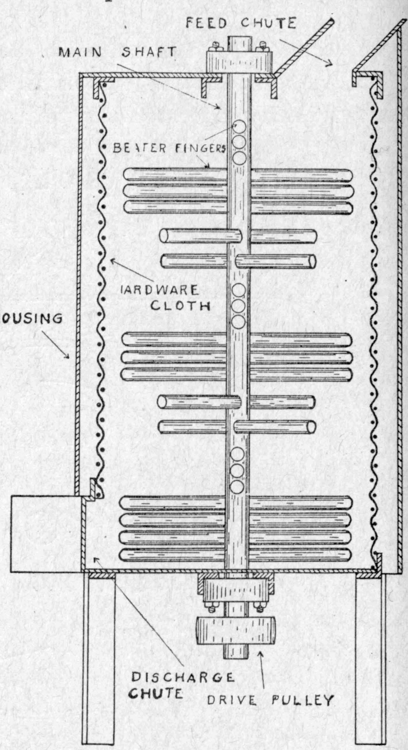


Fig. 6. Cross-section of the Texas Station Cylinder Cleaner, showing the various parts of the machine.

**Construction of Texas Station Cylinder Cleaner:** The Texas Station Cylinder Cleaner consisting of a cylindrical drum 24 inches in diameter, is made of one-half inch mesh heavy hardware cloth, and is mounted in a frame in a vertical position. Within the cylinder of hardware cloth are several groups of beater fingers mounted on a shaft extending through the center of the drum (Fig. 6).

In the operation of the cleaner, seed cotton is fed in at the top of the cylinder. As the cotton drops into the drum it comes in contact with a group of the rotating beater fingers which throw the cotton outward against the hardware cloth with sufficient force to cause dirt and trash to be jarred loose and thrown through the openings. After striking the surface of the drum the cotton drops downward and again comes in contact with another group of beater fingers which throw the cotton against the hardware cloth. This process is repeated until the cotton reaches the bottom of the cylinder where it is thrown by centrifugal force through an opening in the drum. The cotton emerges in a clean fluffy condition ready for ginning (Fig 10 B).

## RESULTS WITH HARVESTING EQUIPMENT

Numerous tests were made with a specially constructed Roll Type Stripper Sled in 1932 to determine what effect the angle of the rolls, the size of the rolls, and the speed at which the stripping rolls revolve, would have on their efficiency in harvesting cotton. A number of tests were made during the three-year period 1932 to 1934 with the Texas Station Cotton Harvester, both at College Station and at Lubbock.

### Roll Type Sled Harvester*

The results shown in Table 1 are averages of the various tests made with the roll type sled harvester shown in Fig. 4. Efficiency in these tests was measured by the percentage of the total yield of seed cotton harvested by the machine. It will be noted from the table that as the angle of the rolls of a given size and material decreases, the efficiency consistently increases, except with the 2-3/16 inch wood rolls in the high speed tests, when the efficiency of these rolls at the 38 degree angle was practically the same as the 31 degree angle.

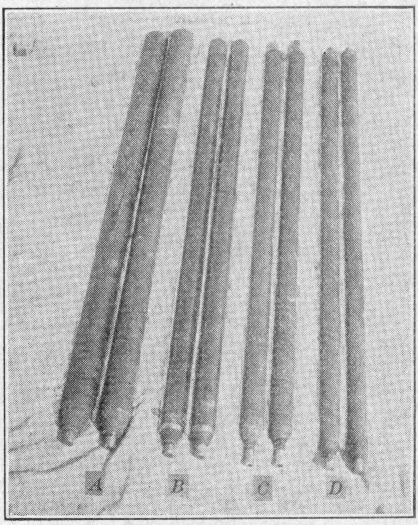


Fig. 7. Rolls tested in the Roll Type Sled.
A. 3 inch wood rolls.
B. 2 3/8 inch steel rolls.
C. 2 3/16 inch wood rolls.
D. 2 inch wood rolls.

The highest efficiency obtained, 94.0 per cent, was with the 2-3/16 inch wood rolls (Fig. 7) set at 24 degrees and operated at high speed (Table 1). Wood rolls 2-3/16 inches in diameter gave the highest efficiency of the materials tested at the 38 and 24 degree angles.

In the low speed tests, the 2-3/16 inch wood rolls were better at 31 and 24 degree angles, while 2-3/8 inch steel rolls gave a higher efficiency at an angle of 38 degrees.

A machine designed and built to operate with any set of these rolls would give better results than those obtained with the sled in which

[8]A detail discussion of these results is given in a thesis, "Factors Affecting the Efficiency of Smooth Cotton Stripping Rolls," by M. H. Byrom.

**Table 1. Influence of size, angle, and speed on the efficiency of smooth surfaced wood and steel stripping rolls**

| Size and kind of roll | Angle of rolls with ground in degrees | Time required in seconds | Feet travel of roll surface | | | Weight in pounds of | | | | | Degree of efficiency as measured by the per cent of seed cotton harvested |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | In feet | Per foot of tractor travel | Per second | Stripped cotton | Trash in stripped cotton | Seed cotton | | | |
| | | | | | | | | Harvested | Left by machine | Total yield | |
| Low speed tests: | | | | | | | | | | | |
| 2-3/16″ wood | 38[1] | 41.5 | 155 | 1.24 | 3.74 | 5.33 | 2.02 | 3.31 | .53 | 3.84 | 86.1 |
| 3″ wood | 38 | 37.3 | 152 | 1.21 | 4.06 | 5.58 | 2.15 | 3.42 | .75 | 4.14 | 81.5 |
| 2-3/8″ steel | 38 | 37.2 | 113 | 0.90 | 3.05 | 5.96 | 2.48 | 3.48 | .49 | 3.97 | 87.4 |
| 2-3/16″ wood | 31 | 40.7 | 132 | 1.06 | 3.22 | 6.55 | 2.60 | 3.96 | .31 | 4.26 | 92.8 |
| 3″ wood | 31 | 42.0 | 181 | 1.45 | 4.30 | 6.05 | 2.52 | 3.53 | .74 | 4.27 | 82.6 |
| 2-3/8″ steel | 31 | 37.3 | 169 | 1.04 | 3.47 | 5.54 | 2.16 | 3.39 | .41 | 3.79 | 89.3 |
| 2-3/16″ wood | 24 | 30.5 | 106 | 0.85 | 3.48 | 5.83 | 2.18 | 3.65 | .27 | 3.92 | 93.2 |
| 3″ wood | 24 | 39.5 | 173 | 1.38 | 4.37 | 6.22 | 2.44 | 3.78 | .42 | 4.20 | 90.0 |
| 2-3/8″ steel | 24 | 36.7 | 111 | 0.89 | 3.03 | 6.31 | 2.65 | 3.66 | .36 | 4.02 | 90.8 |
| High speed tests: | | | | | | | | | | | |
| 2-3/16″ wood | 38 | 39.2 | 211 | 1.69 | 5.39 | 5.39 | 1.92 | 3.47 | .45 | 3.92 | 88.5 |
| 3″ wood | 38 | 39.8 | 299 | 2.39 | 7.51 | 5.89 | 2.13 | 3.76 | .83 | 4.59 | 81.9 |
| 2-3/8″ steel | 38 | 38.3 | 229 | 1.83 | 5.97 | 5.52 | 2.09 | 3.43 | .50 | 3.93 | 87.4 |
| 2-3/16″ wood | 31 | 41.7 | 227 | 1.81 | 5.44 | 6.96 | 2.53 | 4.43 | .60 | 5.03 | 88.4 |
| 3″ wood | 31 | 39.5 | 294 | 2.36 | 7.45 | 6.32 | 2.21 | 4.11 | .76 | 4.87 | 84.4 |
| 2-3/8″ steel | 31 | 40.2 | 226 | 1.81 | 5.64 | 5.66 | 1.99 | 3.66 | .47 | 4.14 | 88.6 |
| 2-3/16″ wood | 24 | 42.0 | 207 | 1.66 | 4.93 | 6.17 | 2.23 | 3.94 | .25 | 4.19 | 94.0 |
| 3″ wood | 24 | 37.5 | 258 | 2.07 | 6.89 | 5.49 | 1.91 | 3.58 | .43 | 4.01 | 89.1 |
| 2-3/8″ steel | 24 | 39.0 | 177 | 1.41 | 4.55 | 7.02 | 2.63 | 4.40 | .43 | 4.83 | 91.1 |

[1]All data are averages.

they were tested. The results are relative, and not the best that can be obtained with any of the rolls under favorable conditions. High efficiency with the 2-3/16 inch wood rolls was due to the slightly rough surface on the rolls and the shallow depression between them. There was a tendency for the fiber to cling to the rough surface and follow the roll around. The peripheral speed of the rolls was great enough, however, to throw most of the cotton off. The cotton which was not thrown off was removed by a guard under the rolls. The smooth, polished surface of the 3 inch wood rolls (Fig 7) and the deeper depression between them permitted the cotton to remain on the rolls longer, which caused more of it to be pulled through with the plant (Fig 8). More bolls were crushed by the 3 inch wood rolls because they were caught farther from

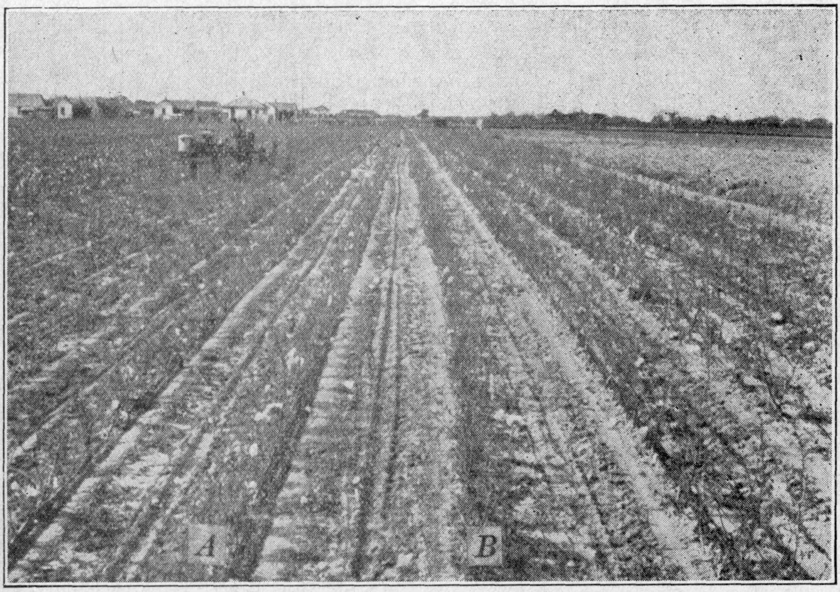


Fig. 8 Cotton rows harvested with Roll Type Sled equipped with 3 inch wood rolls.
Row A, showing where rolls set at 31 degrees with the ground harvested 82.6 per cent of the cotton.
Row B, showing where rolls set 24 degrees with the ground harvested 90 per cent of the cotton.

the stem or the base of the open boll. This not only caused more cotton to be lost, but also caused more fine trash to be ground into the lint. There was no tendency for the fiber to cling to the rolls, and no loss resulted from locks of cotton following the rolls.

The 2-3/8 inch steel rolls had a smooth, polished surface similar to that of the 3 inch rolls, and had less tendency to crush the bolls. However, the smaller diameter of the rolls and the shallower depression between them caused the boll to be caught nearer the stem, and tended to snap it off the stalk without much crushing. Having a shorter distance to travel, the cotton was also thrown out of the depression faster.

The lowest percentage of trash harvested in any test was with the 3 inch wood rolls set at an angle 24 degrees and operated at high speed. An efficiency of 89.1 per cent was obtained, which is very good. This figure, however, was not as good as it appeared, because over 20 per cent of the bolls were crushed with the result that the fine trash was ground into the lint to a greater extent than in some of the tests which showed a much higher trash content. In the low speed tests, the 2-3/16 inch wood rolls gave a lower percentage of trash at the 38 and 24 degree angles, while the steel rolls gave a slightly lower percentage at the 31 degree angle. It will be noted from Table 1 that the high speed tests all ran slightly lower in trash content than the corresponding low speed tests. The 3 inch wood rolls gave a lower percentage of trash at the 31 and 24 degree angles at high speed, while at the 38 degree angle the 2-3/16 inch rolls gave a low percentage. There are certain operating characteristics of the different rolls that should be noticed. The large diameter and smooth surface of the 3 inch wood rolls permitted much of the small trash, such as leaf skeletons and twigs, to slide between the rolls and drop on the ground. The same condition was true with the steel rolls, but to a less extent. The 2-3/16 inch wood rolls appeared to remove smaller amounts of trash because of the small area of the roll surface in contact with the plant. The lower trash content in the high speed tests might be explained by the tendency of the rolls to spread the volume of the branches while harvesting into a thin fan-like position between the rolls, permitting them to slide through without much tearing action on them. The slower speeds tend to bunch the branches and drag them through, pulling off most of the tender vegetation.

## Texas Station Cotton Harvester

After studying the results obtained with the roll type sled, it was found desirable to make tests on a larger scale, comparable with regular harvesting conditions. Consequently, pairs of rolls 2-3/8 inches in diameter were made of wood, steel, and knurled steel to be interchanged and compared with the rubber rolls in the Texas Station Harvester. The actual operating time was kept with a stop watch. The peripheral travel of the rolls was secured by mounting a special roll meter or speed counter (Fig. 9) in contact with the surface of one of the rolls. In each test the length in feet, the time required in seconds, and the peripheral travel of the roll in feet were obtained, from which the feet travel of the roll surface per foot of tractor travel was calculated. In these tests the surface of the wood rolls was smooth and polished; that of the steel rolls was smooth but not polished; that of the knurled steel was a diamond knurl cut approximately 1/32 of an inch in the steel; while that of the rubber was smooth but of such a nature as to offer some friction to lint cotton. The average length of a test was approximately 1800 feet, which was large enough to include all conditions in the field and would indicate what might be expected in harvesting several acres. Where tests were made on the same varieties both at College Station and at Lubbock, the results for each variety were averaged. Consequently, the data shown in Table 2 may be taken as an indication of what may be obtained in mechanical harvesting of these varieties at either location. The results for the Ducona* variety are the average of two years at College Station and one year at Lubbock. Data on the Lone Star variety include two years' results obtained at College Station, while those of Clark and Kubela are for one year at Lubbock.

**Effect of Roll Materials and Surfaces:** The rubber rolls, which have been used as a standard of comparison, harvested at high roll speed† 96.8 per cent of the cotton from Ducona, 95.5 per cent from Lone Star, 99.2 per cent from Clark and 99.7 per cent from Kubela (Table 2). The knurled steel rolls gave an efficiency of 96.2 per cent in harvesting Ducona and 97.0 per cent for Lone Star. The steel rolls harvested 95.3 per cent from Ducona, and 86.3 from Lone Star, while the wood rolls harvested 92.0 per cent of Ducona, and 90.5 per cent of Lone Star. In harvesting Clark and Kubela the rubber rolls gave the highest efficiency, with steel next, and wood lowest.

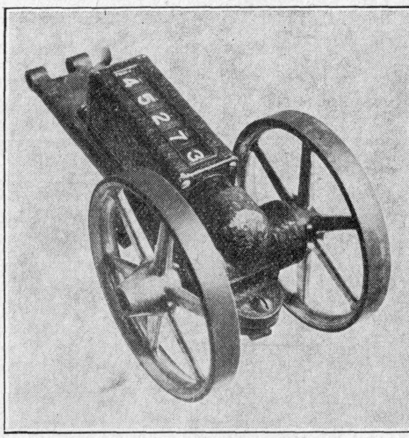


Fig. 9. Roll Meter or Counter used to measure the feet travel of the surface of the stripping rolls on both the Texas Station Harvester and the Roll Type Sled Harvester.

The percentages given for high roll speed indicate that there is no significant difference in the efficiency of rubber and knurled steel rolls in harvesting Ducona and Lone Star cotton. The data do show, however, that steel rolls are better than wood but that they are not as efficient as rubber or knurled steel rolls.

The results with the different roll materials for low and medium roll speeds, with a few exceptions, are quite similar to those obtained with the high roll speed (Table 2).

**Effect of Roll (Peripheral) Speeds:** A study of the data shown in Table 2 shows that, in most cases, the highest percentage of the cotton was harvested with the high roll speed. In one or two instances low roll

*Ducona is a new type of cotton which is being bred especially for mechanical harvesting and is the result of crossing the Durango and Wacona varieties.

†The different roll speeds were obtained by using drive sprockets of different sizes.

**Table 2. Efficiency of different kinds of stripping rolls when operated at three roll speeds**

| Kind of roll | Low roll speed | | | Medium roll speed | | | High roll speed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Feet travel of roll surface | | Per cent of cotton harvested | Feet travel of roll surface | | Per cent of cotton harvested | Feet travel of roll surface | | Per cent of cotton harvested |
| | Per foot of tractor travel | Per second[1] | | Per foot of tractor travel | Per second[1] | | Per foot of tractor travel | Per second[1] | |
| Ducona cotton: | | | | | | | | | |
| Rubber | .76 | 1.76 | 95.7 | .98 | 2.31 | 95.7 | 1.14 | 2.33 | 96.8 |
| Wood | .71 | 1.62 | 92.9 | .92 | 2.33 | 91.5 | 1.06 | 2.92 | 92.0 |
| Steel | .73 | 1.92 | 93.7 | .95 | 1.95 | 91.9 | 1.07 | 2.34 | 95.3 |
| Knurled steel | .80 | 1.64 | 96.9 | 1.03 | 2.30 | 96.1 | 1.19 | 2.34 | 96.2 |
| Lone Star cotton: | | | | | | | | | |
| Rubber | .75 | 1.77 | 93.6 | 1.03 | 2.26 | 94.5 | 1.18 | 2.83 | 95.5 |
| Wood | .76 | 1.89 | 84.4 | .97 | 2.30 | 88.0 | 1.13 | 2.76 | 90.5 |
| Steel | .78 | 2.13 | 85.0 | 1.02 | 2.48 | 84.7 | 1.17 | 3.02 | 86.3 |
| Knurled steel | ---- | ---- | ---- | 1.04 | 1.93 | 96.4 | 1.19 | 2.83 | 97.0 |
| Clark cotton: | | | | | | | | | |
| Rubber | .64 | 1.95 | 98.3 | .86 | 2.04 | 96.7 | .96 | 2.36 | 99.2 |
| Wood | .63 | 1.27 | 90.8 | .83 | 2.58 | 97.0 | .95 | 2.41 | 97.6 |
| Steel | .66 | 1.18 | 95.1 | .86 | 1.71 | 97.1 | .98 | 2.34 | 99.0 |
| Kubela cotton: | | | | | | | | | |
| Rubber | .64 | 1.45 | 99.3 | .84 | 2.47 | 98.5 | .98 | 3.53 | 99.7 |
| Wood | .64 | 1.88 | 94.7 | .83 | 2.58 | 97.3 | .97 | 2.85 | 95.4 |
| Steel | .66 | 1.71 | 98.6 | .87 | 2.06 | 97.7 | .99 | 1.81 | 99.0 |

[1]The fluctation in feet travel of roll surface for the same material in harvesting different varieties was caused by varying field conditions, tractor speed and wheel slippage.

speed was more efficient than high roll speed. It is significant that in 7 of the 13 comparisons the medium roll speed was less efficient than either low or high roll speeds. Consequently, it may be concluded that

**Table 3. Efficiency of the Texas Station Harvester when operated at three tractor speeds**

| Tractor gear | Feet travel of roll surface | | Per cent of cotton harvested |
|---|---|---|---|
| | Per foot of tractor travel | Per second | |
| Low | 1.02 | 2.32 | 96.0 |
| Second | .68 | 2.10 | 95.5 |
| High | .50 | 2.12 | 94.7 |

the differences in roll speed have as much influence on the percentage of cotton harvested as the material the rolls are made of and the condition of the surface of the roll.

**Effects of Forward Speeds:** Tests were made to determine the efficiency of rubber stripping rolls as affected by the forward travel of the tractor when operated in low, second, and high tractor gears.

A study of Table 3 shows that the harvester gave a greater efficiency when operated in low tractor gear and gradually decreased in efficiency when operated in second and in high tractor gears. It may be seen that the feet travel of the roll surface, per foot of tractor travel, is highest in low gear and lowest in high gear, or an average of 1.02 feet for low, .68 feet for second, and .50 feet for high gear. There was an average decrease of approximately 30 per cent in the feet travel of the roll surface per foot of tractor travel when the tractor was shifted from low gear to second gear. There was also a decrease of approximately 26 per cent when the tractor was shifted from second gear to high gear. The average percentage of the cotton harvested was 96.0, 95.5 and 94.7 per cent for low, second, and high tractor gears, respectively. Therefore, there seems to be a relationship between the feet travel of the roll surface per foot of tractor travel and the efficiency of the harvester.

**Relation of Roll Travel to Tractor Travel:** Table 4 is made up from individual tests to show the differences and the percentages of increase in feet travel of the roll surface per foot of tractor travel, and to show the differences in the percentage of cotton harvested as influenced by these factors. In roll travel per foot of tractor travel there was an average

**Table 4. Comparison of the feet travel of the roll surfaces per foot of tractor travel and the effect on the efficiency of different kinds of rolls**

| Kind of roll | Comparison of low and medium roll speeds | | | | Comparison of medium and high roll speeds | | | | Comparison of low and high roll speeds | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feet travel of roll surface per foot of tractor travel in | | Per cent increase in feet travel of medium over low roll speed | Differences in per cent of cotton harvested of low over medium roll speeds | Feet travel of roll surface per foot of tractor travel in | | Per cent increase in feet travel of high over medium roll speed | Differences in per cent of cotton harvested of high over medium roll speeds | Feet travel of roll surface per foot of tractor travel in | | Per cent increase in feet travel of high over low roll speed | Differences in per cent of cotton harvested of high over low roll speeds |
| | Medium roll speed | Low roll speed | | | High roll speed | Medium roll speed | | | High roll speed | Low roll speed | | |
| **Tests at College Station on Ducona cotton** | | | | | | | | | | | | |
| Rubber | .93 | .75 | 19.4 | —0.5 | 1.11 | .93 | 16.2 | +0.5 | 1.11 | .75 | 32.4 | +1.0 |
| Wood | 1.00 | .78 | 22.0 | +0.3 | 1.16 | 1.00 | 13.8 | +1.2 | 1.16 | .78 | 32.8 | +0.9 |
| Steel | 1.03 | .79 | 23.3 | +1.7 | 1.12 | 1.03 | 8.0 | +2.8 | 1.12 | .79 | 29.5 | +1.1 |
| **Tests at College Station on Lone Star cotton** | | | | | | | | | | | | |
| Rubber | .98 | .75 | 23.5 | —1.6 | 1.12 | .98 | 12.5 | —1.5 | 1.12 | .75 | 33.0 | +0.1 |
| Wood | .97 | .76 | 21.7 | —3.6 | 1.13 | .97 | 14.2 | +2.5 | 1.13 | .76 | 32.7 | +6.1 |
| Steel | 1.02 | .78 | 23.5 | +0.3 | 1.17 | 1.02 | 12.8 | +1.6 | 1.17 | .78 | 33.3 | +1.3 |
| **Tests at Lubbock on Ducona cotton** | | | | | | | | | | | | |
| Rubber | .84 | .64 | 23.8 | +1.4 | .97 | .84 | 13.4 | +3.6 | .97 | .64 | 34.0 | +2.2 |
| Wood | .84 | .63 | 25.0 | +2.5 | .96 | .84 | 12.5 | —0.1 | .96 | .63 | 34.4 | —2.6 |
| Steel | .86 | .66 | 23.3 | +1.8 | 1.01 | .86 | 14.9 | +3.9 | 1.01 | .66 | 34.7 | +2.1 |
| **Tests at Lubbock on Clark cotton** | | | | | | | | | | | | |
| Rubber | .86 | .64 | 25.6 | +1.6 | .96 | .86 | 10.4 | +2.5 | .96 | .64 | 33.3 | +0.9 |
| Wood | .83 | .63 | 24.1 | —6.2 | .95 | .83 | 12.6 | +0.6 | .95 | .63 | 33.7 | +6.8 |
| Steel | .86 | .66 | 23.3 | —2.0 | .98 | .86 | 12.2 | +1.9 | .98 | .66 | 32.7 | +3.9 |
| **Tests at Lubbock on Kubela cotton** | | | | | | | | | | | | |
| Rubber | .84 | .64 | 23.8 | +0.8 | .98 | .84 | 14.3 | +1.2 | .98 | .64 | 34.7 | +0.4 |
| Wood | .83 | .64 | 22.9 | —2.6 | .97 | .83 | 13.4 | —1.9 | .97 | .64 | 34.0 | +0.7 |
| Steel | .87 | .66 | 24.1 | +0.9 | .99 | .87 | 12.1 | +1.3 | .99 | .66 | 33.3 | +0.4 |

increase of approximately 23 per cent of medium roll speed over low speed; an increase of approximately 13 per cent of high over medium roll speed; and an increase of approximately 33 per cent of high over low roll speed for the three kinds of rolls and for all varieties harvested.

A careful study of Table 4 shows that in 9 of the 15 comparisons the low roll speed harvested a higher percentage of the cotton than did the medium roll speed. When medium and high roll speeds are compared, the increase of high over medium speed was significant, since in 12 of the 15 comparisons the high roll speed gave an increase in the percentage of cotton harvested. In comparing the low and high roll speeds it is seen that the high roll speed gave an increase over low roll speed in the percentage of cotton harvested in 14 of the 15 comparisons made.

## CLEANING MECHANICALLY HARVESTED COTTON WITH COMMERCIAL GIN EQUIPMENT AND WITH THE TEXAS STATION BUR EXTRACTOR AND THE TEXAS STATION CYLINDER CLEANER

In Texas Station Bulletin 452 detailed results are given of the cleaning and ginning of several varieties of cotton. The data shown in this publication deal with cotton cleaned on a Commercial Bur Extractor and Cleaner,

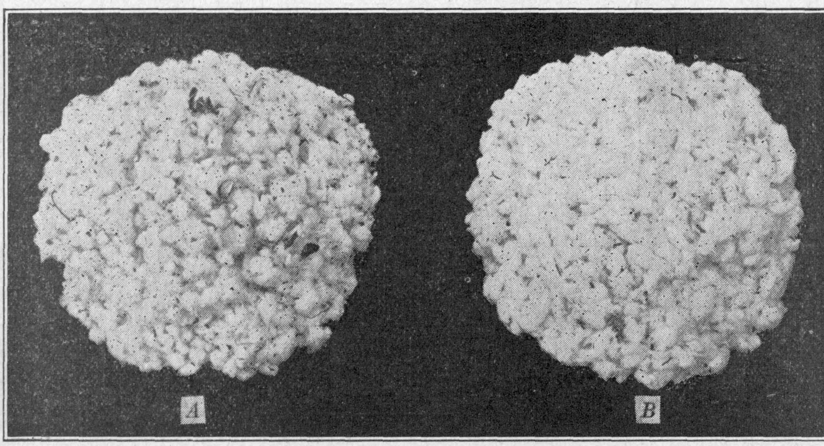


Fig. 10. Ducona cotton harvested with the Texas Station Cotton Harvester after the burs and trash had been removed.

A. Cotton cleaned with a commercial bur extractor and cleaner.
B. Cotton cleaned with the Texas Station Bur Extractor and Cylinder Cleaner.

and also show the results of tests made on the Texas Station Cotton Bur Extractor and the Texas Station Cylinder Cleaner.

**Cleaning with a Commercial Bur Extractor and Cleaner:** Table 5 shows that Lone Star cotton harvested with the Texas Station Harvester and

**Table 5. Mechanically harvested and hand-picked cotton cleaned on a commercial bur extractor and cleaner**

| Variety | Year | Stripped cotton, pounds | Clean seed cotton | | | | | Burs, dirt, and trash removed by bur extractor and by cleaner[3], pounds | Per cent of burs, dirt and trash removed by bur extractor and by cleaner | Grade of lint from mechanically harvested cotton | Staple, inches | Grade of lint from hand-picked cotton | Staple of hand-picked cotton, inches |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | After burs and trash were removed, pounds | Left in burs, pounds | Total, pounds | Per cent | | | | | | | |
| | | | | | | After burs and trash were removed | Left in burs | | | | | | |
| Lone Star[1] | 1932 | 795 | 521.5 | — | 521.5 | 65.6 | — | 273.5 | 34.4 | L M | 15/16 | M | 15/16 |
| Lone Star[2] | 1932 | 1280 | 723.8 | — | 723.8 | 56.6 | — | 556.2 | 43.5 | S L M | 15/16 | M | 15/16 |
| Ducona | 1932 | 384 | 234.2 | — | 234.2 | 61.0 | — | 149.8 | 39.0 | — | — | — | — |
| Lone Star | 1933 | 339 | 213.3 | — | 213.3 | 63.0 | — | 125.7 | 37.0 | L M | 1 | M | 15/16 |
| Ducona | 1933 | 435 | 279.1 | — | 279.1 | 64.2 | — | 155.9 | 35.9 | L M | 1 | S L M | 1-1/32 |
| Ducona[5] | 1934 | 200 | 128.8 | 2.0 | 130.8 | 65.4 | 1.5 | 69.3 | 34.6 | S G O | 1 | M—[4] | 1-1/16 |

[1]Cotton harvested with roll type sled.
[2]Cotton harvested in full foliage.
[3]Includes invisible loss.
[4]Cotton cleaned with small hand-operated laboratory cleaner and ginned on 8-saw laboratory gin.
[5]At the time this cotton was harvested, the leaves had been eaten off by leaf worms.

**Table 6. Amount and percentage of waste removed from mechanically harvested cotton when cleaned with the Texas Station Bur Extractor**

| Kind of roll | Roll speed | Stripped cotton, pounds | Clean seed cotton | | | | | Pounds of burs and trash | Per cent of burs and trash |
|---|---|---|---|---|---|---|---|---|---|
| | | | After burs and trash were removed, pounds | Left with burs, pounds | Total, pounds | Per cent | | | |
| | | | | | | After burs and trash were removed | Left with burs | | |
| **Ducona cotton** | | | | | | | | | |
| Rubber | low | 133.0 | 73.42 | 2.17 | 75.59 | 56.8 | 2.9 | 57.41 | 43.2 |
| ” | medium | 124.0 | 68.58 | 2.16 | 70.74 | 57.1 | 3.1 | 53.26 | 43.0 |
| ” | high | 114.0 | 62.16 | 1.80 | 63.96 | 56.1 | 2.8 | 50.04 | 43.9 |
| Knurled steel | low | 117.7 | 63.65 | 1.86 | 65.51 | 55.7 | 2.8 | 52.19 | 44.3 |
| ” ” | medium | 101.5 | 56.66 | 1.73 | 58.39 | 57.5 | 3.0 | 43.11 | 42.5 |
| ” ” | high | 119.0 | 65.50 | 2.22 | 67.72 | 56.9 | 3.3 | 51.28 | 43.1 |
| **Lone Star cotton** | | | | | | | | | |
| Rubber | medium | 60.85 | 34.65 | .70 | 35.35 | 58.1 | 2.0 | 25.50 | 41.9 |
| ” | high | 51.62 | 28.83 | .42 | 29.25 | 56.7 | 1.4 | 22.37 | 43.3 |
| Knurled steel | medium | 126.65 | 69.22 | 1.20 | 70.42 | 55.6 | 1.7 | 56.23 | 44.4 |
| ” ” | high | 111.76 | 62.24 | 1.22 | 63.46 | 56.8 | 1.9 | 48.30 | 43.2 |

cleaned on a commercial bur extractor and cleaner classed strict low middling in 1932 and low middling in 1933. Hand-picked samples for the same year classed middling. Ducona cotton harvested and cleaned with the same equipment classed low middling in 1933 and strict g ordinary in 1934. Fig. 10 shows how the 1934 seed cotton looked after it had passed through a commercial bur extractor and cleaner. Hand-picked samples for the same years classed strict low middling in 1933, and middling minus in 1934. The hand-picked cotton from which the sample was obtained in 1934, however, was cleaned on a small, hand-operated laboratory cleaner and ginned on an 8-saw laboratory gin, in stead of on standard gin equipment.

Cotton harvested with the roll type sled and cleaned on a commercial bur extractor and cleaner classed low middling.

**Cleaning Cotton with the Texas Station Bur Extractor:** The cotton harvested in 1934 with the Texas Station Harvester was run through the Texas Station Bur Extractor (Fig. 5) to remove the burs, green bolls, and leaves. Fig. 10 B shows how the seed cotton looked after being run through the bur extractor and the cylinder cleaner. Table 6 shows the various weights and percentages of cotton and waste in the stripped cotton harvested in low, medium, and high roll speed tests for both Ducona and Lone Star cotton. An examination of the table reveals that approximately 42 to 44 per cent of trash, including burs, unopen green bolls, leaves, and dirt, was removed from the mechanically harvested cotton. It also shows that approximately 3 per cent of the seed cotton was left with the burs by the extractor when extracting Ducona cotton, and approximately 2 per cent when extracting Lone Star cotton. Most of the cotton left with the burs was composed of small stained tags and of hard, knotty dry locks which were caused by insect injury to bolls before they opened. Such cotton when thrown in with the better cotton tends to lower the grade. All the unopen green bolls in the seed cotton were expelled with the burs, without being broken open.

**Cleaning Cotton with the Texas Station Cylinder Cleaner:** The cotton harvested with the Texas Station Harvester and run through the Texas Station Bur Extractor, the results of which processes are shown in Table 6, was given a final cleaning on the Texas Station Cylinder Cleaner (Fig. 6).

The results of cleaning the seed cotton on the Texas Station Cylinder Cleaner are shown in Table 7. An average of approximately 11 per cent of dirt and trash was removed from the Ducona cotton, and of 14 per cent from the Lone Star cotton. This difference appeared to be due to the difference in the staple length of the two varieties. The Lone Star variety with a staple length of 31/32 inch cleaned better than the Ducona variety with a staple length of 1-1/32 inches. The Lone Star cotton appeared to be slightly cleaner and whiter than the Ducona cotton after passing through the cylinder cleaner. The average percentage of burs, dirt, and trash removed by both the Texas Station Bur Extractor and the Texas Station Cylinder Cleaner was approximately 50 per cent for Ducona,

**Table 7. Amount and percentage of waste removed by the Station Cylinder Cleaner from cotton that was harvested with the Station Harvester and had the burs extracted on the Station Bur Extractor**

| Kind of roll | Roll speed | Weight in pounds of | | | Per cent of | | Weight in pounds of | | Per cent of trash removed by bur extractor and cylinder cleaner | Grade | Staple, inches |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seed cotton before cleaning | Seed cotton after cleaning | Dirt and trash removed | Cleaned seed cotton | Dirt and trash removed | Stripped cotton | All dirt and trash removed | | | |
| **Ducona cotton** | | | | | | | | | | | |
| Rubber | low | 73.42 | 65.64 | 7.87 | 89.40 | 10.59 | 133.0 | 65.19 | 49.0 | S L M | 1-1/32 |
| " | medium | 65.64 | 57.64 | 8.00 | 87.81 | 12.18 | 124.0 | 61.26 | 49.4 | | |
| " | high | 59.00 | 52.64 | 6.36 | 89.22 | 10.77 | 114.0 | 56.40 | 49.5 | | |
| Knurled steel | low | 63.65 | 56.00 | 7.65 | 87.98 | 12.02 | 117.7 | 59.84 | 50.8 | | |
| " " | medium | 53.50 | 47.50 | 6.00 | 88.78 | 11.21 | 101.5 | 49.11 | 48.4 | | |
| " " | high | 65.50 | 55.65 | 9.85 | 84.96 | 15.04 | 119.0 | 61.13 | 51.4 | | |
| **Lone Star cotton** | | | | | | | | | | | |
| Rubber | medium | 34.65 | 29.67 | 4.98 | 85.63 | 14.37 | 60.85 | 30.48 | 50.1 | S L M | 31/32 |
| " | high | 25.62 | 22.68 | 2.94 | 88.52 | 11.47 | 51.62 | 25.31 | 49.0 | | |
| Knurled steel | medium | 66.25 | 55.67 | 10.58 | 84.03 | 15.96 | 126.65 | 66.81 | 52.8 | | |
| " " | high | 59.00 | 50.90 | 8.10 | 86.27 | 13.72 | 111.76 | 56.40 | 50.5 | | |

**Table 8. Amount and percentage of waste removed from 25-pound samples of mechanically harvested cotton by the Texas Station Bur Extractor and the Texas Station Cylinder Cleaner.**

| Burs, dirt, and trash removed | | Green bolls (wet) | | Seed cotton | | | | | | Trash and dirt removed by cylinder cleaner | | Cleaned seed cotton |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Left in burs and lost by extractor | | Total from bur extractor (damp) | | Before being cleaned in cylinder cleaner[1] (dry) | After being cleaned in cylinder cleaner | | | |
| Pounds | Per cent | Pounds | Per cent | Pounds | Per cent | Pounds | Per cent | Pounds | Pounds | Pounds | Per cent | Per cent |
| 9.87 | 39.5 | 1.37 | 5.5 | .40 | 3.9 | 13.36 | 53.4 | 12.00 | 9.88 | 2.12 | 17.7 | 82.3 |
| 9.80 | 39.2 | 1.28 | 5.1 | .42 | 3.9 | 13.50 | 54.0 | 12.56 | 10.36 | 2.20 | 17.5 | 82.5 |
| 10.05 | 40.2 | 1.10 | 4.4 | .38 | 3.5 | 13.47 | 53.9 | 12.80 | 10.60 | 2.20 | 17.2 | 82.8 |
| 9.83 | 39.3 | 1.50 | 6.0 | .25 | 2.5 | 13.42 | 53.7 | 12.13 | 9.74 | 2.39 | 19.7 | 80.3 |
| 9.16 | 36.6 | 1.62 | 6.5 | .18 | 1.7 | 14.04 | 56.2 | 12.96 | 10.60 | 2.36 | 18.2 | 81.8 |
| 9.02 | 36.1 | 1.03 | 4.1 | .28 | 2.5 | 14.67 | 58.7 | 13.45 | 10.78 | 2.67 | 19.9 | 80.2 |
| 8.76 | 35.0 | 1.40 | 5.6 | .28 | 2.5 | 14.56 | 58.2 | 13.25 | 10.80 | 2.45 | 18.5 | 81.5 |
| 9.18 | 36.7 | .45 | 1.8 | .37 | 3.1 | 15.00 | 60.0 | 14.00 | 11.52 | 2.48 | 17.7 | 82.3 |
| 9.01 | 36.0 | .64 | 2.6 | .25 | 2.1 | 15.10 | 60.4 | 14.06 | 11.58 | 2.48 | 17.6 | 82.4 |
| 9.05 | 36.2 | .93 | 3.7 | .32 | 2.8 | 14.70 | 58.8 | 13.70 | 11.32 | 2.38 | 17.4 | 82.6 |
| Average 9.47 | 37.5 | 1.13 | 4.5 | .31 | 2.9 | 14.18 | 56.6 | 13.09 | 10.72 | 2.37 | 18.1 | 81.9 |

[1]The seed cotton was damp when extracted but was dried before cleaning.

and 51 per cent for Lone Star. The cotton from both varieties classed strict low middling (Table 7). Hand-picked samples, cleaned and ginned on small laboratory equipment, classed middling minus (Table 5). An average of about one per cent less trash was collected in harvesting the cotton with the rubber rolls at the three roll speeds than with the knurled surfaced steel rolls (Table 7).

**Special Tests with the Texas Station Bur Extractor and the Cylinder Cleaner:** In 10 special tests on the Texas Station Bur Extractor and on the Texas Station Cylinder Cleaner, the results of which are shown in Table 8, it is seen that the total burs removed from the stripped cotton amounted to 37.5 per cent. The percentage of seed cotton left in the burs was 2.9 per cent. The commercial bur extractor on the other hand left 1.5 per cent of the seed cotton with the burs (Table 5).

The percentage of cotton left with the burs by the Texas Station Bur Extractor could have been reduced by making certain adjustments which observations showed during these tests would be beneficial.

In the 10 special tests (Table 8) with some miscellaneous lots of mechanically harvested cotton that were not thoroughly dry when run through the bur extractor, an average of 18.1 per cent of dirt and trash was removed by the Texas Station Cylinder Cleaner. In tests shown in Table 7, where the cotton was in the proper condition for cleaning, an average of 12 to 14 per cent of the dirt and trash was removed by the cylinder cleaner. In this instance the bur extractor had previously removed a higher percentage of the dirt and fine trash with the burs than was possible in the case of the 10 special tests.

Ducona cotton cleaned on the Texas Station Bur Extractor and on the Texas Station Cylinder Cleaner in 1934 classed two grades higher than Ducona cotton extracted and cleaned the same year with available commercial bur extracting and cleaning equipment (Tables 5 and 7).

## RELATION OF VARIETAL CHARACTERISTICS TO EFFICIENCY OF HARVESTING AND CLEANING MACHINERY

In 1932 at Lubbock, the Texas Station Harvester was used to compare the harvesting qualities of seven varieties of cotton that appeared to have favorable characteristics for mechanical harvesting. Three of these varieties were selected and planted in 1933 for tests on a larger scale. No tests were made at Lubbock in 1934 on account of the poor crop. Tests were made at College Station with two varieties in 1933 and with eight varieties in 1934.

**Results at Lubbock:** Table 9 shows that of the seven varieties harvested in November 1932, the Ducona (Fig. 11) gave the highest efficiency, 99 per cent. This strain of cotton has short fruiting branches, and very little of it is lost by the harvester. Kubela also has relatively short fruiting and vegetative branches and gave good results in stripping. Clark cotton gave good results in the test, ranking third in efficiency (Table 9).

**Table 9. Relation of varietal characteristics to the efficiency of the Texas Station Harvester at Lubbock in 1932**

| Variety | Seed cotton | | | | Burs | | Limbs and sticks | | Dirt and trash | | Total yield of seed cotton | Per cent of | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | On ground before harvesting | Harvested cotton | Dropped on ground by machine | Cleaned harvested cotton | Weight | Per cent | Weight | Per cent | Weight | Per cent | | Total yield harvested by machine | Cotton on plant harvested by machine |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Per cent | Pounds | Per cent | Pounds | Per cent | Pounds | Per cent | Per cent |
| Ducona | .64 | 53.50 | .38 | 37.45 | 12.69 | 23.7 | .66 | 1.2 | 2.70 | 5.0 | 38.48 | 97.4 | 99.0 |
| Clark | .05 | 48.50 | .23 | 33.33 | 12.42 | 25.6 | 1.20 | 2.5 | 1.55 | 3.2 | 34.05 | 97.9 | 98.4 |
| Kubela D/C No. 3 | .19 | 41.25 | .53 | 29.90 | 8.76 | 21.2 | .51 | 1.2 | 2.08 | 5.0 | 30.62 | 97.6 | 98.3 |
| Mebane | .17 | 51.75 | .75 | 39.45 | 10.02 | 19.4 | 1.28 | 2.5 | .99 | 1.9 | 43.37 | 97.7 | 98.1 |
| Ferguson 406 | .56 | 39.25 | .41 | 29.44 | 6.86 | 17.5 | .49 | 1.2 | 2.46 | 6.3 | 30.41 | 96.8 | 98.6 |
| Mebane 804 | 1.86 | 49.75 | 1.11 | 36.06 | 11.18 | 22.5 | .92 | 1.8 | 1.59 | 3.2 | 39.03 | 92.4 | 97.0 |
| Burnett | 2.95 | 72.25 | 2.66 | 52.37 | 16.70 | 23.1 | 1.33 | 1.8 | 1.85 | 2.6 | 57.98 | 90.3 | 95.2 |

Although the other varieties gave relatively high percentages of efficiency for the harvester, they had certain undesirable characteristics, such as long fruiting and vegetative branches, lack of storm resistance, and weak bolls which had a tendency to crush easily and would not snap off readily, all of which caused a higher percentage of cotton to be lost in harvesting.

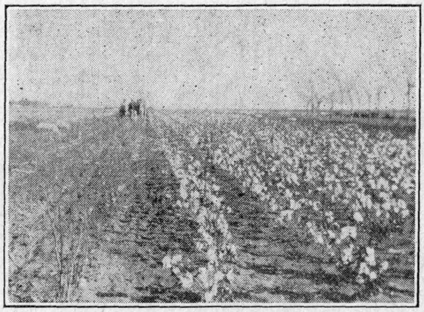

Fig. 11. The Texas Station Cotton Harvester harvesting 99 per cent of Ducona cotton at Lubbock.

Harvesting tests in 1933 showed that the average efficiency of the machine was highest with Kubela, 97.7; was second highest with Clark, 96.7; and third highest with Ducona, 94.3 per cent. The plants put on a late growth and top crop, particularly in the case of the Ducona variety. A high percentage of the bolls matured and opened early on the Ducona, thereby subjecting the open cotton to severe winds which caused it to string out of the boll, a condition which lowered the efficiency of the machine. The Clark and Kubela varieties opened early but the cotton did not become strung out and, consequently, made possible a higher efficiency in the operation of the machine.

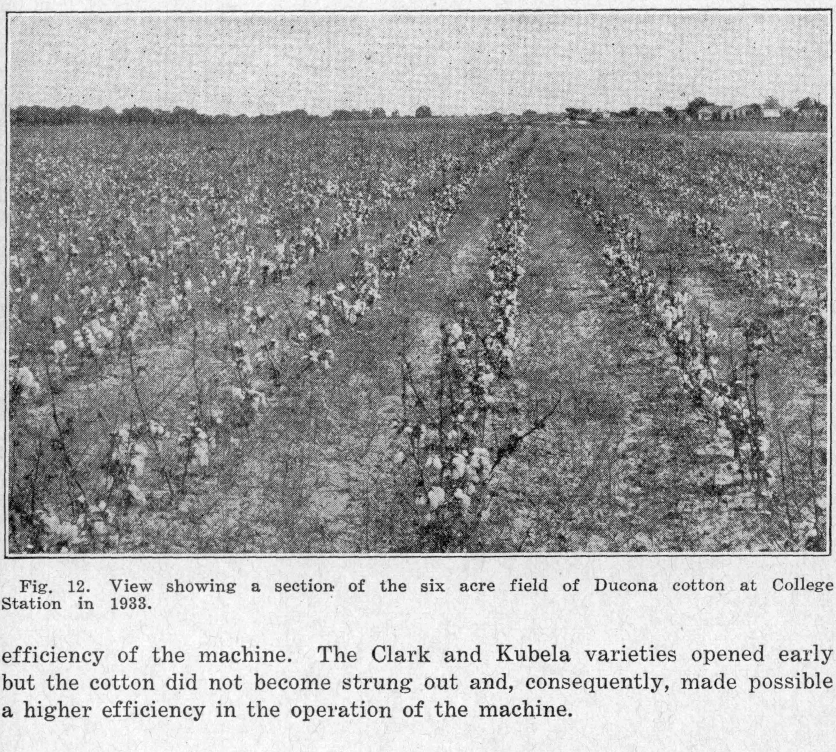

Fig. 12. View showing a section of the six acre field of Ducona cotton at College Station in 1933.

**Table 10. Relation of varietal characteristics to the mechanical harvesting and cleaning of cotton—1934[1]**

| Variety | Spacing between plants | Length of test | Time required | Travel of roll surface | Stripped cotton | Seed cotton after burs were extracted | Seed cotton left in burs by extractor | Per cent of seed cotton left in burs | Total seed cotton after cleaning on Station Cylinder Cleaner | Per cent of cleaned seed cotton from stripped cotton | Burs, dirt, and trash removed by both cleaners | Per cent of burs, dirt, and trash removed | Cleaned seed cotton left by stripper in field | Total yield of clean seed cotton | Per cent of cotton on plant harvested by machine | Grade of lint | Staple |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feet | Feet | Seconds | Feet | Lbs. | Lbs. | Lbs. | % | Lbs. | % | Lbs. | % | Lbs. | Lbs. | % | Grade | Inches |
| Kelly's Lone Star | 2.13 | 750 | 381 | 760 | 51.15 | 31.10 | .78 | 2.5 | 31.88 | 62.3 | 19.27 | 37.7 | 2.96 | 34.84 | 91.5 | S L M | 1 |
| Gorham's Lone Star | 1.28 | 750 | 375 | 783 | 46.60 | 27.19 | .46 | 1.7 | 27.65 | 59.3 | 18.95 | 40.7 | .97 | 28.62 | 96.6 | S L M | 15/16 |
| H X | 2.37 | 750 | 379 | 772 | 38.60 | 21.56 | 1.77 | 7.6 | 23.33 | 60.4 | 15.27 | 39.6 | 1.68 | 25.01 | 93.3 | L M | 1 |
| Clark | 1.91 | 750 | 357 | 769 | 40.38 | 22.97 | 1.14 | 4.7 | 24.11 | 59.7 | 16.27 | 40.3 | 2.46 | 26.57 | 90.7 | S L M | 31/32 |
| Ducona | 1.16 | 670 | 347 | 660 | 44.42 | 24.83 | .90 | 3.5 | 25.73 | 57.9 | 18.69 | 42.1 | .90 | 26.63 | 96.6 | L M | 1-1/32 |
| Roger's Cluster | 1.82 | 186 | 96 | 194 | 8.94 | 5.12 | .23 | 4.3 | 5.35 | 59.8 | 3.59 | 40.2 | .28 | 5.63 | 95.0 | S L M | 1-1/32 |
| Kubela D/C 1-20 | 1.52 | 123 | 73 | 125 | 6.49 | 4.10 | .08 | 1.9 | 4.18 | 60.2 | 2.76 | 39.8 | .30 | 4.48 | 93.3 | L M | 1 |
| Kubela D/C 2-1 | 1.19 | 232 | 120 | 236 | 14.39 | 7.73 | .78 | 9.2 | 8.51 | 59.1 | 5.88 | 40.9 | .44 | 8.95 | 95.1 | L M | 1 |

[1]All tests were made with the tractor operating in second gear and at medium roll speed.

**Results at College Station:** Tests on two varieties of cotton were made in 1933 with the Texas Station Harvester. Ducona (Fig. 12) gave an average of 4 to 6 per cent higher efficiency in harvesting than Lone Star. This difference is attributed to the difference in type of plant, the Lone Star variety having longer fruiting and vegetative branches than Ducona.

In 1934 eight varieties were harvested to determine the effect of varietal characteristics on the efficiency of the Texas Station Harvester. Table 10 shows that Ducona and Gorham's Lone Star each gave the highest efficiency in percentage of cotton harvested, 96.6 per cent. The fact that both varieties gave equal efficiencies in 1934 may be attributed to dry weather conditions which retarded the growth and size of the Lone Star plants, enabling the machine to harvest a higher percentage of the cotton of this variety than would have been possible under normal growing conditions. Kubela D/C 2-1 strain was second with 95.1 per cent, and Roger's Cluster third with 95.0 per cent. The plants of the HX variety with an efficiency of 93.3 per cent had wide spreading branches which caused considerable loss of cotton by the harvester. In some cases fruiting branches pulled off at the axis of the plant. Kelly's Lone Star had an efficiency of 91.5 per cent and a good snapping boll, but the long fruiting and vegetative branches offset the good qualities and caused considerable loss of cotton in harvesting. The Clark variety had the lowest harvesting efficiency, 90.7 per cent (Table 10). The table shows that several of the varieties, Kelly's Lone Star, HX, Clark, and Roger's Cluster, had poor stands caused by dry weather. The wider spacing between the plants caused many of them to develop longer fruiting and vegetative branches, which influenced their harvesting qualities and lowered the percentage of efficiency.

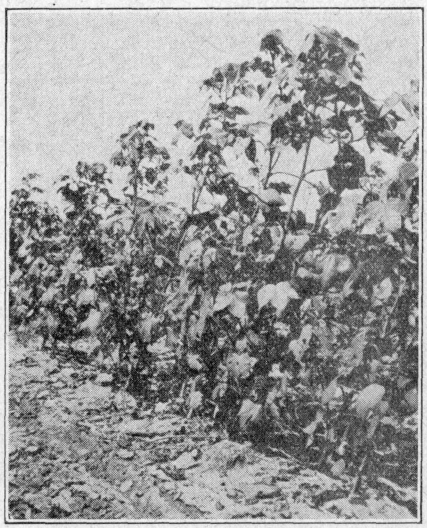

Fig. 13. Cotton plants after the Texas Station Cotton Harvester had removed the cotton, at College Station. An average of 16.5 per cent of the green leaves was removed from the plants when they were in full foliage at the time of harvesting, September 1932.

**Percentage of Green Leaves Harvested:** Several tests on 125-foot lengths of row were made in 1932 to determine the percentage of green leaves that were being harvested with the cotton when the Texas Station Harvester was operated in low, second, and high tractor gears. The data in Table 11 shows that on a dry basis an average of 15.9 per cent of the total amount of leaves on the plant was collected with the stripped cotton when the tractor was operated in low gear, 16.4 per cent when in second gear, and 17.1 per cent when in high gear (Fig. 13). The data

**Table 11. Percentage of green leaves harvested and their moisture content**

| Time required in seconds | Feet travel of roll surface | | | Weight in pounds of wet leaves | | | | Per cent of wet leaves | | | Weight in pounds of leaves after drying | | | | Per cent of dry leaves | | | Per cent of moisture in leaves | | | Per cent of | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In feet | Per foot of tractor travel | Per second | On plant | On ground | In cotton | Total | On plant | On ground | In cotton | On plant | On ground | In cotton | Total | On plant | On ground | In cotton | On plant | On ground | In cotton | Cotton harvested | Trash harvested |
| **When harvested in low tractor gear** | | | | | | | | | | | | | | | | | | | | | | |
| 54 | 137 | 1.09 | 2.54 | 15.62 | 2.39 | 1.96 | 19.97 | 78.2 | 12.0 | 9.8 | 3.50 | .70 | .59 | 4.79 | 73.1 | 14.6 | 12.3 | 77.6 | 70.7 | 69.9 | 95.4 | 38.9 |
| 51 | 133 | 1.06 | 2.61 | 15.26 | 2.84 | 3.78 | 21.88 | 69.7 | 13.0 | 17.3 | 3.49 | .88 | 1.06 | 5.43 | 64.3 | 16.2 | 19.5 | 77.1 | 69.0 | 72.0 | 97.7 | 47.3 |
| Average 53 | 135 | 1.08 | 2.58 | 15.44 | 2.62 | 2.87 | 20.93 | 74.0 | 12.5 | 13.5 | 3.50 | .79 | .83 | 5.11 | 68.7 | 15.4 | 15.9 | 77.4 | 70.0 | 71.0 | 96.6 | 43.1 |
| **When harvested in second tractor gear** | | | | | | | | | | | | | | | | | | | | | | |
| 39 | 88 | .70 | 2.26 | 13.06 | 2.77 | 2.80 | 18.63 | 70.1 | 14.9 | 15.0 | 3.06 | .83 | .83 | 4.72 | 64.8 | 17.6 | 17.6 | 76.6 | 70.0 | 73.9 | 96.4 | 48.7 |
| 46 | 89 | .71 | 1.93 | 13.41 | 2.55 | 2.49 | 18.45 | 72.7 | 13.8 | 13.5 | 3.16 | .80 | .71 | 4.67 | 67.7 | 17.1 | 15.2 | 76.4 | 65.5 | 71.5 | 93.1 | 46.8 |
| Average 43 | 89 | .71 | 2.10 | 13.24 | 2.66 | 2.65 | 18.54 | 71.4 | 14.3 | 14.3 | 3.11 | .82 | .77 | 4.70 | 66.3 | 17.3 | 16.4 | 76.5 | 67.8 | 72.7 | 94.7 | 47.8 |
| **When harvested in high tractor gear** | | | | | | | | | | | | | | | | | | | | | | |
| 28 | 64 | .51 | 2.28 | 11.81 | 2.42 | 2.94 | 17.17 | 68.8 | 14.1 | 17.1 | 2.42 | .70 | .84 | 3.96 | 61.1 | 17.7 | 21.2 | 79.5 | 71.1 | 71.4 | 96.1 | 48.9 |
| 27 | 66 | .53 | 2.44 | 15.18 | 2.95 | 2.27 | 20.40 | 74.4 | 14.5 | 11.1 | 3.52 | .88 | .86 | 5.06 | 69.6 | 17.4 | 13.0 | 76.8 | 70.2 | 70.9 | 91.3 | 41.2 |
| Average 28 | 65 | .52 | 2.36 | 13.50 | 2.69 | 2.61 | 18.39 | 71.6 | 14.3 | 14.1 | 2.97 | .79 | .75 | 4.51 | 65.4 | 17.6 | 17.1 | 77.2 | 70.7 | 71.2 | 93.7 | 45.1 |

Table 12. Percentage of mature and immature unopen bolls collected in green leaf tests, and their moisture content

| Number of bolls | | | | Per cent of bolls | | Weight in pounds of bolls | | | Weight in pounds of bolls | | Per cent of moisture in bolls | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Open (burs only) | Unopen mature | Unopen immature | Total on plant | Open (burs only) | Unopen bolls mature and immature | Open (burs only) | Unopen mature (wet) | Unopen immature (wet) | Unopen mature (dry) | Unopen immature (dry) | Unopen mature | Unopen immature |
| When harvested in low tractor gear | | | | | | | | | | | | |
| Number | Number | Number | Number | Per cent | Per cent | Pounds | Pounds | Pounds | Pounds | Pounds | Per cent | Per cent |
| 368 | 22 | 21 | 411 | 89.6 | 10.4 | 1.93 | .96 | .23 | .34 | .04 | 64.6 | 82.6 |
| 328 | 34 | 16 | 378 | 86.8 | 13.2 | 1.82 | 1.33 | .18 | .53 | .07 | 60.2 | 61.1 |
| Average 348 | 28 | 19 | 395 | 82.2 | 11.8 | 1.88 | 1.15 | .21 | .44 | .06 | 62.4 | 71.9 |
| When harvested in second tractor gear | | | | | | | | | | | | |
| 320 | 55 | 21 | 396 | 80.8 | 19.2 | 1.76 | 2.55 | .29 | 1.09 | .08 | 57.3 | 72.4 |
| 347 | 49 | 26 | 422 | 82.2 | 17.8 | 1.80 | 2.12 | .28 | .95 | .11 | 55.4 | 62.5 |
| Average 334 | 52 | 24 | 409 | 81.5 | 18.6 | 1.78 | 2.34 | .29 | 1.02 | .10 | 56.4 | 67.5 |
| When harvested in high tractor gear | | | | | | | | | | | | |
| 245 | 30 | 13 | 288 | 85.1 | 14.9 | 1.38 | 1.52 | .20 | .54 | .06 | 64.5 | 70.0 |
| 367 | 12 | 16 | 395 | 92.9 | 7.1 | 1.80 | .47 | .16 | .18 | .03 | 62.8 | 81.3 |
| Average 306 | 21 | 15 | 342 | 89.0 | 11.0 | 1.59 | 1.00 | .18 | .36 | .05 | 63.6 | 75.7 |

also shows that for the three tractor gear speeds there was an average of 71.6 per cent moisture in the leaves harvested with the cotton.

**Percentage of Moisture in Mature and Immature Green Bolls:** The green bolls collected in the green leaf tests on 125-foot sections of row were counted, weighed wet, then dried and weighed again to determine the percentage of moisture in both the mature and immature green bolls. Table 12 shows that in the unopen but mature green bolls for the three tractor gear speeds there was an average of 60.8 per cent moisture, while in the unopen immature green bolls for the three tractor gear speeds there was an average of 71.7 per cent moisture present at the time they were harvested.

**Influence of Varietal Characteristics on the Cleaning Qualities of Mechanically Harvested Cotton:** When extracting the burs, and cleaning the seed cotton, it was observed that Gorham's Lone Star left 1.7 per cent of the cotton in the burs and cleaned well enough to class strict low middling (Table 10). The Ducona cotton was extracted with comparative ease and ran through the extractor quickly, with 3.5 per cent of the cotton left as tags in the burs. It also did not appear to machine as much as some of the other varieties. The Kubela D/C 2-1 and HX varieties were noticeably difficult to extract, and considerable cotton was left as tags in the burs (Table 10).

## PROGRESS IN DEVELOPING VARIETIES OF COTTON TO MEET THE NEEDS OF MECHANICAL HARVESTING

Results of breeding work prior to 1932 are reported in Texas Station Bulletin 452, pages 54 to 58. During 1932, 1933, and 1934, numerous additional crosses were made at College Station and Lubbock between Ducona (a new type) and several other varieties to further improve its yield and boll characteristics. The resultant hybrid strains were compared in harvesting trials with the existing types of commercial varieties which had certain promising characteristics for mechanical harvesting. These studies have been made both at College Station and at Lubbock. Since climatic conditions are different at these points, an excellent opportunity is afforded to study the influence of these conditions on the growth and development of the various strains of cotton and their effect on the efficiency of harvesting machinery.

In 1933 a six-acre block of Ducona cotton was grown at College Station (Fig. 12) and a two-acre block at Lubbock. These plantings were used in harvesting trials with the Texas harvester. In these trial tests Ducona gave a higher efficiency in harvesting at College Station than did Lone Star, the only variety with which it was compared in 1933. Lone Star has proved to be one of the better commercial varieties tested. Even though Ducona gave satisfactory results in these trials, the strain is in need of further improvement. Its desirable characteristics include a good quality of 1-1/16 inch staple, an absence of excessive vegetative growth and ear-

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liness of maturity, with a more determinate fruiting habit than ordinary varieties. Its yield, percentage of lint, and boll characters, however, need improving, and breeding work is in progress to bring about these added improvements. In 1934 a new series of crosses was made between Ducona and five better yielding varieties possessing high percentages of lint, semi-cluster fruiting habit, and storm-proof bolls, in an effort to combine the desired qualities in the new hybrid strains. These strains will be back-crossed, inbred, and selected, in order to obtain a strain that will meet the requirements.

Of the 170 inbred hybrid strains of cotton from the crosses grown in 1934, a number of the more promising will be planted in 1935 for harvesting trials.

In the breeding work at Lubbock, where the growing season is shorter and climatic conditions generally are different from those at College Station, particular attention is being given to developing a type of cotton that will mature early enough to escape damage by frost, as this will reduce the amount of "bollie" cotton. Other desirable features being sought for that section include a plant type having a semi-cluster fruiting habit with the first fruiting branch borne fairly high off the ground (since the cotton is planted in listed furrows); a plant type with storm-proof bolls to prevent losses from windstorms occurring during the time the bolls are opening; and bolls having a long peduncle or stem, which will cause the bolls to hang down, thereby reducing weather damage and also creating a tendency for the peduncle to snap off at the base of the boll rather than at the point of attachment to the stalk. In addition to these desirable features the ideal type of cotton should possess high yielding ability, a lint turn out of at least 37 per cent, and a good quality of one-inch staple.

Many of the ordinary varieties and strains studied in the past seven years have varied widely in respect to storm-resistance, ranging from 63.3 to 93.9 per cent estimated relative storm-proofness. Much of the cotton on the ground has shed from the open bolls before all the bolls on the plant have opened. It is necessary for practically all the bolls on the plant to be open before stripper type harvesters such as the Texas Station Harvester can operate satisfactorily. The fact that 99 per cent of the cotton on the plant of a particular variety may be harvested mechanically, does not necessarily reflect the true merit of the variety from the standpoint of its suitability to mechanical harvesting, since this percentage is affected by factors such as storm-resistant qualities and uniformity of opening. This is also no indication of the amount and kinds of trash harvested with the cotton, or of the cleaning qualities of the cotton.

## ACKNOWLEDGMENTS

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## SUMMARY AND CONCLUSIONS

This Bulletin reports the results obtained in the study of the mechanical harvesting of cotton and describes improvements made on the Texas Station Cotton Harvester during the period 1932 to 1934 to increase its efficiency. A complete description is also given of the construction of an experimental roll-type sled harvester, of a bur extractor, and of a cylinder cleaner.

Tests made in 1932 with the roll-type stripper sled to determine what effect the angle of the rolls, the size of the rolls, and the speed at which they revolve would have on the efficiency of stripping rolls constructed of wood and steel, indicated the following:

1. Stripping rolls made from steel or wood, having a slightly roughened surface, gave a high efficiency when used to harvest cotton.
2. Stripping rolls 2-3/16 inches in diameter were more efficient than rolls 3 inches in diameter.
3. The most efficient angle for operating stripping rolls 56 inches in length was between 25 and 30 degrees with the ground.
4. A study of the relation of roll travel to tractor travel showed that a higher percentage of the cotton was harvested when the roll travel was faster than the tractor travel.

When stripping rolls made of wood, steel, and rubber, were used in the Texas Station Harvester at three roll speeds, and set at an angle of approximately 28 degrees, the highest percentage of the cotton was harvested with the highest roll speed. Similar results were secured when rubber rolls and knurled surfaced steel rolls were compared at different speeds. The rubber rolls operated at high roll speed harvested 96.8 per cent with Ducona cotton and 95.5 per cent with Lone Star cotton, while the knurled surfaced steel rolls harvested 96.2 per cent with Ducona and 97.0 per cent with Lone Star.

Rubber stripping rolls harvested a higher percentage of cotton than wood or steel stripping rolls. There was no significant difference in the efficiency of rubber rolls and knurled surfaced steel rolls.

Comparisons of the effect of roll speeds indicate that a higher percentage of the cotton is harvested with a high roll speed.

When the effects of tractor speeds were compared, the average percentage of the cotton harvested was 96.0, 95.5 and 94.7 per cent for low, second, and high tractor gear speeds, respectively. The feet travel of the roll surface per foot of tractor travel was 1.02 feet for low, .68 feet for second, and .50 feet for high tractor gear speeds.

The relation of roll travel to tractor travel was found to be an influencing factor on the efficiency of stripping rolls, since there was an average increase of approximately 23 per cent in roll travel per foot of tractor travel, of medium roll speed over low roll speed. An increase of approximately 13 per cent of high over medium roll speed; and an increase of approximately 33 per cent of high over low roll speed. In 9 of 15 comparisons the low roll speed harvested a higher percentage of the cotton than the medium roll speed; in 12 of 15 comparisons the high roll speed was more efficient than the medium roll speed; and in 14 of 15 comparisons the high roll speed was more efficient than the low roll speed.

Mechanically harvested cotton cleaned on the Texas Station Bur Extractor and on the Texas Station Cylinder Cleaner in 1934 removed burs, unopen green bolls, dirt, and trash, including leaves and stems, amounting to approximately 50 per cent of the weight of the harvested cotton from the Ducona variety, and 51 per cent from the Lone Star variety.

Ducona cotton cleaned on the Texas Station Bur Extractor and on the Texas Station Cylinder Cleaner in 1934, classed two grades higher than Ducona cotton extracted and cleaned the same year with available commercial bur extracting and cleaning equipment.

The efficiency of the Texas Station Cotton Harvester was greatly influenced by the varietal characteristics of the different varieties harvested. In tests with a number of varieties of cotton at College Station and Lubbock in 1932, 1933, and 1934, the highest efficiency, 96.6 to 99.0 per cent, was obtained in harvesting varieties in which the plants had short fruiting branches, short vegetative branches, and storm-resistant bolls.

An average of 16.5 per cent of the green leaves was removed from the plants in full foliage at the time of harvesting the cotton in September. The leaves in the cotton contained an average of 71.6 per cent moisture. There was 60.8 per cent moisture in the unopen mature green bolls, and 71.7 per cent moisture in the unopen immature green bolls that were collected with the green leaves in harvesting the cotton.

Satisfactory progress through hybridization and selection has been made during the three years 1932, 1933, and 1934 both at College Station and Lubbock in the breeding work to develop high-yielding strains of cotton that would be well adapted to mechanical harvesting. The type being sought should possess storm-proof bolls, a relatively high percentage of lint of good staple, a minimum of vegetative growth, a more determinate fruiting habit, and earliness of maturity. The breeding work is being done both at College Station and Lubbock. Since climatic conditions are different at these points an excellent opportunity is afforded to study the influence of these conditions on the growth and development of the various strains of cotton in relation to mechanical harvesting.