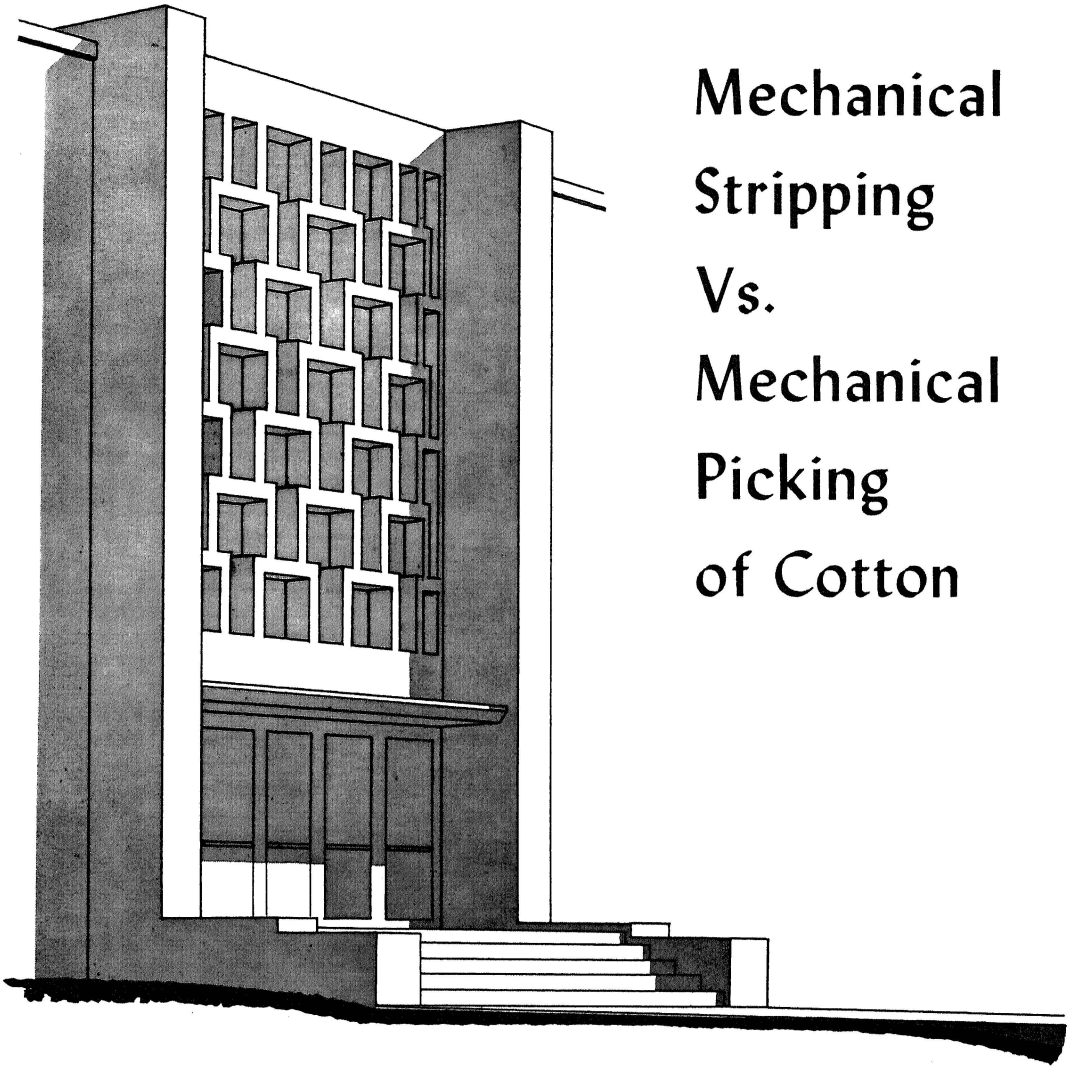

Mechanical Stripping Vs. Mechanical Picking of Cotton

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CONTENTS

This is a report on Missouri Agricultural Experiment Station Project 516

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Kenneth Telgemeier and V. Alonzo Metcalf*

INTRODUCTION

The mechanical cotton picker has, in general, reduced harvesting costs over those of hand harvesting. Harvesting, however, is still one of the major costs of production and in some instances may amount to 30 percent of total production costs.[1]

Many Missouri farmers, because of limited acreage, cannot afford the high fixed cost of owning mechanical spindle type pickers and must rely on custom operators or perhaps even hand pickers to harvest their crops. This situation has led to considerable interest in a cheaper mechanical "stripper" harvester which has only about one-fourth the initial cost of the conventional spindle picker. These machines are much simpler mechanically and can be mounted on most row crop tractors rather easily. Mechanical strippers have been used extensively in the more arid regions of the southern United States but as yet have seen only limited use in the Mississippi River Delta. The possibility of using mechanical strippers in Missouri prompted this study of the economic effects of stripper harvesting, from the farm to the spinning mill.

The research reported in this bulletin was conducted as a part of Missouri Agricultural Experiment Station Project 516. The findings reported are the results of the 1964 crop year. This was the first successful year of a proposed three year project. The project was actually begun in 1963, but due to extreme local wet weather conditions during the growing season the cotton plants grew so tall that it was impossible to use the stripper to harvest any of the test cotton.

The results reported in this bulletin should not be interpreted as final or conclusive since they represent only the first year of the three-year project.

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[1]Fred E. Justus, Jr., "Costs and Returns of Producing Cotton in Missouri," Missouri Agricultural Experiment Station Bulletin, No. 790 (Columbia, Missouri: University of Missouri, March, 1963).

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Procedures and Design of Study

This project was designed to determine and measure differences in lint cotton as affected by the method of harvest. The mechanical stripper method was the variable to be tested. The spindle picker method was the logical choice for the controlled variable because it is also mechanical and is currently the most popular method in use. All other factors of the experiment were held as nearly constant as practical.

The cotton used in the experiment was grown on a 40 acre field near Sikeston, Missouri, which was divided into 4 plots of 10 acres each. The plots were further subdivided into 4 replications of 2.5 acres each. Four varieties of cotton were used in the experiment. Three of these were popular varieties presently grown in the Missouri Delta while one variety, especially adapted to mechanical stripper harvesting, was used. The varieties used were Auburn M., Rex, Fox 4, and Arkansas Stripper. The first three named are presently grown in Missouri, while the fourth is a new variety developed especially for stripper harvest by the University of Arkansas cooperating with the U. S. D. A. The four varieties were planted with four randomized replications of each variety. The cotton was produced under recommended cultural practices and all varieties and replications had the same treatment before harvest.

At harvest, alternate paired rows of each variety and each replication were harvested by mechanical picker and stripper methods. The cotton harvested by spindle picker was picked twice, which is the common practice of that area, while the portion of the crop harvested with the mechanical stripper was harvested in a once-over operation. The picked cotton was harvested the first time when the bolls were about 60 percent open and the second time at the recommended stage and after the alternate rows had been harvested with the stripper. The mechanically stripped cotton was desiccated with arsenic acid when about 85 percent open, as recommended, but a good kill was not obtained, so a second desiccation was required. Harvesting with the stripper proceeded about five or six days after the second desiccation.

All cotton, including both methods of harvest, was ginned immediately after harvest with modern high speed ginning equipment. After ginning, samples were taken from all bales and sent to the U. S. D. A. classing office for grade and staple determinations. Another set of samples was

taken for the purpose of conducting complete fiber tests. These tests included 32 samples, representing both methods of harvest from each of the 16 replications. The fiber properties tested were length, uniformity, fineness, strength, elongation, color, and foreign matter. Eight bales of cotton, representing each of the four varieties and both methods of harvest, were randomly chosen to be tested for spinning qualities and performance. Samples of approximately 100 pounds of cotton were taken from each of the eight bales for full-scale spinning tests. The results of these tests will be available at a later date.

Method of Analysis

The basic approach used in evaluating the economic feasibility of stripper harvesting of cotton in Missouri was to compare many of the possible effects of the two methods of harvest. If differences between methods were found, whether physical or qualitative, their magnitude was measured and statistical tests were conducted to see if these differences were significant. In the final analysis an attempt was made to evaluate the differences in aggregate and translate them into economic implications.

DIFFERENCES IN GINNING CHARACTERISTICS BETWEEN METHODS OF HARVEST

Differences in ginning performance were among the first to be observed. All cotton was ginned at the same gin on modern, high speed ginning equipment. Some differences were encountered in ginning the stripper harvested cotton. Ginning operations were slowed considerably by the extra trash and foreign matter contained in the stripped seedcotton. Because of green leaves and bolls, the stripper harvested seedcotton contained excess moisture which necessitated additional heat in the drying process.

Whether these difficulties would have been encountered by other local gins or even by the same gin if done at a different time is not definitely known. This particular gin would not be expected to have any more trouble than most, however, since it did have the advantage of new equipment, including modern pre-cleaning devices. Gins not so equipped would be expected to encounter difficulty.

Another major difference noted between the two methods of harvest at ginning was in the gin "turnout" of lint. Gin "turnout" relates the total weight of seedcotton ginned to the final weight of lint produced and is usually expressed as a percentage. This figure is especially important to the farmer since ginning charges are made on the basis of seedcotton weight rather than the weight of the lint produced after ginning. The respective percentages of turnout were 19.0 for the stripped cotton and 28.1 for the picked cotton. Although these figures include all varieties and replications in the experiment the results were consistent for individual plots. Percentage ginning turnout for individual plots varied no more than one or two percent about the gross averages for their respective harvest methods. No differences with respect to variety could be observed in gin turnout within a single method of harvest.

QUALITY DIFFERENCES AS INDICATED BY GRADE AND STAPLE DETERMINATIONS

Grade and staple length as determined by classes is the traditional method of specifying cotton quality. Although this method may not be the most accurate method of determining cotton quality, it is one of the most important since it is the basis upon which price is established.

Differences Found in Grade and Staple Length Of Picked vs. Stripped Cotton

Differences did occur in both grade and staple length between the mechanically picked and stripped methods of harvest. Grades for spindle picked cotton ranged from Middling to Strict Low Middling with Strict Low Middling being the modal grade (designated for 9 of the 16 plots). Cotton from the stripper harvested plots graded from Middling Light Spotted to Low Middling Plus. Middling Light Spotted was the modal grade (recorded for 10 of the 16 plots). All of the cotton for both methods of harvest were classified as white or light spotted grades. The incidence of light spotted grades was higher for cotton harvested by stripping than for spindle picking. Cotton from 13 of the 16 stripped plots carried the Light Spotted designation along with their grades while cotton from 6 of the 16 picked plots graded Light Spotted.

To determine the magnitude of difference in grade, the official grade designations were converted to a quantitative index. This provided a means of averaging different grades together which could be used to reflect differences in market value. When all varieties and all replications were considered the over-all mean index was lower for the stripper harvested cotton than for picked (Table I). Both means were slightly above the average grade index of 93.5 recorded for Missouri in 1964[2]. While this difference in grade index between stripped and picked cotton is real, it is not great enough to account for a price break per se. However, it could account for a full grade difference in pricing if the grades in question were near the quantitative limits for a grade. The grade difference was not consistant

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[2]United States Department of Agriculture, Consumer and Marketing Service, Cotton Division: Cotton Quality Crop of 1964, Vol. 38, No. 7 (Memphis, Tennessee, June, 1965), p. 8.

since there were just as many replication plots on which the stripped cotton graded higher than picked as there were plots on which picked cotton graded higher (Table II). The difference observed was not statistically significant.

Staple length also showed an over-all difference in mean length between harvest methods. When all varieties and replications were averaged the overall mean was 32.8 thirty-seconds of an inch for picked cotton while the mean for stripped cotton was 31.6 (Table I). This difference was certainly real and indicated a high level of significance when tested statistically. This difference in staple length was consistent since only 2 of the 16 replication plots were judged to have equal staple lengths for both methods of harvest and none were classed as having longer staple for the stripped portion than for the picked (Table II). While the 1964 Missouri average grade index was slightly below the averages for the individual harvest methods, the 1964 state average staple length of 33.7 thirty-seconds of an inch was greater than the averages for either stripped or picked cotton.[3]

The data seem to indicate that according to the classer's call, there was a quality difference in cotton harvested by the two methods. Average figures, including all varieties and replications, indicate that stripper harvested cotton has slightly shorter staple and may be graded a little lower. The implications of the greater statistical variations as well as the inconsistencies for grade differences as opposed to staple length are not immediately apparent. They may indicate nothing more than that the classer's call for staple length can be determined more accurately and consistently than the grade. The next section will attempt to more closely define actual fiber quality differences.

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[3]Ibid.

TABLE I

PRIMARY RESULTS OF GRADE AND STAPLE DETERMINATIONS
OF COTTON HARVESTED BY MECHANICAL STRIPPER AND PICKER METHODS
MISSOURI, 1964

Statistical measure	Grade	Staple length
Stripper harvest mean[a]	93.9	31.6
Picker harvest mean[a]	95.1	32.8
Significant difference @ 1% level	NO	YES
Overall mean[b]	94.5	32.2
Overall standard deviation[b]	3.6	.66

[a]Treatment sample size=16

[b]Overall sample size=32

TABLE II

CONSISTENT DIFFERENCES IN THE CLASSER'S CALL
OF GRADE AND STAPLE LENGTH BETWEEN STRIPPED VS. PICKED METHODS
OF HARVEST FOR INDIVIDUAL TEST PLOTS, MISSOURI, 1964

Direction of Absolute Difference on Individual Plots	[Number of Observations (plots)] Grade Index	Staple Length
Stripped greater than picked	6	0
Equal for both methods of harvest	4	2
Picked greater than stripped	6	14
Total No. Plots	16	16

QUALITY DIFFERENCES AS MEASURED BY SELECTED FIBER TESTS

Samples from each replication, variety, and method of harvest were tested for differences in various fiber properties. The properties tested included most components of over-all quality. Tests were conducted to determine fiber fineness, strength, elongation, upper half mean length, uniformity ratio, mean length, upper quartile mean length, percentage of fibers less than one-half inch, color, and composition of trash. These properties were tested on special machines designed to measure the individual components of cotton quality. The instruments are highly accurate with closely repreducable results.

Fineness and Maturity

Fiber fineness, tested with the Micronaire instrument, is one of the most popular gauges of cotton quality. The Micronaire measures the surface area of a standard weight of fibers by the amount of air resistance incurred in forcing pressurized air through the sample. Results are reported simply as "micronaire readings" and may be interpreted by applying the following official designations used to describe American upland cottons:[4]

Micronaire Reading	Descriptive Designation
Below 3.5	Very low
3.5 to 3.9	Low
4.0 to 4.4	Average
4.5 to 5.0	High
Above 5.0	Very High

High micronaire readings indicate coarse fibers while low readings represent fineness. Fiber fineness contributes to yarn strength but also tends to increase neppiness and requires a reduced rate of processing. Because micronaire readings are closely related to weight per inch of fiber, and because weight per inch is closely related to the thickness

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[4]Cotton Testing Service: Tests Available, Equipment and Techniques, and Basis for Interpreting Reports, United States Department of Agriculture, Agricultural Marketing Service, No. 16 (Washington: U. S. Department of Agriculture (revised) December, 1963) p. 19.

of the cell wall, the micronaire value becomes a very useful indicator of maturity and, thus, spinability. Micronaire readings are included in establishing government loan prices by allowing premiums and discounts for cotton having certain ranges of micronaire values.

The Micronaire test for fineness and maturity resulted in lower average micronaire readings for stripped than for picked methods of harvest (Table III). As might be expected, varietal differences in micronaire readings were observed along with differences found between methods of harvest. Average micronaire readings by variety corresponded quite closely with the averages listed in the 1964 Annual Cotton Quality Survey[5] for all of the open boll varieties included in the study. Averages for the new stripper variety were not listed in the survey report but the average reading was observed to be higher than that of any of the open boll varieties included in the test. The difference in micronaire values accounted for by method of harvest was not statistically significant but was observed to be fairly consistent. Cotton from all but 2 of the 16 plots had higher micronaire readings for the picked portions than for the stripped portions (Table IV). Although not statistically significant, the difference between average Micronaire values for the two methods of harvest would involve a classification change from "average" for stripper harvested to "high" for picked.

Fiber Strength and Elongation

Fiber strength is probably the second most popular fiber measurement. Closely associated with strength is elongation or the "stretch" of fiber. Both of these properties are desirable since they have a great deal to do with determining spinning qualities and yarn strength. The instrument used to measure both of these properties is the Stelometer. The Stelometer measures strength in terms of grams per grex and elongation as a percentage of

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[5]Agricultural Marketing Service: Annual Cotton Quality Survey, 1964, United States Department of Agriculture, Agricultural Information Bulletin 284 (Washington: U. S. Department of Agriculture, March, 1965).

TABLE III

PRIMARY STATISTICS REPORTING RESULTS OF SELECTED FIBER TESTS CONDUCTED TO FIND DIFFERENCES IN COTTON HARVESTED BY MECHANICAL STRIPPER VS. PICKER METHODS, MISSOURI, 1964

Statistical Measure	Micronaire Reading	Strength (gms/gx)	Elongation (%)	Color		Foreign matter (%)			Length (inches)		
				R_d	+b	Vis.	Invis.	Total	Mean	UHM	UR
Stripper harvest mean[a]	4.33	1.95	5.66	72.82	9.43	1.51	1.29	2.79	.78	.98	79.56
Picker harvest mean[a]	4.53	2.02	5.06	73.29	8.73	.73	.98	1.71	.81	1.01	80.25
Signif. diff. @ 1% level	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES	NO
Overall mean[b]	4.43	1.99	5.36	73.42	9.09	1.19	1.13	2.25	.80	1.00	80.00
Overall standard deviation[b]	.48	.11	.44	1.26	.35	.26	.19	.35	.03	.02	1.76

[a]Treatment sample size = 16

[b]Overall sample size = 32

TABLE IV

CONSISTENT DIFFERENCES BETWEEN STRIPPED AND PICKED METHODS OF HARVEST

INDICATED BY SELECTED FIBER TEST RESULTS FOR INDIVIDUAL TEST PLOTS, MISSOURI, 1964

Direction of Absolute Difference on Individual Plots	Number of Observations (plots)										
	Micronaire Reading	Strength	Elongation	Foreign Matter			Length		Uniformity Ratio	Color	
				Vis.	Invis.	Total	Mean	UHM		R_d	+b
Stripped greater than picked	1	4	10	16	14	16	2	1	3	5	15
Equal for both methods of harvest	1	0	6	0	1	0	0	1	5	0	0
Picked greater than stripped	14	12	0	0	1	0	14	14	8	11	1
Total no. of plots	16	16	16	16	16	16	16	16	16	16	16

length. The following adjective ratings for fiber elongation will assist in the interpretation of the results reported.[6]

Fiber Elongation (1/8-inch gauge)

Designation	Percent
Very low	4.8 and below
Low	4.9 to 5.7
Average	5.8 to 6.6
High	6.7 to 7.5
Very high	7.6 and above

When tested for fiber strength on the Stelometer the picked cotton tended to exhibit greater strength than the stripped cotton. This difference was not statistically significant when tested for the analysis of variance. Varietal deviations were less obvious for strength than for micronaire values. The difference in strength between methods of harvest was fairly consistent with 12 of the 16 plots exhibiting higher strength for the picked than for the stripped portions (Table IV). Cotton from the four plots which tested higher in strength for the stripped than the picked could not be attributed to any certain variety or varieties.

Fiber elongation, also tested on the Stelometer, was greater for stripped than for picked cotton. Such results would not ordinarily be expected in view of the relationship found between harvest methods for micronaire and strength factors. This difference was consistent in that no plots were found to indicate that the picked cotton had greater elongation than the stripped cotton. Six of the plots did, however, exhibit equal fiber elongation (Table IV). The data revealed no varietal patterns with respect to variations in elongation. The average percentage elongation for either harvest method would fall into the "low" elongation category defined previously. The representative difference in fiber elongation between methods of harvest was highly significant when tested statistically (Table III).

Color

The machine used to measure color was the Nickerson-Hunter Cotton Colorimeter. The colorimeter electronically measures reflectance and the degree of yellowness exhibited by the cotton fibers. Reflectance is measured in terms of

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[6]Ibid. p. 98.

a percentage from 0 to 100 and expressed as a value of R_d. Yellowness is expressed as a +b value with the degree of yellowness increasing as the scale number increases. Color is also reported as a code number and provides an identification of the color measurements for an individual lot with the color of the grade standards as shown on a special diagram (Figure 1). The code number can be used to compare the color between individual lots but cannot be used to average the composite color of a number of lots.

Color properties for cotton harvested by mechanical picker tested better than those for stripped cotton with the Nickerson-Hunter Colorimeter. The picked cotton had a higher percentage reflectance and a lower degree of yellowness (Table III). The difference in the degree of yellowness between methods of harvest was more consistent than the difference in reflectance. Stripper harvested cotton exhibited a higher degree of yellowness than picked cotton on all but 1 of the 16 plots (Table IV). Reflectance, on the other hand, measured higher for picker harvested cotton on 11 of the 16 plots and lower on five. Statistical tests for the analysis of variance between harvest methods indicated that the difference in reflectance (R_d) was not significant but that the difference in the degree of yellowness (+b) was highly significant (Table III).

To illustrate this relationship of color properties for cotton harvested by the two methods average indices for the four replications of each variety and each harvest method were plotted on the special color diagram (Figure 1). Averages for all varieties of stripper harvested cotton fell in color code 353, Middling White. Average color indices for spindle picked cotton were plotted to the left and slightly above those of the stripper harvested cotton indicating a lower degree of yellowness and slightly greater reflectance. Although these are more desirable color characteristics it is interesting to note that since the increase in percentage reflectance is not proportionate to the reduced degrees of yellowness for the spindle picked cotton, three of the four varieties that were spindle picked fell into the Strict Low Middling classification.

Nonlint Content

Nonlint content has a direct bearing on the percentage waste as well as an effect on spinning quality and yarn appearance. The machine used to determine the nonlint content

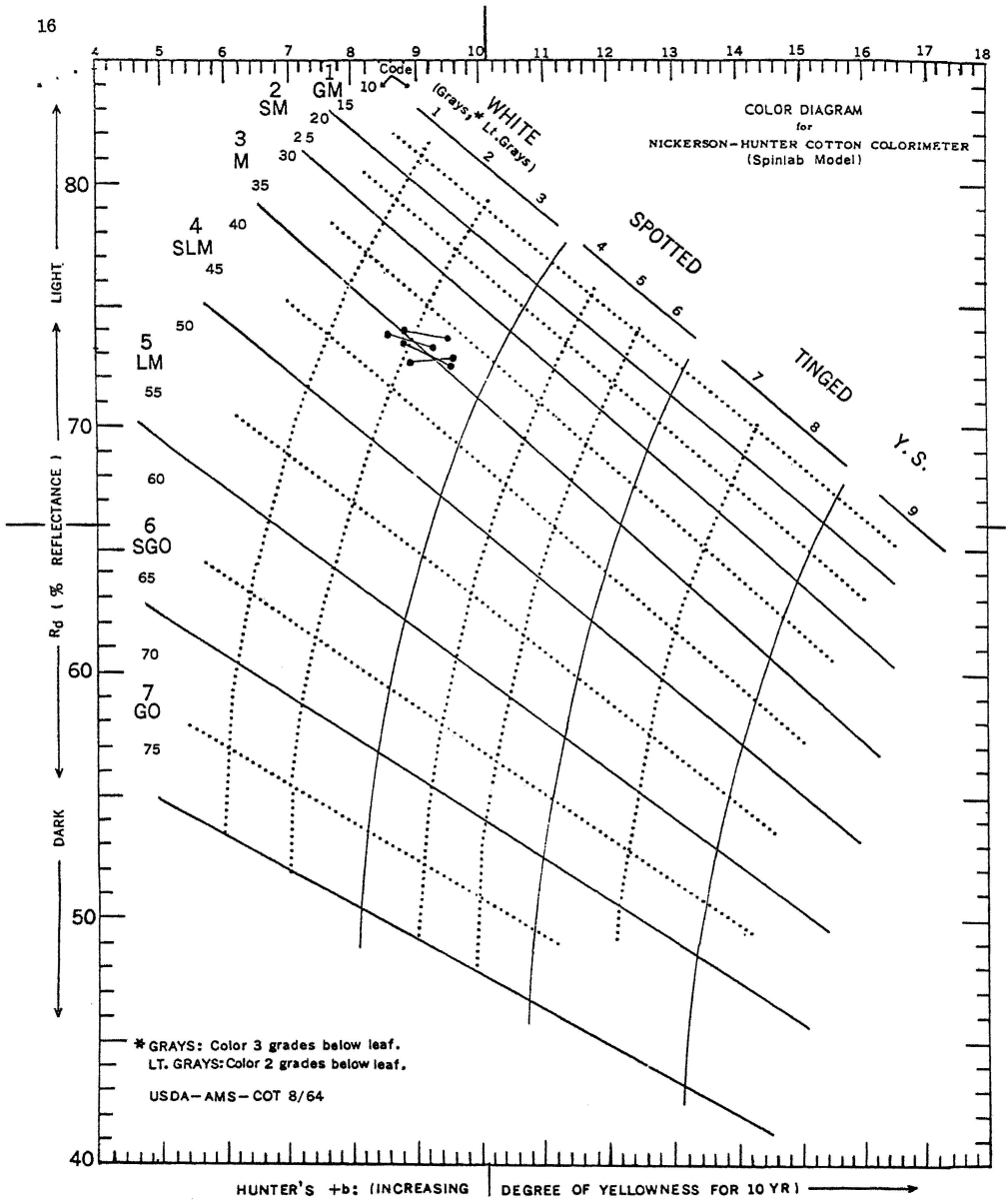

Figure 1 Color Diagram for Cotton Samples Missouri, 1965

of the test cotton is the Shirley Analyzer. It separates all foreign matter from the lint and expresses the weight loss as a percentage of the untreated sample. The total nonlint value is divided into visible and invisible waste which are also expressed as percentage figures. The United States Department of Agriculture reports the following average total nonlint content for the different grades of cotton when measured by the Shirley Analyzer.[7]

Nonlint Content for White Grades of Upland Cotton

Grade	Nonlint Content %
Good Middling	1.5
Strict Middling	1.6
Middling	2.2
Strict Low Middling	3.1
Low Middling	4.5
Strict Good Ordinary	5.8

Stripped cotton was measured to contain a considerably higher nonlint content than the picked cotton when tested with the Shirley Analyzer. Average percentage of foreign matter for stripped ran almost twice that of picked for visible, invisible, and total classifications (Table III). Differences found in nonlint content were quite consistent as illustrated in Table IV. Cotton harvested by mechanical stripper had a higher visible and total foreign matter content on all plots and a higher invisible loss on all but 2 of the 16 plots. Differences in visible, invisible, and total foreign matter of cotton harvested by the two methods indicated a high level of significance when tested statistically (Table III). Comparison of the average total nonlint content for the two methods of harvest with the "averages" established by the United States Department of Agriculture for the various grades would indicate that both the picked and stripped lint had less trash than would be expected for their respective modal grades.

Uniformity Ratio, Upper Half Mean Length, and Mean Length

All of these measures relate to the length of fiber. The mean length is, of course, the average length of all fibers contained in the sample. The upper half mean is a

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[7]AMS No. 16, p. 5.

measure of the average length of all fibers longer than the mean. The uniformity ratio is simply the mean divided by the upper half mean. The instrument used to make these measurements is the Digital Fibrograph. The following official descriptive designations for fiber uniformity may be used as a standard of comparison for the results reported herein:[8]

Fibrograph Length Distributions

Uniformity ratio M/UHM	Descriptive Designation
Below 74	Very low uniformity
74 to 76	Low uniformity
77 to 79	Average uniformity
80 to 82	High uniformity
Above 82	Very high uniformity

High uniformity of fiber length is a desirable quality characteristic in that it tends to decrease manufacturing waste, makes processing less difficult, and raises the quality of the end product.

The uniformity ratios of cotton harvested by the two methods averaged only slightly higher for picked than for stripped cotton (Table III). This difference was not statistically significant. Average uniformity ratios for both picked and stripped methods of harvest would be designated as having "high uniformity" by the U. S. D. A. if rounded off to the nearest whole number.

Measures for the mean and upper half mean length of fibers indicated larger values, and thus longer fibers for the picked than for the stripped cotton (Table III). Some varietal pattern with respect to length variation was noticeable but it was not consistent. The measured difference in length of fiber was consistent in that 14 of the 16 plots exhibited longer mean and upper half mean lengths for picked than for stripped portions of the individual plots (Table IV). The difference in length between methods of harvest was highly significant statistically for both mean and upper half mean lengths (Table III).

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[8]Ibid., p. 14.

Mean Length, Upper Quartile Mean Length, Percentage of Fibers Below One-Half Inch, and Coefficient of Variation

These fiber measures deal with the same general qualities as the ones last mentioned but were obtained from a different instrument. The instrument used is the Suter-Webb Sorter. A complete weight-length frequency distribution or "array" of fibers is made with this instrument.

An explanation of the individual measures of the array method finds the mean length retaining the same meaning as previously defined. The upper quartile mean length indicates the length which is exceeded by 25 percent of the weight of the fibers in the sample. The percentage of fibers below one-half inch is self-explanatory and is closely related to fiber uniformity. The coefficient of variation also expresses fiber uniformity and represents the standard deviation of the weight-length frequencies divided by the mean length. A low coefficient of variation indicates high uniformity of fiber length and thus, desirable cotton quality. The following descriptions will serve to classify cotton from the standpoint of fiber length variation:[9]

Array Length Distribution

Coefficient of Length Variation %	Descriptive Designation
Below 26	Very low variation
26 to 29	Low variation
30 to 33	Average variation
34 to 37	High variation
Above 37	Very high variation

Since this test is more time consuming and results are closely correlated with the Fibrograph, these determinations were obtained for only one replication of each variety, involving only 8 samples rather than the 32 involved in all other fiber tests. The test itself is preferred over the Fibrograph method as it is more accurate, therefore a random sample of 8 bales, one stripped and one picked from each variety, was chosen to be tested by this method.

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[9]Ibid., p. 12.

The mean length of fibers as determined by this method produced results similar to those obtained with the Fibrograph. The mean length of fibers for picked cotton was slightly longer than the mean length of stripped (Table V). The numerical averages indicated by this method were slightly higher for both types of harvest than for the Fibrograph method. A statistical test for the analysis of variance indicated that the difference in mean lengths between harvest methods was significant. The upper quartile mean lengths also measured higher for picked than for stripped methods of harvest; however, this difference was not significant when tested statistically.

Tests for uniformity included percentage of fibers below one-half inch. Results indicated high values for both methods of harvest. The average percentage was less for picked than for stripped cotton (Table V) but this difference between harvest methods was not statistically significant.

The coefficient of variation, the last test of fiber length uniformity, also indicated considerable variation for both methods of harvest. The average coefficient was higher in the case of stripped cotton than for picked cotton, thus indicating lower uniformity (Table V). The picked cotton would be designated as having "high variation" by the U. S. D. A. scale while the average coefficient for the stripped cotton would be designated as having "very high variation." Although the numerical difference of the average coefficients of variation between methods of harvest is considerable, statistical tests did not find the difference significant.

TABLE V

RESULTS OF FIBER ARRAY TESTS CONDUCTED TO FIND DIFFERENCES IN COTTON HARVESTED BY STRIPPED AND PICKED METHODS, MISSOURI, 1964[a]

	Mean Length	Upper Quartile Mean Length	% Fibers Less Than ½ in.	Coefficient of Variation
Stripped mean[b]	.813	1.07	20.4	40.2
Picked mean[b]	.893	1.12	13.6	34.0
Analysis of Variance Significant @ 5% level	Yes	No	No	No

[a]Overall sample size = 8

[b]Treatment sample size = 4

ECONOMIC CONSIDERATIONS OF STRIPPER HARVEST VS. SPINDLE PICKING

The economic significance of the differences indicated between the two harvest methods cannot be put into definite terms but certain inferences can be drawn. The original assertion that stripper harvesting reduces the actual cost of harvesting over spindle picking was not tested in this experiment. Rather, research efforts were concentrated on less obvious differences which might also have considerable economic importance. These included economic effects of stripper harvesting rather than the magnitude of the fixed and variable costs of machine operation.

The harvesting cost advantage of stripper harvesting, if it exists, is left up to the individual farmer to compute for his own situation. Harvesting costs will undoubtedly vary appreciably from farm to farm according to the size of operation as well as with the harvesting practices and procedures now in use. Drawing from general cost data it would be expected that the relative advantage of stripper harvesting over spindle picking would be greater for small scale operations than for larger ones. Whatever the harvesting cost advantage, the farmer should consider all of the economic aspects of stripper harvesting before deciding to adopt it.

Increased Ginning Costs

One of the economic effects of stripper harvesting that would tend to offset the advantage gained on harvesting costs is that of increased ginning costs. Results of this study indicated that ginning costs would be higher for the farmer because of (1) the lower percentage lint turnout and (2) a higher rate charged per unit weight of seedcotton by the ginner. The reason for higher rates charged for stripper harvested cotton over those charged for spindle picked seedcotton apparently would be due to the extra trash and foreign matter which would tend to slow ginning operations. Since little stripper harvested cotton is being ginned in Missouri at present the amount of increase in the rate charged can only be predicted by what local ginners claim they would charge if faced with the situation. The actual amount of difference in ginning rates incurred in this study was only 10 cents per cwt. of seedcotton. Rates

quoted by other local ginners indicated that this difference might be quite conservative. Some felt that they would have to charge as much as $2.00 per cwt. of stripped seedcotton in order for them to have an economical operation.

When both average percentage turnout and price differentiation were accounted for, the stripper harvested cotton incurred an average cost of $2.25 per cwt. of lint more than the spindle picked cotton. If, on the other hand, the ginning cost rate of $2.00 per cwt. of seedcotton were charged the difference would be escalated to $6.95 per cwt. of lint. Whichever cost figure is used the increased cost of ginning stripped seedcotton would certainly make any cost advantage gained with harvesting machinery less attractive to the farmer.

Another complication which stripper harvesting would introduce if it came into widespread use is that the faster, once-over harvesting technique would tend to shorten the harvest season and crowd ginning operations even more. A combination of slowed ginning due to trashier seedcotton along with a shorter harvest season would seem to point toward additional investment in gins and ginning equipment in an industry already plagued with excess capacity and high fixed costs. A possible alternative might lie in seedcotton storage prior to ginning which would in effect help spread out the harvest season for the ginner, allowing him to use his equipment more days per year and thereby lower fixed costs. Research is now underway to determine whether or not storing seedcotton would be feasible for mechanical stripper harvesting since recent investigations have found this technique promising for other harvesting methods.

Economics of Decreased Quality

The difference in quality between stripped and picked cotton is definitely an object of economic concern since quality is determinant of market price. In this study the average market price for stripped cotton was lower than that for spindle picked cotton. The average difference at harvest was computed by averaging the Spot Market Price Quotations for each grade and staple determinations from the individual plots for both methods of harvest.[10] When

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[10]United States Department of Agriculture, Agricultural Marketing Service, Cotton Division--Quotation Section, Spot Cotton Quotations, Vol. 46, No. 58, (15 Designated Markets, Memphis, Tennessee, Oct. 23, 1964), Memphis Market.

the prices quoted for all plots and varieties were averaged together, the average price quoted for picked cotton was $29.23 per cwt. while the average for stripped cotton was quoted at $28.02 per cwt., a difference of $1.21.

An object of still greater concern for spinning mills as final consumers of raw cotton might lie in discrepancies in the amount of quality difference of stripped versus picked cotton reflected by grade and staple as opposed to results of objective fiber tests. Results of the objective fiber tests seemed to indicate a proportionally greater quality loss in the stripped cotton than was apparent indifferences in grade and staple. This might mean that the market price difference as established by the currect grading system does not discount the actual economic difference in spinning quality between the two methods of harvest. If a large proportion of this lower quality cotton were put on the market the price discount for it would surely increase over time as the supply of higher grades decreased in abundance. Whether or not the spinning performance of stripper harvested cotton is appreciably lower than spindle picked cotton can only be established by examining results of spinning tests.

Other Items That Should Be Considered - Future Areas of Research

An item not considered in this experiment was the possibility of lowering ground losses with stripper harvesting. Some researchers claim to lower field losses by as much as five percent with stripper harvesting. It is not known, however, if this would be true for Missouri conditions since many factors besides type of machine affect field losses, such as weather conditions, plant varieties, and machine operators. Such information would be helpful in any final evaluation of stripper harvesting and should be included in future research.

A final item not previously considered which might reduce returns from stripper harvested cotton concerns legal aspects of marketing the cottonseed after ginning. Although cottonseed is considered to be a by-product of the lint, the price paid by commercial oil mills often covers the farmer's ginning costs. Complications are introduced in the case of chemically desiccated stripped cotton by a law enforced by the Federal Food and Drug Administration controlling the use of agricultural chemicals. The law allows only certain chemicals to be used as preharvest desiccants and prohibits the sale of the ginned cottonseed for food, feed or oil purposes for many of these. The specific rulings on the use of the various chemical materials change from year to year making it hard to predict whether the future rulings on these particular chemicals will become more lax or strict. At any rate, the possible loss in revenue because of legal restrictions on the sale of ginned cottonseed would represent a sizable loss to the farmer.

CONCLUSIONS

Final evaluation of the use of mechanical strippers to harvest cotton in Missouri will be reserved for a later publication. This experiment has shown that it is possible to harvest both open boll and special stripper cotton varieties under Missouri conditions. However, certain problems and drawbacks presented themselves. For example, in the initial year of the study unfavorable weather conditions were partly responsible for not being able to harvest any cotton with the mechanical stripper. This might recur in future years.

A second drawback of stripper harvesting indicated by this study is that ginning costs would almost certainly be increased over those for spindle picked cotton. This would be caused by increased rates charged by ginners due to the cotton being trashier and harder to gin and to a lower percentage lint turnout resulting from the extra foreign matter.

Results also indicate a definite decrease in lint quality with both grade and staple determinations and the objective fiber tests. The objective fiber test data seem to indicate a greater quality difference than is discounted by grade and staple.

Whether or not these drawbacks will offset the savings gained in harvesting cost will depend upon the individual producer, his cost relationships, and the size of his operation.