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August 1972

To the Graduate Council:

I am submitting herewith a thesis written by Charles D. Griggs entitled "Analysis of Cotton Production Cost: Tennessee, 1969." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements of the degree of Master of Science, with a major in Agricultural Economics.

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Major Professor

We have read this thesis and recommend its acceptance:

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Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

# ANALYSIS OF COTTON PRODUCTION COST: TENNESSEE, 1969

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A Thesis

Presented to

the Graduate Council of

The University of Tennessee

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Charles D. Griggs

August 1972

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# ABSTRACT

This study was concerned with the cost per unit of production of cotton in Tennessee. The objectives were: (a) to determine the cost of production for a sample of fields in Tennessee in 1969, and (b) to explain the variation in the cost of production among this sample of fields.

The data for the study were obtained from the records kept by 83 cotton producers on 183 fields in West and Middle Tennessee during 1969.

The average total cost per acre was \$131.17, and the total cost per pound of lint averaged 21.53 cents. The gross returns averaged \$152.07 per acre, and the net returns averaged \$20.90 per acre.

There was an inverse relationship between pounds of lint produced per acre and cost per pound of lint; that is, as the yield of lint per acre increased the cost of producing a pound of lint decreased. The correlation coefficient between these two variables, cost and lint, was -.73.

Statistical testing indicated that the fields with a low production cost, 18.5 cents or less per pound of lint, were significantly larger, produced a significantly higher lint yield per acre, and had a significantly lower cost per pound of lint than the fields with a high cost, 30 cents or more, per pound of lint. However, the average total cost per acre was not statistically different between the two cost categories.

Two regression analyses were used to ascertain any relationship between cost per pound of lint and qualitative variables and yield of lint cotton per acre and input variables. The results of the two regression analyses explained a small proportion of the variation in cost per pound of lint cotton and yield of cotton per acre.

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# CHAPTER I

## INTRODUCTION

Man's use of cotton as a fiber has been dated to 3000 B.C. from parts of cloth uncovered in archaeological excavations in West Pakistan (3, p. 1).

Before the saw cotton gin was invented in 1773, lint was separated from the seed by hand or by a crude roller type gin. This was a laborious and time consuming task. Because of the large amount of labor necessary to separate the lint from the seed, most of the cotton grown during this time was for home use (3, p. 17).

In 1793 Eli Whitney invented the saw cotton gin making it less costly to process upland cotton and, therefore, made it a profitable commercial crop to produce (6, p. 8). From 1793 to the Civil War cotton production in the United States increased approximately 1100 times or "from a 4,000 bale crop to a 4,500,000 bale crop" (6, p. 8).

Brown and Ware estimated that in the late 1700's the composition of the world textile market was: cotton four percent, flax 18 percent, and wool 78 percent (3, p. 18). By 1890 cotton accounted for 78.6 percent of the total fiber consumption, wool and flax 21.1 percent and silk 0.3 percent. From 1924 to 1928 cotton had increased to 84.2 percent of the total textile fiber, wool and flax dropped to 13.5 percent, silk increased to 0.7 percent, and rayon, a synthetic, 1.6 percent. In 1948 the figures were: cotton 72.6 percent, wool and flax 15.4 percent, silk 0.2 percent, and rayon 11.8 percent (3, p. 18). By 1968 cotton had declined to 56.9 percent and synthetics had increased to 36.2 percent of the fiber consumption in the world (23, p. 7).

The gross farm income recieved from cotton was the third highest of all cash crops in Tennessee in 1969. Only Tobacco and Soybeans were higher (22, p. 8). Cotton is of particular importance to West Tennessee. In 1969 the 26 western most Tennessee counties had 96 percent of the total cotton acreage in the state and produced 97.5 percent of the total production (22, p. 59). Figure 1 shows the estimated acreage of cotton harvested by county for 1969. In 1969 an estimated 400,000 acres of cotton were harvested in Tennessee. The estimated farm dollar value of lint and cottonseed was $51,810,000 (22, p. 14). Table I shows the acres planted, acres harvested, production, and the combined farm dollar value of lint and cottonseed from 1960 through 1969. From 1960 through 1965 the farm dollar value of cotton exceeded one million dollars each year. During 1966, 1967 and 1968 the farm dollar value was $50,470,000, $24,085,000 and $46,021,000, respectively. An explanation of the decline in farm dollar value in 1966, 1967, 1968 and 1969 is the change in the price support program that went into effect for the 1966 crop.[1] The 1967 value also reflects a poor crop year.

Cotton makes a contribution to the economy beyond the value of the cotton itself by providing jobs in processing raw cotton into consumer goods. "For every $1.00 worth of cotton which the farmer produces,

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[1]The method of supporting cotton was changed from supporting the price per pound to a much lower price per pound with a direct payment being made to the farmer based on yield history.

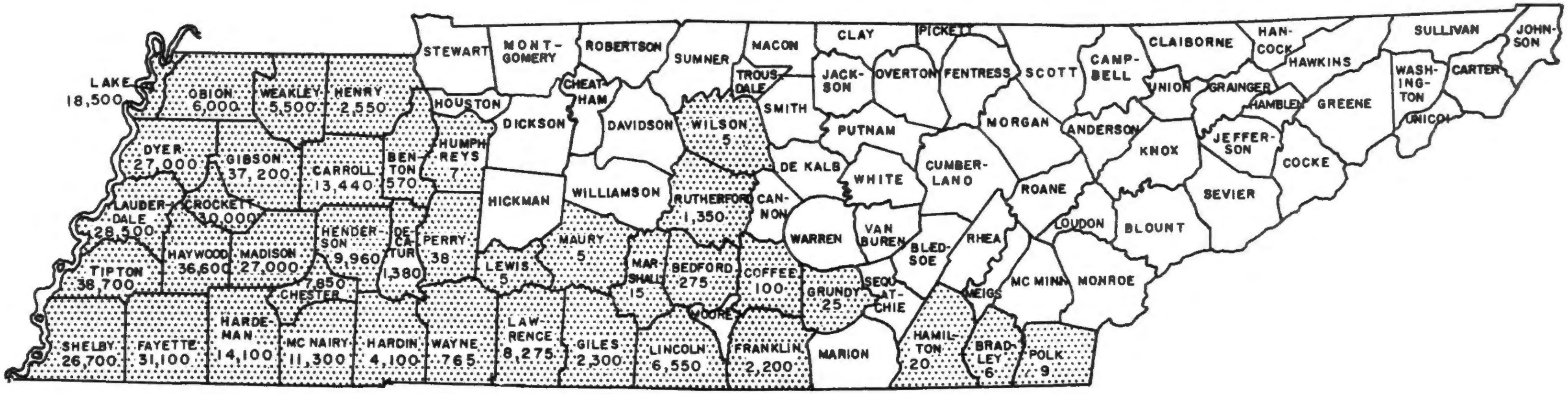


Figure 1. Counties in which cotton was grown and the estimated acres harvested in these counties, 1969.

Source: United States Department of Agriculture and Tennessee Department of Agriculture. Tennessee Agricultural Statistics Annual Bulletin, 1970. Bulletin T-7. Nashville, Tennessee: Tennessee Crop Reporting Service, 1970.

TABLE I

THE ACRES PLANTED, ACRES HARVESTED, POUNDS OF LINT PER ACRE, NUMBER OF 500 POUND BALES, AND THE COMBINED VALUE OF LINT AND COTTONSEED, TENNESSEE, 1960-1969

| Year | Acres Planted | Acres Harvested | Lint Per Harvested Acre | Bales[a] | Combined Value Lint and Cottonseed Thousand of Dollars |
|---|---|---|---|---|---|
| 1960 | 525,000 | 512,000 | 545 | 583,000 | 101,437 |
| 1961 | 557,000 | 538,000 | 493 | 554,000 | 106,074 |
| 1962 | 553,000 | 538,000 | 494 | 555,000 | 101,542 |
| 1963 | 515,000 | 504,000 | 621 | 654,000 | 122,526 |
| 1964 | 512,000 | 502,000 | 640 | 671,000 | 114,498 |
| 1965 | 507,000 | 499,000 | 611 | 637,000 | 104,261 |
| 1966 | 398,000 | 365,000 | 475 | 363,000 | 50,470[b] |
| 1967 | 336,000 | 236,000 | 295 | 145,000 | 24,085[b] |
| 1968 | 394,000 | 360,000 | 432 | 325,000 | 45,972[b] |
| 1969 | 420,000 | 400,000 | 505 | 422,000 | 51,810[b] |

Source: United States Department of Agriculture and Tennessee Department of Agriculture. Tennessee Agricultural Statistics Annual Bulletin, 1970. Bulletin T-7 (Nashville, Tennessee: Tennessee Crop Reporting Service, 1970); and United States Department of Agriculture, Agricultural Stabilization and Conservation Service. Tennessee 1966, 1967, 1968 and 1969 Annual Report (Nashville, Tennessee).

[a]Gross weight = 500 pounds; Net weight = 480 pounds lint.

[b]The total diversion and price support direct government payments to farmers in Tennessee for these years were $33,134,458, $41,537,687, $33,898,703, and $34,045,803, respectively.

$9.00 additional income is generated by adding time, form, and space utility to the raw material before it reaches the final consumer" (10, p. 4).

## II. SITUATION

Although cotton is still a major fiber, it faces strong competition from man-made fibers (2, p. 10). The per capita consumption of cotton in the United States in 1930 was 20.0 pounds. The total per capita consumption of all fibers, excluding flax and silk, was 22.7 cotton equivalent pounds[2] (28, p. 14). The estimated per capita consumption of cotton in 1969 was 20.6 pounds. The estimated total per capita comsumption of all fibers, excluding flax and silk, was 65.8 cotton equivalent pounds (21, p. 7). Although total fiber consumption almost tripled between 1930 and 1969, the per capita consumption of cotton remained about the same.

Production of blends, a fabric made from both cotton and synthetic fiber, is increasing (1, p. 14). In 1960 only 2.4 percent of the active cotton system spindles in the United States were using blends. By 1969 24.6 percent of the United States cotton system spindles were using blends (4, p. 9). The cotton that goes into these blends is generally of higher quality and longer staple than cotton in 100 percent cotton fabrics (1, p. 14).

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[2]Cotton equivalent pounds means the amount of cotton that would be used if all fibers were made from cotton.

## III. THE PROBLEM

A problem faced by cotton farmers in Tennessee was the high unit cost of production relative to price received which resulted in an unfavorable competitive position relative to man-made fibers.

## IV. OBJECTIVES

The objectives of this study were twofold: (a) To determine the cost of cotton production for a sample of fields in Tennessee in 1969, and (b) to explain the variation in the cost of cotton production among this sample of fields.

## V. DATA

The data for the study were obtained from records kept by 83 Tennessee cotton farmers on 183 fields. The number of fields per farmer was as followes: 45 farmers had 1 field, 14 farmers had 2 fields, 7 farmers had 3 fields, 6 farmers had 4 fields, 4 farmers had 5 fields, 5 farmers had 6 fields, 1 farmer had 7 fields, and 1 farmer had 8 fields. The farmers were selected by an associate extension agronomist with the help of various county agents. The selected farmers did not represent a random sample. They were selected because they agreed to cooperate by keeping the records and follow certain suggested practices.

Each farmer in the study recorded the cost of inputs, returns, and production practices for each field in a standardized record book, which also contained soil test information, yield, and soil series.

The study area included the following counties: Carroll, Chester, Crockett, Decatur, Dyer, Fayette, Gibson, Hardeman, Hardin, Haywood, Henry, Henderson, Lake, Lauderdale, McNairy, Madison, Obion, Shelby, Tiption, Bedford, Franklin, Lawrence, Lincoln, and Rutherford (Figure 2).

## VI. PROCEDURE

The analysis for objective (a) was to determine the averages of costs and returns for the sample of fields in the study. The analysis for objective (b) was done with three procedures: (a) The input levels on the highest cost and lowest cost fields were tested for statistical differences to determine if there were differences in the allocation of various inputs between the sample categories. (b) Production cost per pound of lint was regressed on various qualitative variables to attempt to explain the variation in costs. (c) Since increased yields would tend to lower production costs, yield was regressed on input levels.

## VII. REVIEW OF RELATED LITERATURE

T. R. Starbird and B. L. French, in a national study on the cost of producing upland cotton, found the "total cost of producing the U. S. crop of upland cotton in 1966 was 26.6 cents per pound of lint"; in 1965 the cost was 27.3 cents per pound of lint; and in 1964 it was 28.4 cents per pound of lint (16, p. 10).

A 1965 Georgia study conducted by Neil R. Martin, Jr., James E. Nix, W. E. McArthur and S. J. Brannen on a sample of farms in the

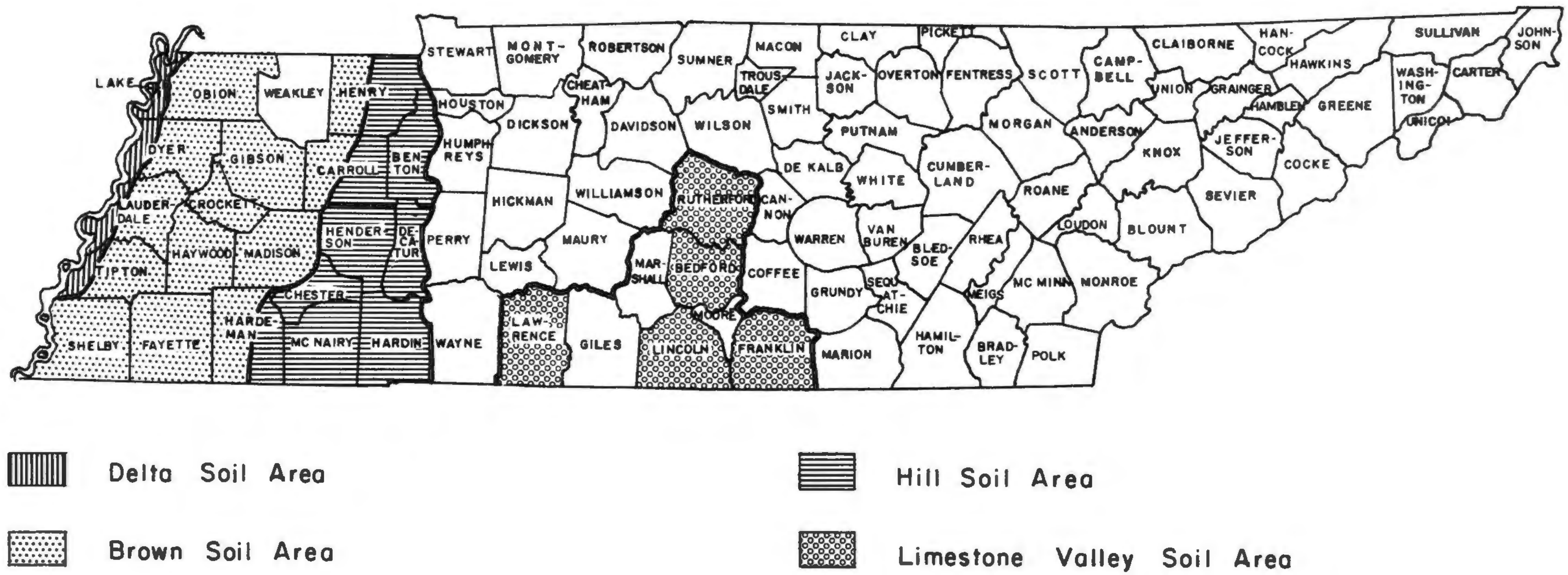


Figure 2. Area included in cotton study, 1969.

Southeastern Coastal plains showed production cost, excluding management and general overhead, to average 21.8 cents per pound of lint for small farms which had a 701.4 pound lint yeild per acre, 19.5 cents per pound of lint for medium size farms which had a yeild of 701.0 pounds of lint per acre, and 19.1 cents per pound of lint for the larger farms which had a yield of 662.8 pounds of lint per acre. The average production cost for all farms in the study area was 19.5 cents per pound of lint and the average yield was 682 pounds of lint per acre (12).

Another study by Martin, et al., using the same procedure and conducted in the Southwestern Costal plains of Georgia, showed total production costs to be 22.5 cents per pound of lint for the small farms which had a lint yield of 989.4 pounds per acre, 21.1 cents per pound of lint on the medium sized farms which had a lint yield of 787.4 pounds per acre, and 21.2 cents per pound of lint on the large size farms which had a lint yield of 736.4 pounds per acre (13). "Labor, power and machinery, fertilizer, insecticides, and ginning cost constituted the major cost items. Each of these items accounted for more than 10 percent of total costs in both areas" (13, p. 9).

A study by James E. Jackson and J. E. Jernigan ascertained that it cost Georgia farmers approximately 25 cents per pound of lint when a yield of 400-500 pounds of lint per acre was produced, 21 cents per pound of lint when a yield of 550-650 pounds of lint per acre was produced and 18 cents per pound of lint when a yield of 750 pounds of lint per acre was produced (11).

Glenn Glover found that for a sample of 390 innovator cotton farmers in Tennessee the average lint yield was 615 pounds per acre, and the average cost of production was 21 cents per pound of lint and cottonseed[3] (8, p. 73). Glover, also found that for a sample of 220 average cotton farmers the average lint yield was 616 pounds per acre, and the average cost of production was 31 cents per pound of lint (8, p. 74).

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[3]The cotton as harvested by the farmer has not been separated into lint and seed and is known as seed cotton. Roughly 40 percent of the total weight is lint and 60 percent is cottonseed. After the lint and cottonseed are separated, lint accounted for approximately 88 percent of the value and cottonseed 12 percent of the value based on average prices received by farmers for the crop years 1960-61 through 1969-70. In this study the value of the cottonseed has been added to the value of the lint and throughout the remaineder of this study the word lint means the value of the lint plus the value of the cottonseed for simplicity.

# CHAPTER II

## AVERAGE COSTS AND RETURNS PER ACRE OF COTTON FOR 183 FIELDS ON 83 TENNESSEE FARMS IN 1969[4]

The first objective of this study was to ascertain the cost of production for a sample of fields in Tennessee in 1969.

### I. PROCEDURE FOR ESTIMATING COST

The average production costs and returns for the 83 farms participating in the study are shown in Table II. There were 4,074 acres in the 183 fields. Each field was treated as a separate observation. The averages in Table II are weighted averages; that is, each item was weighted according to field size.

The direct or out-of-pocket cost items, seed, lime, fertilizer, chemicals, hired labor, custom work, and ginning cost, were as stated in the farmer's record book. The exception was lime cost which was prorated over four years. Direct costs for oil, fuel, and equipment repairs were included with the indirect power and equipment cost.

Several farmers traded their cottonseed for ginning without knowing the poundage or the value of the cottonseed. For these the tonage of cottonseed was estimated by multiplying the pounds of lint by 1.6 and dividing by 2,000 (17). The dollar value was estimated from the

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[4]A progress report was based on data in this study reported by Larry L. Bauer, Charles Griggs, and Haywood W. Luck in "Cotton Production Costs and Returns in Tennessee, 1969." Tennessee Farm and Home Science Progress Report Number 75, July, August, September, 1970.

TABLE II

AVERAGE COST AND RETURNS PER ACRE OF COTTON FOR 183 FIELDS ON 83 TENNESSEE FARMS IN 1969[a]

| Item | Average Per Acre | Percent of Total |
|---|---|---|
| | Dollars | Percent |
| Expenses | | |
| Seed | 3.46 | 2.6 |
| Lime | 1.44 | 1.1 |
| Fertilizer | 12.90 | 9.8 |
| Preherbicide | 3.32 | 2.5 |
| Post-herbicide | 1.33 | 1.0 |
| Lay-by herbicide | .51 | .4 |
| Insecticide - early | 1.07 | .8 |
| Insecticide - late | 1.24 | 1.0 |
| Defoliant - desiccant | .46 | .4 |
| Hired labor | 9.21 | 7.0 |
| Ginning-bagging-ties[c] | 24.17 | 18.4 |
| Custom work | 8.45 | 6.5 |
| Total direct cost | 67.56 | 51.5 |
| Land owned | 18.32 | 14.0 |
| Rented land | 12.37 | 9.4 |
| Interest | 1.37 | 1.0 |
| Power and equipment | 28.66 | 21.9 |
| Operator and family labor | 2.89 | 2.2 |
| Total indirect cost | 63.61 | 48.5 |
| Total cost | 131.17 | 100.0 |
| Income[b] | 152.07 | — |
| Net return | 20.90 | — |

[a]The information in this table was reported by: Bauer, Larry L., Charles Griggs, and Haywood Luck in "Cotton Production Costs and Returns in Tennessee, 1969," Tennessee Farm and Home-Science Progress Report Number 75, July, August, September, 1970.

[b]Does not include government payments.

[c]Includes $1.00 per bale promotion charge or approximately $1.27 per acre.

appropriate issue of the Cottonseed Review (18). An average price of $40.00 per ton was used in the cases where the sale date could not be established.

The land charge for those who owned land included a property tax charge of $1.00 per acre plus six percent of the value of the land and the associated cotton allotment. The estimated values for the different soil acres (Figure 2, p. 8) were $500.00 per acre for Delta Soil, $400.00 per acre for Brown Soil, $400.00 per acre for Limestone Valley Soil, and $250.00 per acre for Hill Soil. These data were based on work by Glenn Glover (10, p. 8); however, they were adjusted to reflect an increase in land values. The $150.00 value for the cotton allotment was based on work by Keller and Trevena (12, p. 34). The estimated land with allotment charge for each land area, based on this procedure, was $40.00 per acre for Delta Soil, $34.00 per acre for both Brown Soil and Limestone Valley Soil, and $25.00 per acre for Hill Soil. Although there were variations in land values in each soil area, the values were believed to reflect an approximate average.

Power and equipment charges were based on a study by Glover in which fixed and variable cost were estimated for equipment used in cotton production (9, pp. 22-32). The equipment charges were estimated as follows: (a) The horsepower of the tractor was determined from the Tractor and Farm Equipment Guide (14). (b) The fixed cost per hour was estimated by dividing the total hours the equipment was used annually for all enterprises into the annual fixed cost for the equipment as estimated by Glover (9). (c) The total fixed cost was estimated by multiplying the fixed cost per hour obtained in step b by the hours used in the cotton enterprise as indicated in the respective farmer's record book. (d) The total variable cost was estimated by multiplying the hours the equipment was used in cotton by the estimated power and machinery variable cost per hour from Glover's work (9). Total fixed cost and total variable cost were added together to arrive at the total cost of machinery for cotton. This figure included cost of oil, gas, and repairs. Only variable cost were charged when tractors were known to be old enough to be fully depreciated. The known cases of farmers buying damaged equipment and repairing it at a cost lower than market price were taken into consideration.

For the cases in which cost could not be estimated from Glover's work, a custom rate as reported by Cooper and Keller was used (5).

Operator and family labor was charged $1.18 per hour as reported in the USDA publication Farm Labor (19, p. 10).

The interest charge was eight percent per year of the total direct cost excluding ginning and picking (15). Interest on ginning and picking cost was excluded because these costs came at the end of the season. Interest was charged for only six months on the interest bearing direct cost because the money was invested in cotton production for only about six months.

## II. AVERAGE RETURNS AND COST PER ACRE

Gross returns from cotton, excluding government payment, averaged $152.07 per acre on the 83 farms in the study in 1969. The average yield per acre was 609.0 pounds of lint. The average net return, to land, operator and family labor, and management was $42.11 per acre, excluding government payment. This figure does not reflect any charge for land or operator and family labor. If the land charge of $18.32 is made, the return to operator and family labor and management was $23.79 per acre. When the $2.89 per acre charge for operator and family labor is also made, the return to management was $20.90.

The total cost per acre averaged $131.17. The total cost per pound of lint averaged 21.53 cents. This cost was almost evenly divided between direct and indirect cost, 51.5 percent and 48.5 percent, respectively. Five items accounted for 73.5 percent of the total cost: fertilizer, 9.8 percent; ginning-bagging-ties, 18.4 percent; land, 14.0 percent; rent, 9.4 percent; and power and equipment, 21.0 percent.

The average per acre expenditures as shown in Tabble II, page 12, were as follows: seed, $3.48; lime, $1.44; fertilizer, $12.90; herbicides, $5.16; insecticides, $2.31; defoliant-desiccant, $.46; hired labor, $9.21; ginning-bagging-ties, $24.17; land, $18.32; rent, $12.37; interest, $1.37; power and equipment, $28.66; and operator and family labor, $2.89.

## III. DISTRIBUTION BY YIELD AND COST PER POUND OF LINT

There was a strong inverse relationship between pounds of lint per acre produced and cost per pound of lint; that is, as the yield of lint per acre increased, the cost of producing a pound of lint decreased. The correlation coefficient between these two variables was -.73.

As shown in Table III, all the fields producing more than 700 pounds of lint per acre had a production cost of less than 23 cents per pound of lint. Those with a yield of 900 or more pounds of lint per acre had a production cost of 20 cents or less per pound of lint. In the 801-900 pounds of lint per acre range, 75 percent of the fields had a production cost under 20 cents per pound of lint. When 701-800 pounds of lint was produced per acre, 63.63 percent of the fields had a production cost under 20 cents per pound of lint. Thirty-two and one-half percent of the fields producing 601-700 pounds of lint per acre had a production cost under 20 cents per pound of lint. Only 17.14 percent of the fields producing 501-600 pounds of lint per acre had a production cost under 20 cents per pound of lint.

A total of 48 fields or 26.2 percent produced a pound of lint under 20 cents.

There were no fields producing 500 pounds or less of lint per acre with a production cost under 20 cents per pound of lint.

TABLE III

DISTRIBUTION BY YIELD AND PRODUCTION COST PER POUND OF LINT COTTON
FOR 183 FIELDS IN TENNESSEE 1969

| Pound of Lint Per Acre | Cost Per Pound of Lint | | | | | | | | | | | | | | | | | | | Accumulative Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Below 15 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Over 31 | Total | |
| 1001-1100 | | | | | | 1 | | | | | | | | | | | | | | 1 | |
| 901-1000 | 1 | | | 1 | 1 | 2 | | | | | | | | | | | | | | 5 | 6 |
| 801-900 | | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | | | | | | | | | | | 12 | 18 |
| 701-800 | 2 | 2 | 1 | 1 | 6 | 2 | | 4 | 4 | | | | | | | | | | | 22 | 40 |
| 601-700 | | | 2 | 2 | 6 | 3 | 4 | 7 | 5 | 4 | 2 | 3 | 1 | | | 1 | | | | 40 | 80 |
| 501-600 | | | | | 5 | 1 | 2 | 2 | 9 | 5 | 3 | 3 | 3 | 1 | 1 | | | | | 35 | 115 |
| 401-500 | | | | | | | 1 | 3 | 6 | 3 | 4 | 4 | 1 | 2 | 2 | 1 | 2 | 1 | 10 | 40 | 155 |
| 301-400 | | | | | | | | | | | | 1 | 3 | 3 | 2 | 4 | 3 | | 7 | 23 | 178 |
| 200-300 | | | | | | | | | | | | 1 | | | | | | | 4 | 5 | 183 |
| Totals | 3 | 4 | 6 | 5 | 20 | 10 | 8 | 17 | 25 | 12 | 9 | 12 | 8 | 6 | 5 | 6 | 5 | 1 | 21 | 183 | |
| Accumulative Total | | 7 | 13 | 18 | 48 | 58 | 66 | 83 | 108 | 120 | 129 | 131 | 139 | 145 | 150 | 156 | 161 | 162 | 183 | | |

# CHAPTER III

## ANALYSIS TO ASCERTAIN WAYS TO REDUCE THE PER UNIT COST OF PRODUCING COTTON

The second objective of this study was to ascertain ways to reduce the per unit cost of producing cotton. Three procedures were used to accomplish this objective: (a) statistical comparison of low cost fields and high cost fields, (b) regressing average total cost per pound of lint on qualitative variables, and (c) regressing average lint yield per acre on inputs and qualitative variables.

### I. STATISTICAL COMPARISON OF LOW COST FIELDS AND HIGH COST FIELDS

The fields were divided on the basis of total cost per pound of lint. The 24 low cost fields had a production cost per pound of lint of 18.5 cents or less. The 27 high cost fields had a production cost per pound of lint of 30.0 cents or more. The 18.5 and 30.0 cent levels were chosen because it was believed if cotton could be produced for 18.5 cents per pound of lint, the farmer could make the necessary net profit needed for an adequate income without government payment. At the 30.0 cents cost per pound of lint level it would be difficult for the farmer to continue in business even with a government payment.

The average lint yield per acre, average field size, average total cost per acre, average total cost per pound of lint, average gross returns per acre, and average gross return per pound of lint for the low cost and the high cost fields are shown in Table IV. The average expenditures per acre for various input items are shown in Table V.

To test if each of the means in Tables IV and V were different for the two categories, a pooled, one tail t test was used to test the null hypothesis that the means of the two categories were equal. The formula used was (7, p. 268):

$$t = \frac{\bar{X}_1 - \bar{X}_2 - \sigma}{\sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}} \cdot \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where: $\bar{X}_1$ = estimated mean of low cost fields

$\bar{X}_2$ = estimated mean of high cost fields

$\sigma$ = hypothesized difference in turn means, 0 in our hypothesis

$N_1$ = number of observation in low cost fields

$S_1^2$ = estimated variance of low cost fields

$N_2$ = number of observation in high cost fields

$S_2^2$ = estimated variance of high cost fields

The alternative hypothesis for those cases in Table IV was the low cost fields had a greater mean for: pounds of lint per acre, field size, gross return per acre, and gross return per pound of lint than the high cost fields and a smaller mean for total cost per acre, and total cost per pound of lint.

The alternative hypothesis for those cases in Table V was the low cost fields had a greater mean for: ginning-bagging-ties,

TABLE IV

AVERAGE YIELD, FIELD SIZE, TOTAL COST, AND RETURNS FOR LOW AND HIGH COST FIELDS, 1969, TENNESSEE[a]

| Item | Cost Per Pound of Lint 18.5¢ or Less (Low Cost Fields) Averages (n = 24) | Standard Deviation | Cost Per Pound of Lint 30.0¢ or More (High Cost Fields) Averages (n = 27) | Standard Deviation | Pooled t Value | Significance Level, One Tail Test (Percent) |
|---|---|---|---|---|---|---|
| Pounds of lint/acre | 767.6 | 105.5 | 386.1 | 70.66 | 15.1090 | ≥ 5 |
| Acre/field | 20.86 | 14.21 | 12.65 | 10.63 | 2.3219 | ≥ 5 |
| Total cost/acre | 128.60 | 18.20 | 136.40 | 23.18 | 1.3146 | NS |
| Total cost/pound lint | .168 | .01278 | .3597 | .06347 | 14.5108 | ≥ 5 |
| Gross returns/acre | $185.40 | 28.61 | $92.10 | 92.10 | 13.4424 | ≥ 5 |
| Gross return/pound lint | .2412 | .01292 | .2376 | .01877 | .788264 | NS |

[a]These are simple averages per acre.

TABLE V

AVERAGE COST OF INPUTS PER ACRE OF COTTON LOW AND HIGH COST FIELDS, 1969, TENNESSEE[a]

| Item | Average Cost Per Acre 18.5¢ or Less (Low Cost Fields) Dollars (n = 24) | Standard Deviation | Average Cost Per Acre 30.0¢ or More (High Cost Fields) Dollars (n = 27) | Standard Deviation | Pooled t Value | Significance Level, One Tail Test (Percent) |
|---|---|---|---|---|---|---|
| Seed | 3.348 | 1.911 | 3.378 | 1.523 | .0615 | NS |
| Lime | 1.430 | 1.055 | 1.819 | 1.238 | -1.1897 | NS |
| Fertilizer | 11.760 | 3.470 | 15.730 | 4.135 | -3.6575 | ≥ 5 |
| Preherbicide | 3.328 | 1.527 | 3.682 | 2.068 | - .6832 | NS |
| Postherbicide | .890 | 1.175 | 1.049 | 1.751 | - .3746 | NS |
| Lay-by herbicide | .000 | .000 | .546 | 1.327 | -2.0149 | ≥ 5 |
| Insecticide - early | 1.360 | 1.805 | .987 | 1.034 | .9031 | NS |
| Insecticide - late | .637 | 1.350 | 1.545 | 2.937 | -1.3836 | NS |
| Defoliant | .000 | .000 | .276 | .863 | -1.5644 | NS |
| Hired labor | 4.738 | 3.895 | 6.201 | 9.185 | - .7465 | NS |
| Genning-bagging-ties | 26.360 | 6.029 | 14.340 | 4.091 | 8.2944 | ≥ 5 |
| Custom work | 6.310 | 17.360 | 10.790 | 13.800 | -1.0132 | NS |
| Research, promotion, storage and other | 3.091 | 1.463 | 1.855 | 1.272 | 3.1905 | ≥ 5 |

TABLE V (continued)

| Item | Average Cost Per Acre 18.5¢ or Less (Low Cost Fields) Dollars (n = 24) | Standard Deviation | Average Cost Per Acre 30.0¢ or More (High Cost Fields) Dollars (n = 27) | Standard Deviation | Pooled t Value | Significance Level, One Tail Test (Percent) |
|---|---|---|---|---|---|---|
| Land owned | 16.250 | 16.780 | 23.310 | 18.170 | -1.4232 | NS |
| Land rented | 15.710 | 17.830 | 9.803 | 15.530 | 1.2501 | NS |
| Interest | 1.076 | 0.198 | 1.378 | 0.410 | -3.2671 | ≥ 5 |
| Power and equipment | 28.830 | 9.723 | 33.240 | 20.730 | - .9491 | NS |
| Operator and family labor | 3.444 | 3.730 | 6.385 | 3.755 | -2.7726 | ≥ 5 |

[a]These are simple averages per acre.

research, promotions, storage, and other charges; early insecticide and land rented than the high cost fields and a smaller mean for: seed, lime, fertilizer, preherbicide, post-herbicide, lay-by herbicied, late insecticide, defoliant, hired labor, custom work land owned, interest, power and equipment, and operator and family labor then the high cost field.

The testing of the means in Table IV, page 21, indicates that the producers with the low cost fields had a higher average lint yield, larger field size, higher gross return per acre, and lower production cost per pound of lint. As shown in Table IV these differences were highly significant. There was no significant difference in total cost per acre or gross return per pound of lint between the low cost fields and the high cost fields; therefore, the significant difference in yields can at least partially be attributed to the different ways resources were allocated.

The means of the input variables for the low cost fields and the high cost fields are shown in Table V, page 22. The null hypothesis was rejected at the 5 percent level for average fertilizer cost per acre; ginning-bagging-ties cost per acre; research, promotion, storage and other charges per acre; interest cost per acre; and operator and family labor. Therefore, the producers with the high cost fields had a higher per acre expenditure for fertilizer, lay-by herbicide, interest, and operator and family labor. The reason the low cost producers had a lower interest charge was because they spent less on those items for which an interest charge was made.

The higher ginning-bagging-ties and research and promotion charge for the producers with the low cost fields reflects the larger lint yield per acre, that is, the charges were made by the bale and were thus a function of yield; therefore, the producer had no control over the charges on a per pound basis.

The producers with the high cost fields spent more on fertilizer and lay-by herbicide than the producer with the low cost fields but did not produce the yields as the producer with the low cost fields. There was no significant difference in land cost, a measure of land productivity, between the low cost fields and the high cost fields so the yield difference could not be attributed to differences in land quality as it was assessed in this study.

## II. AVERAGE TOTAL COST PER POUND OF LINT REGRESSED ON QUALITATIVE VARIABLES

In order to ascertain statistical relationship between average total cost per pound of lint and selected qualitative variables the following regression equation was estimated:

$$Y = a + \hat{b}_1X_1 + \hat{b}_2X_2 + \hat{b}_3X_3 + \ldots + \hat{b}_{25}X_{25}$$

where: $Y$ = production cost per pound of lint

$a$ = equation constant

$\hat{b}_i$ = estimated regression coefficient for $X_1$

$X_1$ = number of operations preparing the field for planting

$X_2$ = number of times cultivated

$X_3$ = 1 if soil pH was below 6.0; otherwise 0 (this variable was deleted from the euqation to avoid singularity)

$X_4$ = 1 if soil pH was between 6.0-6.5; otherwise 0

$X_5$ = 1 if soil pH was above 6.5; otherwise 0

$X_6$ = 1 if soil tested low in phosphorus; otherwise 0 (this variable deleted from the equation to avoid singularity)

$X_7$ = 1 if soil tested medium in phosphorus; otherwise 0

$X_8$ = 1 if soil tested high in phosphorus; otherwise 0

$X_9$ = 1 if soil tested low in potassium; otherwise 0 (this variable was deleted from the equation to avoid singularity)

$X_{10}$ = 1 if soil tested medium in potassium; otherwise 0

$X_{11}$ = 1 if soil tested high in potassium; otherwise 0

$X_{12}$ = 1 if producer used preemerge herbicide; otherwise 0

$X_{13}$ = 1 if producer used postemerge herbicide; otherwise 0

$X_{14}$ = 1 if producer used lay-by herbicide; otherwise 0

$X_{15}$ = 1 if Limestone Soil Area; otherwise 0 (this variable was deleted from the equation to avoid singularity)

$X_{16}$ = 1 if Delta Soil Area; otherwise 0

$X_{17}$ = 1 if Brown Soil Area; otherwise 0

$X_{18}$ = 1 if Hill Soil Area; otherwise 0

$X_{19}$ = 1 if DPL 16 variety of seed; otherwise 0 (this variable deleted from the equation to avoid singularity)

$X_{20}$ = 1 if Stoneville 213 Variety; otherwise 0

$X_{21}$ = 1 if Dixie King Variety; otherwise 0

$X_{22}$ = 1 if Auburn M Variety; otherwise 0

$X_{23}$ = 1 if Hancocke Variety; otherwise 0

$X_{24}$ = 1 if Rex Smoothleaf Variety; otherwise 0

$X_{25}$ = 1 if other variety of seed; otherwise 0

The results of this regression are shown in Table VI.

TABLE VI

REGRESSION COEFFICIENTS AND STATISTICAL SIGNIFICANCE LEVELS FOR COST PER POUND OF LINT REGRESSED ON QUALITATIVE VARIABLES: 183 FIELDS, TENNESSEE, 1969

| | Variable | Regression Coefficient | Standard Error of Estimate | F Value | Significant Level[a] (Percent) |
|---|---|---|---|---|---|
| $X_1$ | Number of operations preparing the field for planting | -.00083522 | .0032061 | .06786 | NS |
| $X_2$ | Number of times cultivated | -.00569230 | .0044640 | 1.62600 | NS |
| $X_3$ | Soil pH below 6.0[b] | -- | -- | -- | -- |
| $X_4$ | Soil pH between 6.0-6.5 | -.00901530 | .0112620 | .64080 | NS |
| $X_5$ | Soil pH above 6.5 | .01075900 | .0148990 | .52140 | NS |
| $X_6$ | Soil tested low in phosphorus | -- | -- | -- | -- |
| $X_7$ | Soil tested medium in phosphorus | .00390640 | .0166720 | .05491 | NS |
| $X_8$ | Soil tested high in phosphorus | -.01673100 | .0166970 | 1.00400 | NS |
| $X_9$ | Soil tested low in potassium[b] | -- | -- | -- | -- |
| $X_{10}$ | Soil tested medium in potassium | .01440700 | .0153270 | .88350 | NS |
| $X_{11}$ | Soil tested high in potassium | .00937230 | .0160870 | .33940 | NS |
| $X_{12}$ | Producer used preemerge herbicide | -.07532800 | .0413760 | 3.31400 | 10 |
| $X_{13}$ | Producer used postemerge herbicide | .00489650 | .0105780 | .21430 | NS |
| $X_{14}$ | Producer used lay-by herbicide | .01662100 | .0176320 | .88860 | NS |
| $X_{15}$ | Limestone Soil Area[b] | -- | -- | -- | -- |
| $X_{16}$ | Delta Soil Area | -.04917200 | .0250480 | 3.85400 | 10 |
| $X_{17}$ | Brown Soil Area | -.03393100 | .0188800 | 3.23000 | 10 |
| $X_{18}$ | Hill Soil Area | -.03009200 | .0203340 | 2.19000 | NS |
| $X_{19}$ | DPL[b] Variety | -- | -- | -- | -- |

TABLE VI (continued)

| Variable | Regression Coefficient | Standard Error of Estimate | F Value | Significant Level[a] (Percent) |
|---|---|---|---|---|
| $X_{20}$ Stoneville 213 Variety | -.02987700 | .0183100 | 2.66300 | NS |
| $X_{21}$ Dixie King Variety | .01158500 | .0149150 | .60330 | NS |
| $X_{22}$ Auburn M Variety | .01678000 | .0158260 | 1.12400 | NS |
| $X_{23}$ Hancocke Variety | .01657900 | .0136440 | 1.47600 | NS |
| $X_{24}$ Rex Smoothleaf Variety | -.04705800 | .0292350 | 2.59100 | NS |
| $X_{25}$ Other varieties | .04372100 | .0656650 | 0.4433 | NS |
| Equation constant | | .36376 | | |
| Coefficient of determination | | .18540 | | |

[a]Probability of having a partial regression coefficient of this size when there is actually no relationship between the independent and dependent variable.

[b]Deleted from equation; used as a base for comparison.

A coefficient statistically significant at the 10 percent level means there is a 90 percent probability a relationship exists. Coefficients that were significant at the 10 percent level were considered as significant in this study.

The variables with significant coefficients were $X_{12}$, producers used preemerge herbicide, $X_{16}$, Delta Soil Area, and $X_{17}$, Brown Soil Area.

The coefficient, -.075328, for the $X_{12}$ variable indicated that on the average those producers who used preemerge herbicide produced cotton for 7.5 cents less than those producers not using preemerge herbicide.

The coefficients -.04917 and -.033931 for the $X_{16}$ and $X_{17}$ variables indicated that on the average the cost of producing a pound of lint cotton was about 5.0 cents less on Delta Soil than Limestone Valley Soil and 3.4 cents less on Brown Soil than Limestone Valley Soil. The coefficients on the soil group variables indicated that on the average cotton was produced for the least cost on Delta, followed in order by Brown, Hill, and Limestone Valley soils; however, the coefficient on Hill Soil was not significant from Limestone Valley Soil. The results of these variables were as expected.

The magnitudes of the coefficients on the remaining 17 variables in the equation were not statistically significant at the 10 percent level. The signs of the coefficients on soil pH between 6.0-6.5, soil pH above 6.5, soil testing high in $P_2O_5$, producer used postemerge herbicide, producer used lay-by herbicide, and Hill Soil were as expected. The signs of the coefficients on the variables number of operations preparing the field for planting, the number of times cultivating, soil testing medium in phosphorus, and soil testing high in potassium were opposite the expected sign. The magnitude of the coefficients on the seed variety variables indicate Rex Smoothleaf Variety had the lowest production cost per pound of lint followed by Stoneville, DPL 16, Dixie King, Hancocke, Auburn M and other seed varieties; however, none of the coefficients was statistically significant.

The regression equation was statistically significant at the 5 percent level. The coefficient of determination was .19 which implies that only 19 percent of the variation in the cost of producing a pound of lint was explained by this analysis.

## III. YIELD OF LINT COTTON PER ACRE REGRESSED ON INPUT AND QUALITATIVE VARIABLES

The correlation coefficient between cost per pound of lint and lint yield per acre was -.73, indicating one way to reduce the production cost per pound of lint would be to increase lint yield per acre. To ascertain the relationship between lint yield per acre and inputs, the following regression analysis was performed:

$$Y = \hat{a} + \hat{b}_1X_1 + \hat{b}_2X_2 + \hat{b}_3X_3 + \ldots + \hat{b}_{33}X_{33}$$

where: $Y$ = pounds of lint cotton per acre

$\hat{a}$ = equation constant

$\hat{b}_i$ = estimated regression coefficient for $X_i$

$X_1$ = number of operations preparing the field for planting

$X_2$ = number of times cultivated

$X_3$ = 1 if soil pH was below 6.0; otherwise 0

$X_4$ = 1 if soil pH was between 6.0-6.5; otherwise 0 (this variable was deleted from the equation to avoid singularity)

$X_5$ = 1 if soil pH was above 6.5; otherwise 0

$X_6$ = 1 if soil tested low in phosphorus; otherwise 0

$X_7$ = 1 if soil tested medium in phosphorus; otherwise 0 (this variable deleted from the equation to avoid singularity)

$X_8$ = 1 if soil tested high in phosphorus; otherwise 0

$X_9$ = 1 if soil tested low in potassium; otherwise 0

$X_{10}$ = 1 if soil tested medium in potassium; otherwise 0 (this variable deleted from the equation to avoid singularity)

$X_{11}$ = 1 if soil tested high in potassium; otherwise 0

$X_{12}$ = 1 if producer used preemerge herbicide; otherwise 0

$X_{13}$ = 1 if producer used postemerge herbicide; otherwise 0

$X_{14}$ = 1 if producer used lay-by herbicide; otherwise 0

$X_{15}$ = 1 if Delta Soil; otherwise 0

$X_{16}$ = 1 if Hill Soil; otherwise 0

$X_{17}$ = 1 if Limestone Valley Soil; otherwise 0

$X_{18}$ = 1 if Brown Soil; otherwise 0 (this variable was deleted from the equation to avoid singularity)

$X_{19}$ = 1 if Stoneville 213 Variety of seed; otherwise 0

$X_{20}$ = 1 if Dixie King Variety; otherwise 0

$X_{21}$ = 1 if Auburn M Variety; otherwise 0

$X_{22}$ = 1 if Hancocke Variety; otherwise 0

$X_{23}$ = 1 if Rex Smoothleaf Variety; otherwise 0

$X_{24}$ = 1 if other variety; otherwise 0

$X_{25}$ = 1 if DPL 16 Variety; otherwise 0 (this variable was deleted from the equation to avoid singularity)

$X_{26}$ = 1 if the producer owned the land; otherwise 0

$X_{27}$ = 1 if the producer used seed treatment; otherwise 0

$X_{28}$ = dollar expenditure per acre on preemerge herbicide

$X_{29}$ = dollar expenditure per acre on postemerge herbicide

$X_{30}$ = dollar expenditure per acre on lay-by herbicide

$X_{31}$ = dollar expenditure per acre on early insecticide

$X_{32}$ = dollar expenditure per acre on late insecticide

$X_{33}$ = dollar expenditure per acre on defoliant

The results of this regression are shown in Table VII. Only two coefficients were statistically significant at the 5 percent level; however, five were significant at the 10 percent level. The two coefficients significant at the 5 percent level were for the variables $X_2$, number of times cultivated, and $X_{23}$, Rex Smoothleaf Variety. The five coefficients significant at the 10 percent level were for the variables $X_3$, soil pH below 6.0, $X_8$, soil tested high in phosphorus, $X_{17}$, Limestone Valley Soil, $X_{19}$, Stoneville 213 Variety, and $X_{31}$, expenditure per acre for early insecticide.

The coefficient, 25.648, for the $X_2$ variable indicated that on the average an additional cultivation would increase yield by 25 pounds of lint per acre. The number of cultivations ranged from 1 to 7. The coefficient on $X_{23}$ variable was 182.37, which implied that on the average Rex Smoothleaf Variety produced 182 pounds of lint more than the DPL Variety.

TABLE VII

REGRESSION COEFFICIENTS AND STATISTICAL SIGNIFICANCE LEVELS FOR YIELD OF LINT COTTON PER ACRE REGRESSED ON INPUTS AND QUALITATIVE VARIABLES: 183 FIELDS, TENNESSEE, 1969

| | Variable | Regression Coefficient | Standard Error of Estimate | F Value | Significant Level[a] (Percent) |
|---|---|---|---|---|---|
| $X_1$ | Number of operations preparing the field for planting | 5.9854 | 8.3169 | .51790 | NS |
| $X_2$ | Number of times cultivated | 25.6480 | 11.5060 | 4.96900 | 5 |
| $X_3$ | Soil pH below 6.0 | -51.5190 | 27.3370 | 3.55200 | 10 |
| $X_4$ | Soil pH between 6.0-6.5[b] | -- | -- | -- | -- |
| $X_5$ | Soil pH above 6.5 | -3.8463 | 35.4320 | .01178 | NS |
| $X_6$ | Soil testing low in phosphorus | -9.5552 | 41.8270 | .05219 | NS |
| $X_7$ | Soil testing medium in phosphorus[b] | -- | -- | -- | -- |
| $X_8$ | Soil testing high in phorphorus | 42.9210 | 28.5820 | 2.25500 | 10 |
| $X_9$ | Soil testing low in potassium | 31.6270 | 37.6060 | .70730 | NS |
| $X_{10}$ | Soil testing medium in potassium[b] | -- | -- | -- | -- |
| $X_{11}$ | Soil testing high in potassium | 33.7530 | 26.9030 | 1.57400 | NS |
| $X_{12}$ | Producer used preemerge herbicide | 93.9050 | 108.7400 | .74580 | NS |
| $X_{13}$ | Producer used postemerge herbicide | -43.6740 | 37.3110 | 1.37000 | NS |
| $X_{14}$ | Producer used lay-by herbicide | 58.8540 | 61.2410 | .92350 | NS |
| $X_{15}$ | Delta Soil Area | 30.0840 | 50.6450 | .35290 | NS |
| $X_{16}$ | Hill Soil Area | 15.7050 | 36.4250 | .18590 | NS |
| $X_{17}$ | Limestone Soil Area | -87.2450 | 47.8520 | 3.32400 | 10 |
| $X_{18}$ | Brown Soil Area[b] | -- | -- | -- | -- |
| $X_{19}$ | Stoneville 213 Variety | 87.3300 | 44.9600 | 3.77300 | 10 |
| $X_{20}$ | Dixie King Variety | 7.1197 | 36.4480 | .03816 | NS |

TABLE VII (continued)

| Variable | Regression Coefficient | Standard Error of Estimate | F Value | Significant Level[a] (Percent) |
| --- | --- | --- | --- | --- |
| $X_{21}$ Auburn M Variety | 7.2961 | 38.7510 | .03545 | NS |
| $X_{22}$ Hancocke Variety | -25.6520 | 33.6720 | .58030 | NS |
| $X_{23}$ Rex Smoothleaf Variety | 182.3700 | 74.2060 | 6.04000 | 5 |
| $X_{24}$ Other variety | 87.9120 | 166.5000 | .27880 | NS |
| $X_{25}$ DPL 16 Variety[b] | -- | -- | -- | -- |
| $X_{26}$ Own land | 4.1180 | 25.7750 | .02550 | NS |
| $X_{27}$ Producer used seed treatment | 21.8480 | 27.8490 | 1.30800 | NS |
| $X_{28}$ Dollar expenditure per acre on preemerge herbicide | 2.4746 | 7.4717 | .10970 | NS |
| $X_{29}$ Dollar expenditure per acre on postemerge herbicide | 19.9850 | 12.7820 | 2.44500 | NS |
| $X_{30}$ Dollar expenditure per acre on lay-by herbicide | -25.2410 | 24.2130 | 1.08700 | NS |
| $X_{31}$ Dollar expenditure per acre early insecticide | 7.9368 | 6.9093 | 1.32000 | 10 |
| $X_{32}$ Dollar expenditure per acre late insecticide | -3.0721 | 6.0793 | .25540 | NS |
| $X_{33}$ Dollar expenditure per acre defoliant | -6.7923 | 14.6530 | .21490 | NS |
| Equation constant | | 356.4800 | | |
| Coefficient of determination | | .2979 | | |

[a]Probability of having a partial regression coefficient of this size when there is actually no relationship between the independent and dependent variables.

[b]Deleted from equation; used as a base for comparison.

The coefficient, -51.519, for the $X_3$ variable indicated that soil with a pH below 6.0 produced an average of 51 pounds less lint per acre than soil with a pH between 6.0-6.5. The coefficient for the $X_8$ variable was 42.921, which indicated that soil testing high in phosphorus produced an average of 43 pounds of lint more than soil testing medium in phosphorus. The coefficient for $X_{17}$ implied that land in the Limestone Valley Soil Area produced an average of 87 pounds of lint less than land in the Brown Soil Area. The coefficient for $X_{19}$ implied that Stoneville 213 Variety produced an average of 87 pounds of lint more than the DPL 16 Variety. The coefficient for $X_{31}$ indicated that an additional dollar spent on early insecticide would increase yield by eight pounds of lint per acre.

The coefficients for 22 of the variables were not significant. The positive sign of the coefficients for $X_1$, number of operations preparing the field for planting, $X_{11}$, soil testing high in potassium, $X_{12}$, producer used preemergence herbicide, $X_{15}$, Delta Soil Area, $X_{26}$, producer owned the land, and $X_{27}$, producer used seed treatment, were positive indicating an increase in lint yield per acre. The sign of these coefficients were positive as expected. However, the positive coefficients for $X_9$, soil testing low in potassium, $X_{14}$, producer used lay-by herbicide, and $X_{16}$, Hill Soil Area, were opposite the expected. The negative signs of the coefficients for $X_3$, soil pH below 6.0, $X_5$, soil pH above 6.5, $X_6$, soil testing low in phosphorus, $X_{13}$, producer used postemerge herbicide, $X_{17}$, Limestone Valley Soil Area, $X_{28}$, cost per acre of preemerge herbicide, $X_{29}$, cost per acre of postemerge herbicide, $X_{30}$, cost per acre on lay-by herbicide, $X_{32}$, cost per acre on insecticide, late, and $X_{33}$, cost per acre of defoliant, were all negative as expected.

The coefficients for the seed varieties indicated the highest yield was obtained with Rex Smoothleaf followed in order by other seed varieties, Stoneville 213, Auburn M, Dixie King, DPL 16, and Hancocke; however, the coefficients on other seed varieties, Auburn M, Dixie King and Hancocke were not significantly different from DPL 16.

The regression equation was statistically significant at the .005 level. The coefficient of determination was 30. The variables in the regression analysis explained approximately 30 percent of the variation in lint yield.

## V. CONCLUSION

The objective to explain the variation in cost per pound of lint was not successful. The low coefficient of determination and few significant coefficients in the regression analysis of cost per pound of lint regressed on qualitative variables indicated the regression analysis explained very little of the variation in costs per pound. The regression analysis used in an effort to explain the relationship between yield of lint cotton and inputs also yielded a low coefficient of determination and few significant variables indicating limited success in explaining variation in yield.

## CHAPTER IV

## SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

### I. SUMMARY

Cotton will continue to be a major cash crop in Tennessee if it can be produced at a cost competitive with man-made fibers, and if the producers can recieve an adequate income for their investment and labor.

This study was concerned with the cost of producing a pound of lint cotton. The objectives were: (a) to determine the cost of production for a sample of fields in Tennessee in 1969, and (b) to explain the variation in the cost of production among this sample of fields.

The data for the study were obtained from the record books kept by 83 cotton producers in West and Middle Tennessee.

The analyses of the data were performed as follows: (a) the record book of each farmer was summarized to ascertain his average costs and returns and all the books were summarized to get overall averages: (b) subgroups of low cost and high cost fields were obtained and statistical tests performed to determine if any statistical differences existed between the averages of costs and returns; (c) two regression analyses were made to determine if there was any relationship between cost per pound of lint and selected qualitative variables, or between the inputs and qualitative variables and yield.

The total costs per acre averaged \$131.17, and the total cost per pound of lint averaged 21.53 cents. The gross returns averaged \$152.07 per acre, and net returns to management averaged \$20.90 per acre.

The low cost producers, those with production costs of 18.5 cents or less per pound of lint, had a significantly higher lint yield per acre, larger field size and higher net return per acre than the high cost producers, than those fields with costs of 30 cents or more per pound of lint. The low cost fields had a significantly lower cost per pound of lint compared with high cost fields. There was a statistically significant difference in lint yield per acre between the producers with the low cost fields and the high cost fields; however, there was no statistical difference in total cost per acre between the two categories.

The high cost fields had a significantly higher average per acre expenditure for fertilizer, lay-by herbicides, and operator and family labor than the low cost fields.

When the average total cost per pound of lint was regressed on selected qualitative variables to asertain if any statistical relationship existed between them, only the coefficients on three variables, producers used preemerge herbicide, Delta Soil Area, and Brown Soil Area, were significant at the 10 percent level.

The coefficient for used preemerge herbicide implied that on the average those producers who used preemerge herbicide produced cotton for 7.5 cents less than those producers who did not use preemerge herbicide. The coefficients for Delta Soil and Brown Soil implied that the average cost of producing cotton was about five cents less on Delta than on Limestone Valley Soil and 3.4 cents less on Brown Soil than Limestone Valley Soil. The regression equation explained only about 19 percent of the variation in the cost of producing a pound of lint cotton, but was significant at the five percent level.

The coefficient of determination was .53, which means that approximently 53 percent of the variation in cost per pound of lint was explained by yield per acre. Lint yield and cost per pound of lint were inversely related. The higher the lint yield per acre the lower the cost of production per pound of lint. The correlation coefficient between yield and cost per pound of lint was very high, -.7295, which implies cost per pound of lint decreases as yield per acre increases. Regression analysis was, therefore, used to try to explain the variation in yield. Two coefficients were statistically significant at the five percent level and five were significant at the 10 percent level of the 33 variables.

The implications of the significant coefficients were as follows: An additional cultivation would increase yield by about 25 pounds of lint per acre; Rex Smoothleaf Variety produced approximately 182 pounds of lint more per acre than DPL 16 and Stoneville 213 Variety produced an average of 87 pounds of lint more than the DPL 16 Variety; a soil with a pH below 6.0 produced an average of 51 pounds less lint per acre than a soil with a pH between 6.0-6.5; soil testing high in phosphorus produced an average of 43 pounds of lint more than soil testing medium in phosphorus; land in the Limestone Valley Area produced an average of 87 pounds of lint less than land in the Brown Soil Area; and an additional dollar per acre spent on early insecticide would increase yield by eight pounds of lint per acre.

The coefficient of determination was .30, which means the regression explained approximately 30 percent of the variation in yield.

The low coefficient of determination and the few significant cofficients, especially at the five percent level implies that the regression analysis exhibited limited success in explaining the variation in yield.

## II. CONCLUSIONS

The results of this study should be of some value to cotton farmers in identifying and controlling cost of production items.

The study should emphasize to the farmer and educational personnel that to reduce the cost of producing a pound of lint, yield must be increased.

There were statistically significant relationships between yield and seven items. An additional cultivation would on the average tend to increase yield. The analysis indicated Rex Smoothleaf and Stoneville 213 varieties produced on the average a higher lint yield per acre than DPL 16. The analysis indicated that a soil with a pH below 6.0 produced less than a soil with a pH between 6.0-6.5. A soil that tested high in phosphorus would on the average produce more than a soil that tested medium in phosphorus. It was indicated from the analysis that land in the Limestone Valley Area produced less than land in the Brown Soil Area, and an additional expenditure on early insecticide would increase yield.

However, the low coefficient of determination and only two variables significant at the five percent level implied that some of the variables necessary to explain the variation in yield were not included in the equation. The attempt to explain the variation in the cost of production in this study was essentially limited in its success.

One cost item, ginning-bagging-ties, needs special consideration. Few of the farmers in this study indicated that they knew the dollar value of the ginning costs. They traded the cottonseed or cottonseed plus a specified amount of money per bale for the ginning costs. The farmer may increase dollar returns, and reduce cost per pound of lint by having the ginner place money costs on ginning and selling the cottonseed at market value.

## III. SUGGESTIONS FOR FURTHER RESEARCH

Several areas in cotton production need further research and study.

Moisture data and other growing conditions need to be secured and analyzed. Additional research needs to be carried out in the area of management and ginning. Additional research and study needs to be done on testing the soil for organic content and matching the herbicide to the soil. Further study is needed on developing a program or system allowing the farmer to match the characteristics of his soil, average moisture and other growing conditions to various productions inputs to determine the most efficient allocations of inputs for optimum returns.

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# VITA

Charles D. Griggs was born in Leoma, Tennessee, on June 6, 1935, the son of Bertha and Huel Griggs. He was graduated from Loretto High School in May, 1953.

In September, 1954, he entered Tennessee Technological University, where he majored in Animal Husbandry. He was graduated from Tennessee Technological University in June, 1958, with a Bachelor of Science degree.

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