RESEARCH BULLETIN 812 AUGUST, 1962

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
ELMER R. KIEHL, *Director*

Irrigation Practices and Costs in Southeastern Missouri 1959

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(Publication authorized August 20, 1962)

COLUMBIA, MISSOURI

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SUMMARY AND CONCLUSIONS

The data for the analysis in this publication were obtained from farmers who owned or controlled irrigation equipment in Dunklin, Pemiscot, New Madrid, and Mississippi Counties. A random sample of 65 operators was selected from a population of 186 farmers who were known to have irrigating equipment.

Wells were the major source of irrigation water. Seventy-seven percent of the farmers from whom data were obtained used wells exclusively, 18 percent used a combination of wells and drainage ditches, and 5 percent used drainage ditches exclusively.

Sprinkler systems were the major method of distributing water. Three different types were used. Fifty-four percent used the portable pipe and sprinkler system exclusively. Eleven percent used the giant sprinkler system, and 9 percent used the trailer boom method

Two methods of surface irrigation were used in the area. Fifteen of the 17 percent in this group used gated pipe and 2 percent used ditches and furrows.

Twenty-six percent of the farmers from whom data were obtained had changed their methods of distributing water since originally investing in irrigation equipment. Only one had changed from using gated pipe; the others changed from portable pipe and sprinkler systems to other sprinkler or surface methods. The main reason for the change was the labor required for portable pipe and sprinkler systems. Eighty-eight percent of the farmers made the change to reduce labor requirements or to be able to hire personnel to work with irrigation equipment.

The fixed investment in irrigation equipment averaged $7,122 per farm, or $56 per capacity acre, for the 65 farmers.

Farmers with trailer boom systems averaged $13,200 in investment, with an average capacity of 290 acres per farm. The investment per capacity acre was practically constant, ranging from $45 to $56, with a mean of $46.

Farmers with giant sprinkler systems had average investments of $8,844 per farm. The average capacity was 144 acres. The average investment per capacity acre decreased from $74 in the 60 to 99 acre group to $50 in the 200 to 259 acre group.

Farmers with portable pipe and sprinkler systems averaged $6,810 invested, and had an average capacity of 118 acres. The average investment per capacity acre decreased from $360 for the 19 acres or less group to $52 for the 140 to 179 acre group.

Farmers with gated pipe and ditch and furrow systems had average investments of $5,518 and $4,100, respectively. The average capacity was 87 acres on the 11 farms with gated pipe systems. The average investment per capacity acre was $63 and $62 for the 60 to 99 and 140 to 179 acre groups, respectively, which was approximately twice as large as the ditch and furrow systems, with the same number of acres irrigated.

The average investment per capacity acre declined as capacity increased for the portable pipe and sprinkler and the giant sprinkler systems, but remained approximately constant for the surface and trailer boom and surface systems.

Forty-six, or 71 percent, of the 65 farmers applied water to 2,637 acres. The average number of acres irrigated per farm was 57. Cotton was the major irrigated crop. An average of 2.9 inches of water was applied to 1,523 acres. Cotton accounted for 58 percent of the total irrigated acres. The average yield response was 66 pounds of lint per acre, even though 57 percent of the cotton irrigators obtained no increase in yield.

In 1959, 659 acres of corn received an average of 5.25 inches of water per acre. An average of 41 acres per farm was irrigated with an average yield increase of 30 bushels. Sixty-three percent of the corn irrigators obtained increases in yield.

Thirteen farmers applied an average of 4.4 inches of water per acre to 316 acres of soybeans. The average acreage per farm was 24. Sixty-nine percent of these irrigators reported average yield increases of 8.5 bushels per acre.

Fixed costs averaged 80 percent of total irrigation costs for the surface and the portable pipe and sprinkler systems, and 65 percent for the trailer boom-giant sprinkler systems. The averages varied from 59 to 91, from 48 to 91, and from 38 to 98 percent for the surface, trailer boom-giant sprinkler, and portable pipe and sprinkler systems, respectively, depending upon amount of use.

Variable costs averaged 20 percent of total irrigation costs for surface and portable pipe and sprinkler systems, and 35 percent for the trailer boom-giant sprinkler types.

The average labor, tractor, fuel, and oil costs per acre of application varied significantly among the different types of systems. The average labor cost was significantly higher for the portable pipe and sprinkler systems than for the surface systems. The average tractor, fuel, and oil, costs were significantly higher for the trailer boom-giant sprinkler and portable pipe and sprinkler systems than for the surface systems.

Costs per irrigated acre of cotton averaged $20.31, $15.96, and $11.61 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Net returns per irrigated acre were—$4.66, $4.12, and $2.57, and returns above variable costs $12.64, $15.33, and $11.80 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively.

Costs per irrigated acre of corn averaged $16.01, $13.20, and $8.38 for portable pipe and sprinkler, trailer boom-giant sprinkler and surface systems, respectively. Net returns were $10.34, and $14.00, and $13.72, and returns above varia-

ble costs $23.31, $21.33, and $19.51 for the portable pipe and sprinkler, trailer boom-giant sprinkler and surface systems, respectively.

Costs per irrigated acre of soybeans averaged $13.12, $13.21, and $15.21 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Net returns were -$6.52, $1.64, and $4.59, and returns above variable costs $2.50, $10.08, and $17.99 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively.

Twenty-nine percent of the farmers increased their net farm incomes by irrigating cotton, corn, and soybeans. Irrigation was not profitable for a majority of farmers controlling irrigation equipment in 1959. Thirty-three percent of the farmers obtained returns that were greater than variable irrigation costs. Therefore, less than 50 percent of those who had irrigation equipment obtained increases in returns large enough to pay variable irrigation costs.

Nineteen, or 29 percent, of the 65 farmers did not apply water in 1959. The average fixed cost attributable to investment in irrigation equipment was $490. As a result, net farm income was reduced by this amount on these farms.

Net farm income was not increased for a majority of the farmers who irrigated corn, cotton, and soybeans in 1959. Net returns from irrigation for those who received them showed no significant relationship to the method of distributing water. Adjusted gross returns per acre differed significantly for corn and soybeans, with irrigated corn having the higher return.

The average cost of irrigation and the yield responses needed for a profit are influenced by many factors. Probably the most important in humid areas such as the Delta of Missouri are the amount and distribution of rainfall. Other factors include number of acres irrigated, number of irrigations during the year, amount of water applied, price of the product, cost of the variable inputs, and the managerial skill of the farm operator.

The average labor, tractor, fuel, and oil costs per acre application differed significantly among the methods of distributing water.

A large yield response from irrigation was not needed to pay the variable costs of applying water to corn, cotton, and soybeans.

Farmers in the Delta Area of Missouri are shifting from the portable pipe and sprinkler method of applying water to other sprinkler and surface methods, because of the high labor requirements associated with the former.

The data contained in the study reported cover only the crop year of 1959. The yield responses reflect returns to a random sample of irrigators under general farm conditions for a single year. Weather was favorable for crop production. The year was near normal in rainfall, and distribution throughout the growing season was better than usual. In fact, the average cotton yield without irrigation was the highest ever obtained in the area. These facts should be considered in evaluating the results.

If profits are to be made, careful attention must be given to varieties and stands of crops, levels of fertility, weed control, and other managerial practices. If careful attention is given to these details, irrigation can be profitable in most years.

The results of the study point to the need for additional research. Studies of the type reported here should be repeated over a period of years to increase the reliability of the findings. The intensity and frequency of drought should be determined to establish the frequency of need for supplemental water. This work would require an analysis of long-time weather records in the area. A detailed analysis of the managerial practices on farms where irrigation has been profitable over a period of years would help to identify the procedures that need to be followed by other farmers to make irrigation pay.

IRRIGATION PRACTICES AND COST IN SOUTHEASTERN MISSOURI—1959

TED L. JONES AND FRANK MILLER[1]

INTRODUCTION

Farmers, as well as extension and research personnel of the Land Grant Colleges and the United States Department of Agriculture, have become increasingly interested in irrigation in the humid areas of the United States. The primary reason has been reductions in crop yields in extremely dry years. Periodic shortages of natural moisture have encouraged the use of supplemental irrigation in an effort to maintain satisfactory levels of income where water has been available. Furthermore, the technological advances that have been made in crop varieties, in use of fertilizers, and in irrigation equipment have lowered the cost of applying irrigation water per unit of output and stimulated a persistent demand for information on the use of supplemental irrigation to help reduce the risk and uncertainty of crop production.

As interest in irrigation increased, the need for basic data concerning its use also increased. Information needed included specific data on response of different crops, most satisfactory types of equipment to use, amount of investment required, and factors influencing costs in relation to returns. Most farm operators have limited capital to invest in their businesses. If it is put into irrigation equipment, alternative uses must be postponed for the present or indefinitely.

In deciding whether or not to irrigate land, farm operators need several types of information: (1) the quantity and quality of water available; (2) the cost of installing equipment and distributing water on the land; (3) the additional yield that can reasonably be expected from each type of crop; (4) frequency of need for supplemental water; (5) additional returns in relation to costs. This information has not been available to Missouri farmers, yet many of them have acquired and are using irrigation equipment. In order to take advantage of the experiences of these farmers, this and several other studies were initiated.

[1]Agricultural Economist, Farm Economics Division, Economic Research Service, U. S. Department of Agriculture; and Professor of Agricultural Economics, University of Missouri, respectively.

Objectives of the Study

The investigations in Missouri had the following objectives.

1. To determine the costs of installing and operating various types of irrigation systems
2. To determine the changes in yield and quality of product obtained from various quantities of water applied to specific types of crops
3. To determine the effects of irrigation on farm income.

Need for the Study

For several years, Missouri farmers have used supplemental irrigation to increase production, stabilize yields, improve the quality of their products, and reduce the risk and uncertainty incident to variable weather. Natural moisture conditions fail to meet optimum requirements for crops at some time during the growing season in most years. According to the 1954 Census of Agriculture, Missouri farmers applied water to 1,113 acres in 1944 and to 33,314 acres in 1954. Additional reports indicated that irrigation continued to expand within the state up to 1956. After that year, the total irrigated acreage and the number of farmers applying water to their crops declined. The primary reason for the decline was a more nearly uniform distribution of rainfall throughout the growing season.

The investigation reported in this manuscript covers the second part of a two-phase study. The first was concerned with the nature and extent of irrigation in Missouri.[2] During the initial phase, information was obtained by mail questionnaire to indicate the types of crops receiving water and the acreages irrigated in the various areas of the state, sources of water supply, and types of distribution systems used. Information was obtained for the years 1954 to 1958.

Only limited information was available concerning the costs and returns that could be expected when water was applied to crops and no effort was made to obtain data of this type in the first round of inquiry. The study reported here deals with costs and returns in the southeastern delta area where most of the irrigation water is used.

The Economics of Irrigation

For many years, field crops have been produced commercially in the humid areas of the United States without irrigation. The tremendous technological changes that have occurred in the production and marketing of agricultural products within the last 40 years have greatly increased investments in farm businesses. They have also brought on a diligent search for methods that can be used to reduce unit costs and stabilize farm incomes. Farm tractors and other machinery, commercial fertilizer, superior crop varieties, and portable irrigation

[2]Ted L. Jones and Frank Miller, *Nature and Extent of Irrigation in Missouri,* Missouri Agr. Expt. Sta. Res. Bul. 735, April 1960.

equipment are only a few innovations that have been introduced. It is only natural that questions should arise as to the specific conditions under which these new practices and devices can be used profitably.

Irrigation requires relatively large investments, regardless of type of system used. Consequently, the annual fixed cost is high. In addition, the use of an irrigation system leads to variable costs, such as wages for labor, fuel, and repairs.

Since most farm operators do not have unlimited capital, a choice must be made between two or more alternative uses. Here, opportunity costs become the guide. Before the decision is made to invest in irrigation equipment, the income that might be obtained by putting the money into some alternative use needs to be considered. The decision to buy the equipment should be based on rejection of the second best available alternative use of the funds. After the decision has been reached and the capital investment has been made, the capital is fixed or sunk for a given period of time. When a well is used as a source of water, its cost can be recovered only through use or sale of the land at a higher price, because the well is there ready for use. Movable equipment can be sold. If the assumption is made that the fixed capital cannot be recovered for a given period of time, then only the variable costs should be considered. The opportunity cost after acquisition of the water-distributing system is the amount of farm income that will be forgone if the value or amount of variable costs needed is put to uses other than operation of the irrigation equipment.

Irrigation in the humid areas may not be required each year because of fluctuations in amount and distribution of rainfall. Because of this fact, yield response varies from year to year. The fixed costs of irrigation equipment are annual charges, while variable costs are incurred only when the irrigation system is used. If, over time, investments in irrigation are to be profitable, the yield response in dollar terms during the years of use must exceed the fixed and variable costs incurred throughout the total period, including years when water is not applied to crops.

Farm operators who irrigate crops in humid regions face difficult managerial decisions. They must decide what crop will receive the water, when, and how much will be applied. In a given year, the guide is marginal cost and marginal returns: the application of water up to the point at which the cost of an additional unit (acre-inch) is equal to the value of the additional output of product resulting from use of the water. The stand of the crop, the level of plant nutrients in the soil, the presence or absence of weeds, temperature, relative humidity, subsequent rainfall, and many other factors influence response. No method or technique is known that will inform the operator when the equimargin of all these factors is reached; he must act on his best judgement.

METHOD OF INVESTIGATION

Data for this analysis were obtained from farmers who owned or controlled irrigation equipment in Dunklin, Pemiscot, New Madrid, and Mississippi Coun-

ties, Missouri. An earlier study had shown that the greatest concentration of irrigation was in this region. A list of 186 farmers who owned or controlled irrigation equipment was compiled from information furnished by county agents, soil conservation personnel, well-drillers, and irrigation-equipment dealers. Each farmer was given an identification number and with the aid of tables of random numbers, 65 were drawn from the list. Each farm operator chosen by this procedure was interviewed three times during 1959. The first interview was in May and June. Basic information, including amount of investment in irrigation equipment, was obtained during this interview. The second interview was conducted in August and September when data on operating costs were obtained. The third and final interview was made in December to obtain estimates of yield responses.

Description of the Area and Irrigation Practices

The records for the study were obtained from four Counties in the Delta corn and Cotton Areas of the state (Figure 1). They encompass approximately 1,357,440 acres. New Madrid County is the largest with approximately 434,560 acres, of which 84.2 percent was in farms in 1959. Dunklin is second with 347,520 total acres and 89.2 percent in farms. Approximately 92.8 percent of the 312,230 acres in Pemiscot County was in farms in 1959. The smallest of the four, Mississippi County, contains approximately 263,040 acres, of which 86.6 percent was in farms in 1959[3] Crop production is the dominant enterprise in the area with cotton, soybeans, and corn the major crops produced.

Soils

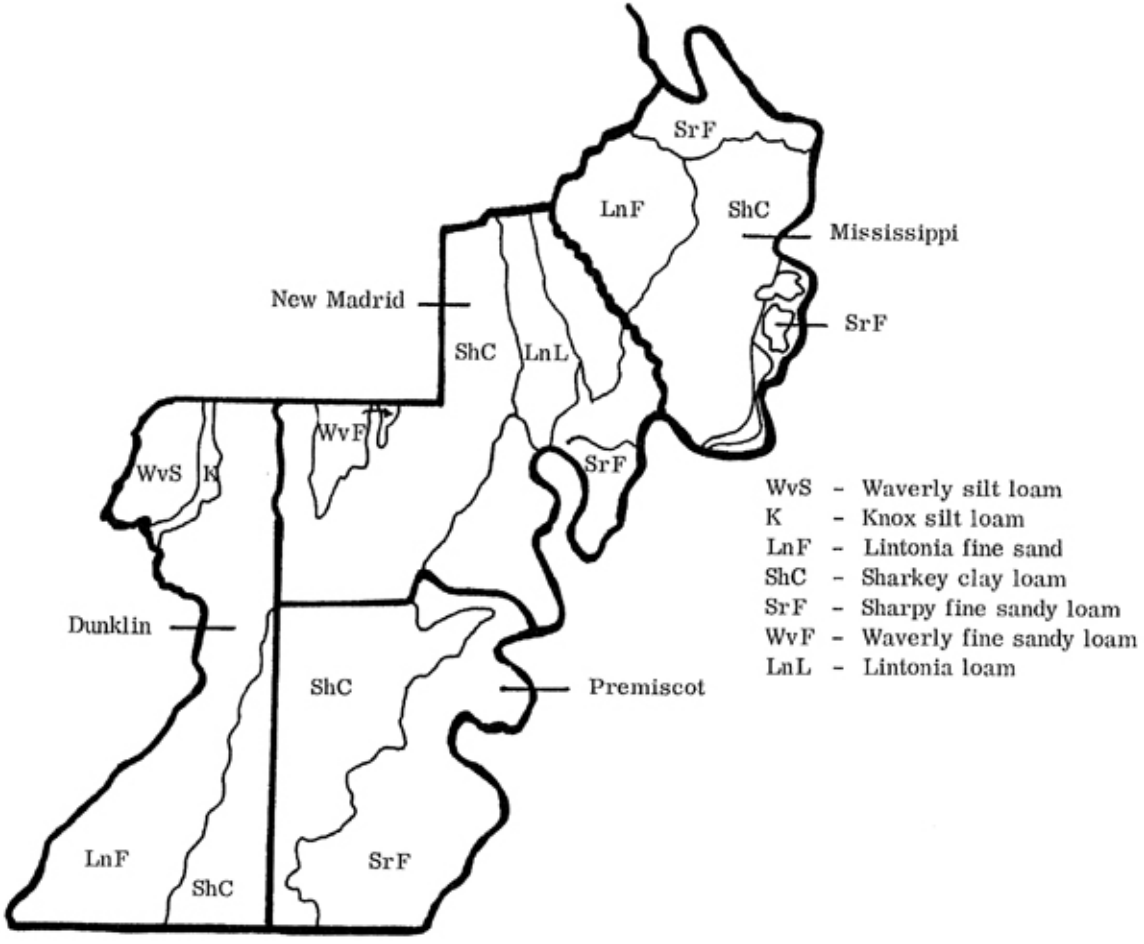
The soils are of alluvial origin, but they show extreme variations in texture, profile, and drainage. The deposits from which they were derived were largely laid down by the Mississippi and other large rivers and are of complex origin. It is difficult to find even a 10-acre field with soils of the same character throughout. Sandy spots or streaks are common even in the prevailingly heavier soils, while the sandy soil areas are interlaced with swales of lower-lying silts and clays. This extreme variability makes a general classification of southeastern Missouri soils difficult.[4] The dominant series are Sharkey clay loam, Sarpy fine sandy loam, Lintonia fine sand, and Waverly and Knox silt loams (Figure 2).

Because of the wide range of soils it was difficult to make a general classification of the types to which water was applied in 1959. The following procedure was used to determine soil types on the 65 farms. The fields that were irrigated or that could have been irrigated were plotted on a county highway map. Soil conservation personnel inspected the maps and compared them with

[3]United States Bureau of the Census, *1959 Census of Agriculture-Preliminary:* Missouri, U.S. Govt. Print. Off., Washington D. C., September 1960.
[4]M. F. Miller, and H. H. Krusekopf, *The Soils of Missouri,* Missouri Agr. Expt. Sta. Bul. 264, January 1929, pp. 95-98.

FIGURE 1-SOUTHEASTERN MISSOURI COUNTIES WHERE IRRIGATORS WERE INTERVIEWED, 1959

FIGURE 2-GENERALIZED SOIL MAP OF DUNKLIN, PEMISCOT, NEW MADRID, AND MISSISSIPPI COUNTIES



detailed county soil maps to determine the soil characteristics. The soils were divided into four groups for analysis, predominantly sandy, silt loam, clay loam, and combinations of the first three, as shown in Table 1.

Thirty-five, 23, 14, and 28 percent of the farm operators reported their soil types as clay loam, sandy, silt loam, and combinations, respectively.

The hypothesis of independence between type of tenure and type of soils was tested. A chi square of 8.31 was obtained, which was not statistically significant at the .05 level. The hypothesis was not rejected. The probability of obtaining a chi square larger than 8.31 was .22.

A chi square statistical test was used to determine whether there was a significant relation between type of soil and use of irrigation in 1959. A value of 5.18 was obtained, which was not statistically significant at the .05 level. The result indicates that the type of soil was not an important reason for either irrigating or not irrigating in 1959.

Climate

The area has a humid (continental) climate. The average annual precipitation is approximately 50 inches, the highest in the state.[5] Precipitation is greatest in January, March, and April.[6] The average growing season is 210 days. The first parts of June, July, and August are periods of low dry-weather risk, but early May, late June, July, and August have high frequencies of dry periods.[7] From the standpoint of crop production, lack of moisture during the growing season is often critical. Also, the area has more dry periods lasting 3 and 4 weeks than other areas of the state, except east-central Missouri.[8]

Economic Characteristics

The population of the area was slightly over 2,100 when New Madrid County was organized[9] (Table 2). It increased slowly until the 1840's, then more than doubled by 1850. The population peak was reached at 154,750 in 1940. During the 1940's there was a net decrease of 1,802 persons.

Agriculture has remained the major industry of the area up to the present time (Table 3). In 1930, 71.5 percent of the people employed were engaged in agriculture. The percentage had decreased to 58.1 percent in 1950 but agricultural workers were still the most prominent group. The percentage of people employed by wholesale and retail stores has steadily increased—from 6.8 to 9.4

[5] *Climate and Man,* U. S. Dept. Agr., Yearbook of Agriculture, 1941, pp. 550-554.
[6] Wayne L. Decker, *Monthly Precipitation in Missouri,* Missouri Agr. Expt. Sta. Bul. 650, March 1955, pp. 38-39.
[7] Wayne L. Decker, *Chances of Dry Periods in Missouri.* Missouri Agr. Expt. Sta. Bul. 707, June 1959, pp. 10-11.
[8] *Ibid.*
[9] Goodspeed's History of Southeast Missouri, Goodspeed publishing Company, 1888, pp. 284-291.

TABLE 1-SOIL TYPES, BY TENURE OF OPERATOR, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

	Type of Soil							
	Predominantly:			Combination:				
	Sandy	Silt Loam	Clay Loam	Sandy and Silt Loam	Sandy and Clay Loam	Silt and Clay Loam	Silt, Sandy and Clay Loam	Total
Owner-Operators								
Irrigated	5	2	5	1	---	---	---	13
Did Not Irrigate	1	1	5	---	---	---	---	7
Part-Owner								
Irrigated	5	2	5	1	3	1	---	17
Did Not Irrigate	---	2	2	1	2	1	1	9
Tenant								
Irrigated	4	1	5	4	1	1	---	16
Did Not Irrigate	---	1	1	---	---	1	---	3
Total								
Irrigated	14	5	15	6	4	2	---	46
Did Not Irrigate	1	4	8	1	2	2	1	19

TABLE 2-POPULATION OF DUNKLIN, PEMISCOT, NEW MADRID AND MISSISSIPPI COUNTIES, MISSOURI, 1810-1960[1]

Year	Number of People
1810	2,103
1820	2,445
1830	2,351
1840	4,554
1850	9,884
1860	18,501
1870	19,380
1880	30,867
1890	40,493
1900	56,938
1910	83,932
1920	97,447
1930	119,107
1940	154,750
1950	152,948
1960	128,779

[1]Data for 1810 to 1880 from Tenth Census of the United States, Volume I, pp. 68-69. Data for 1890 to 1910 from Thirteenth Census of the United States, Volume II, pp. 1074-1082. Data for 1920 from Fourteenth Census of the United States, Volume III, pp. 554-58. Data for 1930, 1940, and 1950 from United States Census of Population, 1930, Volume III, Part 1, pp. 1339-1370; 1940, Volume II, Part 4, pp. 368-69, and 1950, Volume II, Part 25, pp. 123-36.

TABLE 3-CHARACTERISTICS OF THE POPULATION, BY SEX, DUNKLIN, PREMISCOT, NEW MADRID, AND MISSISSIPPI COUNTIES, MISSOURI, 1930, 1940, AND 1950.

Item	1930[1]		1940[2]		1950[3]	
	Male	Female	Male	Female	Male	Female
	Number		Number		Number	
Total Population	62,115	56,992	154,749	74,595	77,490	75,458
Percentage:	Percent	Percent	Percent	Percent	Percent	Percent
14 years of age & over	63.3[4]	61.4[4]	68.8	67.6	64.8	65.7
In labor force	----	----	54.9	10.0	49.9	11.4
Employed in industry	56.3	8.3	44.9	8.0	44.2	10.2
Employed in W. P. A.	----	----	5.1	.8	----	----
Unemployed	----	----	4.9	1.1	3.7	1.2
	Number		Number		Number	
Total number employed in industry	34,979	4,724	35,991	5,983	32,223	7,731
Percentage in:	Percent	Percent	Percent	Percent	Percent	Percent
Agriculture	71.5	29.3	69.1	12.4	58.1	14.2
Forestry & mining	1.3	----	.2	----	.2	----
Construction	1.8	----	3.1	----	5.4	.3
Manufacturing	6.2	9.0	5.9	23.1	6.3	16.4
Transportation and Communication	3.6	1.7	2.8	1.3	3.4	2.1
Public Utilities	.9	.8	.3	.2	.9	.5
Wholesale & Retail trade	6.8	8.8	9.4	13.5	13.6	23.7
Service	4.4	49.1	6.6	44.3	8.9	35.6
Public Administration	.9	.4	1.3	2.6	1.6	2.8
Other	2.6	.9	1.3	2.6	1.6	4.4

[1]Census of Population, 1930, Volume III, Part 1, pp. 1339-1370.
[2]Census of Population, 1940, Volume II, Part 4, pp. 368-69.
[3]Census of Population, 1950, Volume II, Part 25, pp. 123-36.
[4]Over 15 years of age.

to 13.6 percent in 1930, 1940, and 1950, respectively. This group was second in importance to agricultural workers. Manufacturing was third in 1930, but was replaced by service groups in 1940 and 1950.

Agriculture

In the early period of agricultural development, farms were small, reflecting the high labor requirements of the principal cash crop—cotton. Cotton still brings more money into the area than any other crop, but the trend is toward mechanization. Thus labor is released from agriculture and larger operating units are necessary. From 1950 to 1954, the number of farms decreased 21.8 percent. By 1959, an additional 24.8 percent of the farm operators had quit farming. Farm businesses were being reorganized into larger, more efficient units in an attempt to lower the cost of production per unit of output. The average size was 91.4 acres in 1950, 111.6 acres in 1954, and 163.7 acres in 1959, an increase of 79.1 percent from 1950 to 1959.

Farm assets increased in value throughout the 1950's. The value of land and buildings averaged $14,048 per farm in 1950, $18,991 in 1954, and $38,714 in 1959. The average value of land and buildings per farm was 175.6 percent greater in 1959 than in 1950. The average price per acre was $274.09 in 1959 as compared with $154.15 in 1950, an increase of 77.8 percent (Table 4).

From 1950 to 1954, the total number of commercial farms decreased 20 percent (Table 5). The number of farms in classes I, II, and III increased as the number in classes IV, V, and VI decreased. From 1950 to 1954, class I had the largest increase with 36 percent, while class VI had the greatest decline, a decrease of 74 percent (Figure 3).

There were no irrigators in the four-county area in 1949, according to the 1954 Census of Agriculture. In 1954, 108 farmers were reported to be irrigating 8,348 acres. The number had decreased to 88 in 1959 with 6,609 irrigated acres Table 6).

The number of full owners and tenants decreased during the 1950-59 period, while the number of part owners remained constant (Table 7). The number of tenants decreased by 4,137 or 47 percent, as the number of full owners decreased 958, or 40 percent. In 1950, the percentage of tenancy in the area was 70.5; in 1959 it was 63.2. This decline was the result of a reduction in the number of people employed in agriculture and use of hired labor whereas the work had previously been done by farm operators.

Size of Farms Where Irrigation Water Was Used

The average size of farm operated by the 65 farmers with irrigation equipment was 405 acres. The median was 342 and the modal size was 216 acres. The 0.95 confidence interval for the average size in the universe was from 325 to 485 acres. This means that the interval has a 0.95 chance of including the universe mean, or 95 times in 100, samples drawn from this universe would lead to confidence intervals that would include the universe value.

TABLE 4–NUMBER, AVERAGE SIZE OF FARM, AND VALUE OF LAND AND BUILDINGS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1950, 1954, AND 1959[1]

County	Farms			Average Size of Farm			Value of Land and Buildings					
							Average Per Farm			Average Per Acre		
	1950	1954	1959	1950	1954	1959	1950	1954	1959	1950	1954	1959
	Number	Number	Number	Acres	Acres	Acres	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Dunklin	3,313	2,605	2,525	90.8	103.4	137.7	14,511	20,537	35,008	155.41	204.17	249.37
Pemiscot	3,347	2,794	1,844	81.3	96.0	151.2	15,500	20,334	44,239	188.16	237.84	323.82
New Madrid	3,857	2,865	2,108	89.1	116.8	173.5	12,165	17,673	35,870	150.24	191.79	280.25
Mississippi	1,879	1,435	1,085	115.1	146.4	209.8	14,510	16,203	42,541	115.83	141.51	234.57
Total	12,396	9,699	7,289	--	--	--	--	--	--	--	--	--
Average	--	--	--	91.4	111.6	163.7	14,048	18,991	38,714	154.15	196.52	274.09
Percentage Change:												
1950 to 1954		-21.8			+22.1			+35.2			+27.5	
1954 to 1959			-24.8			+46.7			+104.4			+39.5
1950 to 1959			-41.2			+79.1			+175.6			+77.8

[1]Data for 1950 and 1954 from Census of Agriculture, Volume 1, Part 10, pp. 47-51. Data for 1959 from Census of Agriculture - Preliminary Report, By Counties.

FIGURE 3-NUMBER OF FARMS BY SIZE IN DUNKLIN, PEMISCOT, NEW MADRID, AND MISSISSIPPI COUNTIES, MISSOURI, 1950 - 1954 - 1959.

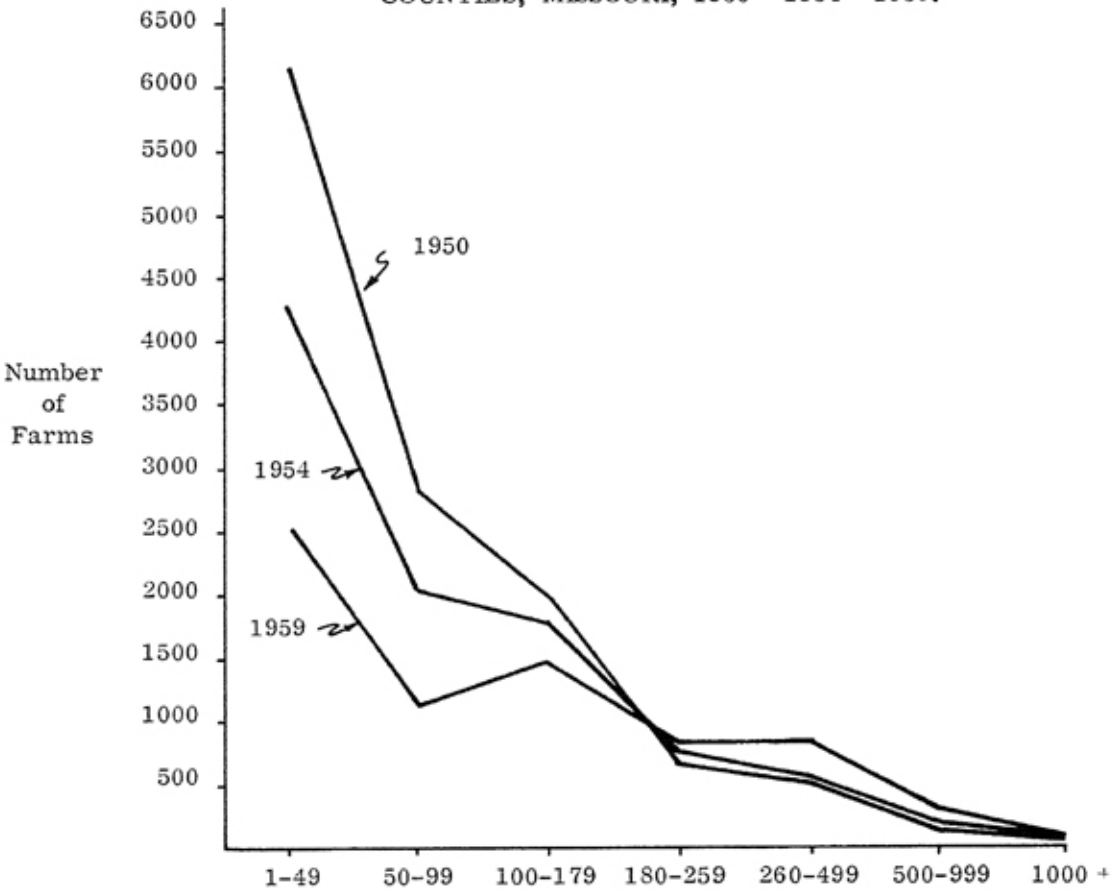


TABLE 5-NUMBER OF COMMERCIAL FARMS, BY ECONOMIC CLASS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1950-54[1]-59[1]

County	Commercial Farms						
	I	II	III	IV	V	VI	Total
	Number	Number	Number	Number	Number	Number	Number
Dunklin							
1950	112	450	851	915	518	237	3,083
1954	50	430	750	680	320	110	2,340
1959	76	266	605	610	340	120	2,017
Pemiscot							
1950	66	361	790	886	788	252	3,143
1954	182	585	795	780	315	65	2,722
1959	160	220	770	345	365	120	1,680
New Madrid							
1950	103	380	808	1,106	974	318	3,689
1954	150	480	1,020	850	355	35	2,890
1959	122	323	475	505	765	160	2,030
Mississippi							
1950	46	198	358	443	580	166	1,791
1954	63	290	290	420	260	40	1,363
1959	83	147	200	225			955
Total							
1950	327	1,389	2,807	3,350	2,860	973	11,706
1954	445	1,785	2,855	2,730	1,250	250	9,315
1959	441	956	1,750	1,685	1,330	520	6,682
Percentage Change							
1950 to 1954	+36	+29	+2	-19	-56	-74	-20
1955 to 1959	+35	-31	+18	-50	-53	-47	-42

[1]Data from 1954 Census of Agriculture, Missouri, pp. 83-87.

The average size of farm in 1959 for all farmers in the four county area was 164 acres (Table 4). The average farm in the sample was 147 percent larger than the average size of all farms. Since the fixed investment required for irrigation is large, it was expected that, in general, irrigators would operate larger than average farms.*

Year Irrigation Was Started

As shown in Table 8, none of the farmers had irrigation systems before 1952, and only 8 bought their equipment before 1954. The largest number started irrigating in 1954, when 28 percent applied water to crops for the first time. Twenty-five percent started irrigating in 1956.

Apparently, there is no particular relation between size of farm and year when irrigation was started. In 1953 the largest proportion of farmers in the 240 to 359 acre class started to irrigate. The largest proportion of farmers in the 480 to 599, 1,060 to 1,279 and over 1,280 acres classes started in 1954. Since the last two of these classes had only 1 farm each, the data have very little meaning. The

*Additional information about the farmers from whom data were obtained are presented in the appendix.

TABLE 6-FARMERS REPORTING IRRIGATED LAND, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1949, 1954, AND 1959[1]

County	Farms Reporting	Total Acreage Irrigated
	Number	Acres
Dunklin		
1949	---	---
1954	43	2,458
1959	47	2,831
Pemiscot		
1949	---	---
1954	20	2,086
1959	26	2,526
New Madrid		
1949	---	---
1954	34	2,531
1959	12	982
Mississippi		
1949	---	---
1954	11	1,273
1959	3	270
Total		
1949	---	---
1954	108	8,348
1959	88	6,609
Percentage Change		
1954 - 1959	-19	-21

[1]Data for 1949 and 1954 from 1954 Census of Agriculture, pp. 47-51. Data for 1959 from 1959 Census of Agriculture, Preliminary Report, By Counties.

largest proportion of farmers in the 1 to 119, 120 to 239, 360 to 479, 600 to 719, and 840 to 1,059 acre classes started after 1954. The hypothesis of independence between the year irrigation was started and whether the farmer irrigated or did not irrigate was tested. As the chi square of 2.97 calculated was not significant at the .05 level, the hypothesis was not rejected.

Eighteen and 3 percent of the 65 farmers obtained irrigation equipment in 1957 and 1958, respectively. These farmers have made limited use of their irrigation systems primarily because of changes in amount and distribution of rainfall. In 1957, more than 100 inches of rain fell in various areas of the Delta. The amount and distribution of precipitation in 1958 and 1959 permitted better than average crop yields without irrigation. As a result, farmers who obtained irrigation systems in 1957 and 1958 have had a rather large investment tied up in equipment that has had only limited use. When the 25 percent of farmers who

TABLE 7-TENURE OF OPERATORS, IN FOUR SOUTHEASTERN MISSOURI COUNTIES, 1950, 1954, AND 1959[1]

Tenure and Year	County					Percentage Change in Total		
	Dunklin	Pemiscot	New Madrid	Mississippi	Total	1950-1954	1954-1959	1950-1959
	Number	Number	Number	Number	Number			
Full owner								
1950	963	593	517	329	2,402			
1954	746	449	426	256	1,877	- 22		
1959	626	284	313	221	1,444		- 23	- 40
Part owner								
1950	498	318	241	163	1,220			
1954	439	304	198	161	1,102	- 10		
1959	449	374	227	170	1,220		+ 10	2/
Manager								
1950	5	8	8	9	30			
1954	4	6	5	6	21	- 30		
1959	4	3	7	5	19		- 10	- 37
All tenants								
1950	1,846	2,428	3,091	1,378	8,743			
1954	1,416	2,035	2,236	1,012	6,699	- 23		
1959	1,173	1,183	1,561	689	4,606		- 31	- 47
	Percent	Percent	Percent	Percent	Percent			
Percentage of Tenancy Shown in U. S. Census								
1950	55.7	72.5	80.1	73.3	70.5			
1954	54.4	72.8	78.0	70.5	69.1	-1.4		
1959	52.1	64.2	74.1	63.5	63.2		-5.9	-7.3

TABLE 7 Continued

Tenure and Year	County					Percentage Change in Total		
	Dunklin	Premiscot	New Madrid	Mississippi	Total	1950-1954	1954-1959	1950-1959
	Number	Number	Number	Number	Number			
Types of Leases								
Cash								
1950	104	86	76	17	283			
1954	37	37	37	10	121	- 57		
1959	3/	---	---	---	---		---	---
Crop Share								
Cash								
1950	1,017	1,820	2,567	1,272	6,676			
1954	1,064	1,771	2,026	982	5,843	- 12		
1959	---	---	---	---	---		---	---
Crop Share								
and Cropper								
1950	1,017	1,820	2,567	1,272	6,676			
1954	1,064	1,771	2.026	982	5,843	- 12		
1959	---	---	---	---	---		---	---
Types of Leases								
Livestock								
Share								
1950	23	6	18	60	107			
1954	18	12	36	46	112	+ 5		
1959	---	---	---	---	---		---	---
Other								
1950	67	76	100	56	299			
1954	37	69	82	8	196	- 34		
1959	---	---	---	---	---		---	---

[1]Data for 1950 and 1954 from 1954 Census of Agriculture, Volume I, Part 10, pp. 57-61. Data for 1959 from 1959 Census of Agriculture - Preliminary Report, By Counties.
[2]No Change.
[3]Data were not available.

TABLE 8-YEAR IRRIGATION BEGAN, BY TOTAL ACRES OPERATED, 65 FARMERS IN FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Total Acres Operated	Irrigation Started in-- 1951 or before	1952	1953	1954	1955	1956	1957	1958	Total
1-119	---	---	---	1	2	---	2	---	5
120-239	---	---	1	2	1	8	2	1	15
240-359	---	---	4	3	1	1	3	1	13
360-479	---	1	---	3	4	1	2	---	11
480-599	---	---	1	4	---	---	1	---	6
600-719	---	---	1	1	---	2	2	---	6
720-839	---	---	---	2	---	1	---	---	3
840-1,059	---	---	---	---	1	1	---	---	2
1,060-1,279	---	---	---	1	---	---	---	---	1
Over 1,280	---	---	---	1	---	---	---	---	1
Total	---	1	7	18	9	16[1/]	12	2	65[1/]

[1] Includes two farmers who started irrigating in 1956, but did not report total acres operated.

started in 1956 is added to the 21 percent who started in 1957 and 1958, 46 percent have had limited opportunities to recover their fixed investments and have borne a relatively large annual fixed cost in depreciation, interest, and taxes. The amount of annual fixed costs is discussed later.

Part owners, in general, started to irrigate and stopped buying irrigation equipment earlier than owners or tenants, as shown in Table 9. Twenty-three percent of the part owners and 11 percent of the tenants started to irrigate in 1952 and 1953, but none of the owners started irrigation in these years. Seventy-five percent of the tenants started irrigating their crops between 1954 and 1956. Twenty-five percent of the owners and 21 percent of the tenants started irrigation in 1957 and 1958. Nineteen percent of the part owners started in 1957, but none started in 1958. In general, part owners are more responsive to changes in weather than owners or tenants.

Method of Distributing Water

Sprinklers were the major method of distributing water on farms of all sizes, as shown in Table 10. Three different types were used. The most common was the conventional sprinkler system, which usually has 12 to 22 small sprinklers 60 to 90 feet apart on lateral lines. This type operates under low pump pressure, and applies water at a relatively slow rate. It is called the 60 X 60 or 90 X 90 system, meaning that the sprinklers are 60 to 90 feet apart on the lateral lines

TABLE 9-YEAR IRRIGATION BEGAN, BY TENURE OF OPERATORS, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Year	Owner Operator	Part Owner	Tenant	Total
1952	--	1	--	1
1953	--	5	2	7
1954	6	5	7	18
1955	4	4	1	9
1956	5	6	5	16
1957	4	5	3	12
1958	1	--	1	2
Total	20	26	19	65

and the entire line is moved 60 to 90 feet after completion of irrigation from each set. Twenty-five of the 46 farmers used this method exclusively in 1959.

The second type of sprinkler system has two or three giant sprinklers per quarter mile of lateral line. It uses high pump pressure, and applies water rapidly. Four farmers used this method exclusively, and one farmer used both of these methods.

The third type of sprinkler system has a large rotating boom mounted on a trailer. It operates under high pump pressure and has a high rate of application. Three farmers used this method exclusively, and one used both this method and portable pipe and sprinklers.

Eight farmers used surface irrigation exclusively. Two procedures of distribution were followed. Seven of the eight farmers used light portable pipes with gates or openings 36 to 40 inches apart to carry water to the rows. One used ditches and furrows exclusively in 1959.

The chi square technique was also used in testing the hypothesis of independence between use of irrigation in 1959 and tenure of the farm operators. A chi square of 2.34 was calculated, which was not statistically significant at the .05 level. The probability of obtaining a chi square larger than the one above was approximately .33.

Nineteen farmers with irrigation equipment did not irrigate in 1959. Of this group, 13 owned portable pipe and sprinklers; three had gated pipe; two had used ditches and furrows, and one had used a trailer boom type of water-distribution system.

The portable pipe and sprinkler system was the major type used by all tenure groups, as shown in Table 11. Forty-six, 47, and 69 percent of the owners,

TABLE 10-METHODS OF APPLYING WATER BY TOTAL ACRES OPERATED, 46 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Method of applying water	Total Acres Operated										
	1-119	120-239	240-359	360-479	480-599	600-719	720-839	840-1,059	1,060-1,279	Over 1,280	Total
Sprinkler Only:											
Portable pipe and sprinkler	1	11	5	4	2	1	1	---	---	---	25
Trailer boom	---	---	---	2	---	---	---	---	1	---	3
Giant sprinkler	1	1	1	---	---	1	---	---	---	---	4
Surface Only:											
Gated pipe	2	---	2	1	1	1	---	---	---	---	7
Ditches and furrows	---	---	---	---	---	1	---	---	---	---	1
Combination of Methods:											
Portable pipe and sprinkler and											
a. Gated pipe	---	---	---	1	---	---	---	---	---	---	1
b. Ditches and furrows	---	---	1	---	---	1	---	---	---	---	2
c. Giant sprinkler	---	---	---	1	---	---	---	---	---	---	1
d. Trailer boom	---	---	---	---	---	---	---	---	---	1	1
Gated sprinkler and											
a. Gated pipe	---	1	---	---	---	---	---	---	---	---	1
Total[1]	4	13	9	9	3	5	1	---	1	1	46

[1]Nineteen farmers did not irrigate in 1959. The types of irrigation system available were: 13, portable pipe and sprinkler; 3, gated pipe; 2, ditches and furrows, and 1, trailer boom.

TABLE 11-METHODS OF APPLYING WATER BY TENURE OF OPERATORS, 46 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Method of applying Water	Owner Operator[1]	Part Owner[2]	Tenant[3]	Total
Sprinkler only:				
Portable pipe and sprinkler	6	8	11	25
Trailer boom	---	1	2	3
Giant sprinkler	3	1	---	4
Surface only:				
Gated pipe	3	3	1	7
Ditches and furrows	---	1	---	1
Combination of methods:				
Portable pipe and sprinkler and				
a. Gated pipe	---	1	---	1
b. Ditches and furrows	---	1	---	1
c. Giant sprinkler	1	---	1	2
d. Trailer boom	---	---	1	1
Giant sprinkler and				
a. Gated pipe	---	1	---	1
Total	13	17	16	46

[1]Seven owner operators did not irrigate in 1959. Six - portable pipe and sprinkler systems, one - ditch and furrow system.

[2]Nine part owners did not irrigate in 1959. Five - portable pipe and sprinkler systems, three - gated pipe systems and one - trailer boom.

[3]Three tenants did not irrigate in 1959. Two - portable pipe and sprinkler systems, one - ditch and furrow system.

part owners, and tenants, respectively, who applied water in 1959, used this type of system exclusively. Twenty-three, 12, and 13 percent of the owners, part-owners, and tenants, respectively, used trailer booms or giant sprinklers to apply water. Surface irrigation methods were employed by 23, 24, and 6 percent of the owners, part owners, and tenants, respectively. Six farmers used a combination of methods in applying water.

For purposes of analysis, the different types of irrigation systems were divided into three classifications. The first was the portable pipe and sprinkler system. Classification 2 was a combination of trailer booms and giant sprinklers. The two surface irrigation methods were combined for the third classification. The above classifications were used to test the hypothesis of independence between the tenure classification of the farm operators and the type of irrigation system used to distribute water.

Changes in Methods of Distributing Water

Seventeen, or 26 percent, of the 65 farmers have changed the method of distributing water since their original investment in equipment was made (Table 12). The sample statistic, .2615 was considered to be the best estimate of the proportion in the population that had changed methods of applying water. The 0.95 confidence interval was .158 to .372. Ninety-five percent had originally purchased portable pipe and sprinkler systems. One had changed from using gated pipe to sprinklers, because the land had not been graded and distribution of the water over the field was unsatisfactory. Nine changed from the conventional portable pipe and sprinkler method to either the trailer boom or the giant sprinkler method. The other eight changed to surface irrigation. Seven of the latter had changed to gated pipe and one to ditches and furrows.

The primary reason for the change was the labor required to operate the portable pipe and sprinkler system. Eighty-eight percent of the farmers had made the change to reduce labor requirements or to be able to hire personnel to work with the irrigation equipment.

TABLE 12-CHANGE IN TYPE OF IRRIGATION SYSTEM USED, BY TENURE OF OPERATOR, 17 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of Irrigation System	Owner Operator	Part Owner	Tenant	Total
Changed From:				
Portable Pipe and Sprinkler	4	7	5	16
Gated Pipe	---	1	---	1
Total	4	8	5	17[1]
Changed To:				
Trailer Boom	---	1	3	4
Giant Sprinkler	3	1	1	5
Gated Pipe	1	6	---	7
Ditch and Furrow	---	---	1	1
Total	4	8	5	17
Reasons for Changing Type of Irrigation System:				
Less Labor Required	4	2	4	10
Could Not Hire Labor for Portable Pipe and Sprinkler	---	4	1	5
Better Drainage	---	1	---	1
Land Not Level Enough for Gated Pipe	---	1	---	1
Total	4	8	5	17

[1] 48 of 65 farmers have not changed type of system.

The hypothesis of independence between type of tenure and whether the farmer had changed or did not change methods of applying water was tested. The chi square of .68 obtained was not significant at the .05 level. The hypothesis was not rejected. In addition, the relationship between type of tenure and type of original irrigation system was tested. The chi square of .98 obtained was not statistically significant.

The relationship between type of tenure and the new method of distributing water was tested. The chi square of 4.78 obtained was not statistically significant at the .05 level. The probability of obtaining a chi square larger than 4.78 was .093, which is relatively close to the zone of rejection.

Sources and Supply of Water

The south area appears to have an unlimited supply of water for irrigation. Wells from 80 to 125 feet in depth have suplied farmers with sufficient water for all irrigation needs.[10] However, only a small percentage of the farmers have used water for irrigation. Whether the supply would be adequate if all farmers were irrigating intensively is unknown.

Wells were the major source of water in 1959. Fifty of the 65 farms had only wells; three used drainage ditches only, and 12 used a combination of wells and drainage ditches, as shown in Table 13.

Wells were the exclusive source of water on 60, 81, and 89 percent of the owner, part-owner, and tenant-operated farms. An additional 35, 15, and 5 per-

TABLE 13-SOURCES OF WATER USED FOR IRRIGATION BY TOTAL ACRES OPERATED, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Total Acres Operated	Source of Water			
	Wells Only	Drainage Ditch Only	Combination-Well and Drainage Ditch	Total
1-119	4	---	1	5
120-239	12	1	2	15
240-359	11	---	2	13
360-479	8	---	3	11
480-599	5	1	---	6
600-719	5	---	1	6
720-839	2	---	1	3
840-1,059	1	---	1	2
1,060-1,279	1	---	---	1
Over 1,280	---	---	1	1
Total	50[1]	3[1]	12	65[2]

[1]Includes one farmer who did not report total acres operated.
[2]Includes two farmers who did not report total acres operated.

[10]Albert Hagan, "Missouri Custom Rates" (University of Missouri Department of Agricultural Economics, 1960), pp. 1, 4, and 19. (mimeographed).

cent, respectively, had drainage ditches in addition to wells as sources of water. The rest considered drainage ditches as their exclusive source of water, as shown in Table 14.

TABLE 14-SOURCES OF WATER USED FOR IRRIGATION BY TENURE OF OPERATORS, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Source of Water	Owner Operator	Part Owner	Tenant	Total
Wells	12	21	17	50
Drainage Ditch	1	1	1	3
Combination Well and Drainage Ditch	7	4	1	12
Total	20	26	19	65

INVESTMENT IN IRRIGATION EQUIPMENT

The fixed investment in irrigation equipment for the 65 farmers averaged $7,122 per farm (Table 15). This amount was considered the best estimate of the population value. The 0.95 confidence interval was from $6,282 to $8,012. This interval has a 0.95 chance of including the value of the universe mean. There was a wide variation in average fixed investment. Sprinkler systems cost more than surface systems, but required less expenditure for land leveling.

Trailer Boom—The average fixed investment for the five farmers with trailer boom systems was $13,210, the largest investment among the five types. Wells, pumps, power units, and distribution systems made up 19, 13, 15, and 53 percent, respectively, of the total investment per farm. The average amount invested in the distribution system, $6,970, was larger than the total investment for portable pipe and sprinkler, gated pipe, and ditches and furrows.

Giant sprinkler—The five farmers with giant sprinkler systems had average investments of $8,784 per farm. The average cost per well, pump, power unit, and distribution system was smaller for the giant sprinkler than for the trailer boom system. Twenty-two, 14, 17, and 47 percent of the total investment was in wells, pumps, power units, and distribution systems, respectively.

Portable pipe and sprinkler—Forty-one farmers had an average of $6,810 per farm invested in portable pipe and sprinkler systems. The total invested per well, pump, power unit, and distribution equipment was smaller for portable pipe and sprinkler systems than for trailer boom and giant sprinkler systems. The percentage of the total investment per farm for wells, pumps, and power units was smaller for portable pipe and sprinkler systems than for the other types. The distribution system investment for portable pipe and sprinkler systems was 57 percent of the total, higher than for any other type of system.

TABLE 15-FIXED INVESTMENT IN IRRIGATION EQUIPMENT, BY TYPE OF IRRIGATION SYSTEM, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of Equipment	Sprinkler			S		
	Trailer Boom	Giant Sprinkler	Portable Pipe and Small Sprinkler	Gated Pipe	Ditches and Furrows	Total
Wells:						
Number	11	12	71	24	4	122
Average Cost Per Well	$ 1,127	$ 827	$ 711	$ 550	$ 775	$ 735
Average Investment Per Farm	$ 2,480	$1,984	$1,232	$1,200	$1,033	$1,379
Percent of Total Investment	19	22	18	22	25	19
Pumps:						
Number	10	8	54	17	4	93
Average Cost Per Pump	$ 860	$ 775	$ 647	$ 618	$ 850	$ 684
Average Investment Per Farm	$ 1,720	$1,240	$ 851	$ 955	$1,133	$ 978
Percent of Total Investment	13	14	12	17	28	14
Power Units:[1]						
Number	10	8	48	14	4	84
Average Cost Per Power Unit	$ 1,020	$ 912	$ 756	$ 843	$1,125	$ 846
Average Investment Per Farm	$ 2,040	$1,460	$ 886	$1,073	$1,500	$1,094
Percent of Total Investment	15	17	13	19	36	15
Distribution Systems:						
Number	5	5	41	11	3	65
Average Investment Per Farm	$ 6,970	$4,100	$3,841	$2,291	$ 434	$3,671
Percent of Total Investment	53	47	57	42	11	52
Total Investment	$13,210	$8,784	$6,810	$5,519	$4,100	$7,122

[1]Excludes power unit on two farms using farm tractor as source of power.

Surface irrigation-gated pipe—The average investment per farm for the 11 farmers with gated pipe was $5,519. The average cost per well and pump was the lowest of all systems. The average cost of the power unit was lower than in the other systems, except those that used portable pipe and sprinklers. As the water was not distributed under pressure, there was less need for high-capacity pumps. The investment in the distribution system averaged 42 percent of the total investment per farm.

Surface irrigation-ditches and furrows—The percentage of total investment that was in wells, pumps, and power units was higher for this system than for any other type. Only 11 percent of the total was invested in the distribution equipment. Compared with the cost of pipes and sprinklers, the cost of siphon tubes was small. In most instances, water was pumped from wells or other sources of supply into the irrigation ditch. Siphon tubes transferred the water from the irrigation ditch to the furrows or rows. The three farmers who used this system had an average investment per farm of $4,100.

Statistical tests

The null hypothesis of no difference between type of irrigation system and average investment per farm was tested. The five different types were divided into three categories because of the small number in certain systems. Category I contained the portable pipe and sprinkler systems exclusively. Trailer boom and giant sprinklers were combined to form category II. The two methods of surface irrigation were combined as category III. With this arrangement, the average investment per farm was $6,810 for category I; $11,022, category II, and $5,252 for category III.

The difference between the means of the categories was tested by use of the "t" statistic. The standard deviations were unknown, but assumed to be equal. A "t" value of 1.59 was obtained when the difference between the means of categories I and III was tested. The "t" value was not statistically significant at the .05 level. As a result, the null hypothesis was not rejected. The "t" values, when the differences between the means of categories I and II and categories II and III were tested, were -3.38 and -4.34 respectively. The former was statistically significant at the .01 level, and the latter at the .001 level. The null hypotheses were rejected in both tests. There was a significant difference between the average investment in irrigation equipment on category II farms and categories I and III farms.

To obtain additional insight into the reasons for a significant difference between the means, the average cost per well, pump, power unit, and distribution system was determined. By reducing the analysis of costs to a per well, pump, and power unit basis, the effects of the larger capacity systems were partially eliminated. But the larger capacity effect was not removed by using the cost per distribution system, because the larger systems of all categories directly reflected the increased quantity of main and lateral lines or gated pipe.

The average cost per well was $850 for category I, $893 for category II, and $881 for category III systems. The differences between the means were tested but were not statistically significant. The null hypotheses were not rejected.

The average cost per pump was $639, $790 and $771 for category I, II, and III systems, respectively. The differences between the means were not statistically significant.

Category I, II, and III systems had an average cost per power unit of $848, $1,027, and $1,042, respectively. The differences between the means were not statistically significant.

The average cost per distribution system was $3,842, $5,560 and $1,893 for category I, II, and III systems, respectively. A "t" value of -2.44 was calculated when the difference between the means of categories I and II were tested. The "t" value was statistically significant at the .02 probability level. The null hypothesis was rejected. There was a significant difference in the average cost of distribution equipment for category I and II systems.

A "t" value of 3.46 was calculated when the difference between the means of categories I and II were tested, which was statistically significant at the .01 probability level. The null hypothesis was rejected.

The null hypothesis also was rejected, when the difference between the means of category II and III systems was tested A "t" value of 4.19 was computed, which was statistically significant at the .001 probability level.

Capacity of Irrigation Systems

The capacity of irrigation equipment was defined as the total number of acres the farmer thought the system could cover to prevent decreased crop yields from lack of moisture. Implicit in the definition is the fact that the total number of acres may be irrigated more than one time and/or different crops may be irrigated at different times during the growing season.

The average capacity of all irrigation systems in the sample was 128 acres. The capacity of individual systems ranged from 11 to 510 acres per farm. The modal size was in the 60 to 99 acre class, as shown in Table 16.

The hypothesis of independence between capacity of irrigation system and total acres operated was tested. A chi square of 23.5 was obtained, which was not significant at the .05 level.

The 60 to 99 acre group was the modal acreage for all tenure classes, as shown in Table 17. Forty-two, 50, and 37 percent of the owners, part owners, and tenants were in this group.

The mean capacity of the irrigation system for owner operators was 105 acres; 121 for part owners, and 160 for tenants. The average capacity of the tenant-operated farms was 52 and 32 percent larger than the systems on the farms of owners and part owners, respectively.

The difference between the mean capacity of irrigation systems was tested for the three tenure classes. The null hypothesis, that $X_1 - X_2 = 0$, was used The standard deviations of the populations were not known, but were assumed

TABLE 16-CAPACITY OF IRRIGATION SYSTEMS, BY TOTAL ACRES OPERATED, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Capacity of Irrigation System	Total Acres Operated										
	1-119	120-239	240-359	360-479	480-599	600-719	720-839	840-1,059	1,060-1,279	Over 1,280	Total
(Acres)											
19 or Less											
Irrigated	---	1	1	---	---	---	---	---	---	---	2
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
20-59											
Irrigated	---	2	---	---	---	---	---	---	---	---	2
Did Not Irrigate	---	---	1	---	---	---	---	---	---	---	1
60-99											
Irrigated	3	4	2	2	1	3	2	---	---	---	17
Did Not Irrigate	1	1	3	2	2	---	1	---	---	---	11[1]
100-139											
Irrigated	1	4	---	1	---	1	---	---	---	1	8
Did Not Irrigate	---	1	---	---	---	---	---	---	---	---	1
140-179											
Irrigated	---	---	2	2	1	---	---	---	---	---	5
Did Not Irrigate	---	---	1	---	1	1	---	2	---	---	5
180-219											
Irrigated	---	1	2	1	1	1	---	---	---	---	6
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
220-259											
Irrigated	---	1	1	2	---	---	---	---	---	---	4
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
300-339											
Irrigated	---	---	---	1	---	---	---	---	---	---	1
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---

TABLE 16 Continued

Capacity of Irrigation System	Total Acres Operated										
	1-119	120-239	240-359	360-479	480-599	600-719	720-839	840-1,059	1,060-1,279	Over 1,280	Total
Over 340											
Irrigated	---	---	---	---	---	---	---	---	1	---	1
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
Total											
Irrigated	4	13	8	9	3	5	2	---	1	1	46
Did Not Irrigate	1	2	5	2	3	1	1	2	---	---	19[2]

[1]Includes one farmer who did not report total acres operated.
[2]Includes one farmer who did not report total acres operated or capacity of irrigation system.

TABLE 17-CAPACITY OF IRRIGATION SYSTEMS, BY TENURE OF OPERATOR, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Tenure	Capacity of Irrigation System (Acres)										
	19 or Less	20-59	60-99	100-139	140-179	180-219	220-259	260-299	300-399	340 or Over	Total
Owner-Operator											
Irrigated	1	2	5	4	---	1	---	---	---	---	13
Did Not Irrigate	---	---	3	1	2	---	---	---	---	---	6
Part-Owner											
Irrigated	1	1	6	1	3	3	2	---	---	---	17
Did Not Irrigate	---	---	7	---	2	---	---	---	---	---	9
Tenant											
Irrigated	---	---	5	3	2	2	2	---	1	1	16
Did Not Irrigate	---	---	2	---	1	---	---	---	---	---	3
Total											
Irrigated	2	3	16	8	5	6	4	---	1	1	46
Did Not Irrigate	---	---	12	1	5	---	---	---	---	---[1]	18

[1]One owner-operator did not irrigate and did not report capacity of system.

to be equal. A "t" value of -.79 was obtained, when the difference between the system capacity of owners and part owners was tested. A "t" value of 2.021 was necessary to reject the null hypothesis. Consequently, the null hypothesis was not rejected. Values for "t" of -1,812 and 1.47 were obtained when the differences between owners and tenants and tenants and part-owners were tested. The null hypothesis was not rejected in either test.

The hypothesis of independence between the capacity of the irrigation system and whether the farmer irrigated or did not irrigate in 1959 was tested. A chi square of 5.29 was obtained. The chi square at the .05 level was 7.81. As a result, the hypothesis was not rejected. The probability of obtaining a chi square larger than 5.29 was .17.

Investment and Capacity

The average capacity of the portable pipe and sprinkler systems was 118 acres. The range was from 11 to 219 acres. The average investment in irrigation equipment ranged from $3,600 for the 19 acres or less group to $10,660 for the 180 to 219 acres group, as shown in Table 18. The average investment per acre of irrigation capacity varied from $360 for the 19 acres or less group to $52 for the 140 to 179 acre group.

The five farms with giant sprinkler systems had an average capacity of 144 acres. The range was from 60 to 259 acres, as shown in Table 19. The average investment in irrigation equipment ranged from $5,900 for the 60 to 99 acre group to $12,122 for the 220 to 259 acre group. The small number of cases within each class limited the importance of the data for purposes of projection.

The trailer boom system was the largest of the five and had an average capacity of 290 acres. The range was from 140 to 510 acres. The limited number of cases, particularly in the large-capacity systems, affected the data considerably. The average investment in irrigation plants of this type ranged from $7,400 to $16,100. The average investment per capacity acre was practically constant, ranging from $45 to $56, with a mean of $46.

The capacity of the irrigation systems on the three farms using ditches, furrows and siphon tubes to distribute the water differed for each farm. Essentially, the analysis required a case study of each operating unit. The cost of grading land was not included in the total investment for the two surface-type systems. The total investment for the 60-99, 100-139, and 140-179 acre systems, was $2,500, $4,600, and $5,200, respectively, as shown in Table 20. The average investment per acre was $31, $38, and $32 for the 60-99, 100-139, and 140-179 acre groups, respectively.

The average capacity of the irrigation systems of the 11 farmers with gated pipe was 87 acres. Ten of the 11 had systems with capacities in the 60-99 acre range. The total investment in equipment averaged $4,970 for the 60-99 acre group, and $10,000 for the 140-179 acre group. The average investment per acre was $63 and $62, as shown in Table 20.

Based on the above analysis, it appeared that with the same number of acres irrigated, total investment and average investment per acre were approximately twice as much for gated pipe equipment as for the ditch and furrow systems.

TABLE 18-FIXED INVESTMENT IN PORTABLE PIPE AND SPRINKLER IRRIGATION SYSTEMS, BY CAPACITY OF SYSTEM, 39 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of Equipment	Capacity of Irrigation System (Acres Per Year)					
	19 or Less	20-59	60-99	100-139	140-179	180-219
Wells:						
Number of Wells	2	3	27	11	11	13
Average Cost Per Well	$ 600	$ 633	$ 550	$ 764	$ 936	$ 892
Average Investment Per Farm	$ 600	$ 633	$ 993	$1,200	$1,471	$ 2,320
Percent of Total Investment	17	18	17	18	18	22
Pumps:						
Number of Pumps	2	3	17	9	7	11
Average Cost Per Pump	$ 500	$ 400	$ 632	$ 733	$ 725	$ 627
Average Investment Per Farm	$ 500	$ 400	$ 714	$ 943	$ 828	$ 1,380
Percent of Total Investment	14	11	13	14	10	13
Power Units:[1]						
Number of Power Units	1	2	16	8	7	9
Average Cost Per Power Unit	$ 500	$ 600	$ 806	$ 787	$1,086	$ 655
Average Investment Per Farm	$ 250	$ 400	$ 860	$ 900	$1,086	$ 1,180
Percent of Total Investment	7	11	15	14	13	11
Distribution System:						
Number of Systems	2	3	15	7	7	5
Average Investment Per Farm	$2,250	$2,167	$3,113	$3,514	$4,942	$ 5,780
Percent of Total Investment	62	60	55	54	59	54
Total Investment:	$3,600	$3,600	$5,680	$6,557	$8,327	$10,660
Average Per Acre Investment	$ 360	$ 90	$ 71	$ 55	$ 52	$ 53

[1]Excludes power unit investment on one farm using farm tractor as a source of power.

TABLE 19-FIXED INVESTMENT IN TRAILER BOOM AND GIANT SPRINKLER IRRIGATION EQUIPMENT BY CAPACITY OF SYSTEM, 10 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

	Capacity of Irrigation System (Acres Per Year)							
	Giant Sprinkler			Trailer Boom				
Type of Equipment	60-99	100-139	180-219	220-259	140-179	220-259	330-339	340 or Over
Wells:								
Number	2	4	4	2	2	5	2	2
Average Cost Per Well	$ 750	$ 725	$ 1,025	$ 711	$ 650	$ 880	$ 800	$ 2,550
Average Investment Per Farm	$ 750	$2,900	$ 4,100[1]	$ 1,422	$1,300	$ 2,200	$ 1,600	$ 5,100
Percent of Total Investment	13	35	34	12	18	16	10	32
Pumps:								
Number	2	1	3	2	1	5	2	2
Average Cost Per Pump	$ 750	$ 400	$ 1,033	$ 600	$ 800	$ 640	$ 1,300	$ 1,000
Average Investment Per Farm	$ 750	$ 400	$ 3,100	$ 1,200	$ 800	$ 1,600	$ 2,600	$ 2,000
Percent of Total Investment	13	5	26	10	11	12	17	12
Power Units:								
Number	2	1	3	2	1	5	1	3
Average Cost Per Power Unit	$ 700	$1,700	$ 800	$ 900	$ 900	$ 840	$ 1,800	$ 1,100
Average Investment Per Farm	$ 700	$1,700	$ 2,400	$ 1,800	$ 900	$ 2,100	$ 1,800	$ 3,300
Percent of Total Investment	12	20	20	15	12	16	12	21
Distribution System:								
Number	2	1	1	1	1	2	1	1
Average Investment Per Farm	$3,700	$3,300	$ 2,400	$ 7,700	$4,400	$ 7,600	$ 9,500	$ 5,700
Percent of Total Investment	62	40	20	63	59	56	61	35
Total Investment	$5,900	$8,300	$12,000	$12,122	$7,400	$13,500	$15,500	$16,100
Average Per Acre Investment	$ 74	$ 69	$ 60	$ 50	$ 46	$ 56	$ 48	$ 45

[1]Drainage ditch was used as a source of irrigation also.

TABLE 20-FIXED INVESTMENT IN SURFACE IRRIGATION EXPERIMENT BY CAPACITY OF SYSTEM, 14 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of Equipment	Capacity of Irrigation System (Acres Per Year)				
	Ditches and Furrows			Gated Pipe	
	60-99	100-139	140-179	60-99	140-179
Wells:					
Number of Wells	1	1	1	21	3
Average Cost Per Well	$ 700	$ 700	$1,700	$ 581	$ 333
Average Investment Per Farm	$ 700	$ 700	$1,700	$1,220	$ 1,000
Percent of Total Investment	28	15	33	24	10
Pumps:					
Number of Pumps	2	1	1	15	2
Average Cost Per Pump	$ 300	$1,600	$1,200	$ 524	$ 800
Average Investment Per Farm	$ 600	$1,600	$1,200	$ 870	$ 1,600
Percent of Total Investment	24	35	23	17	16
Power Units:					
Number of Power Units	2	1	1	12	2
Average Cost Per Power Unit	$ 450	$1,500	$2,100	$ 825	$ 950
Average Investment Per Farm	$ 900	$1,500	$2,100	$ 910	$ 1,900
Percent of Total Investment	36	33	40	20	19
Distribution Systems:					
Number of Systems	1	1	1	10	1
Average Investment Per Farm	$ 300	$ 800	$ 200	$1,970	$ 5,500
Percent of Total Investment	12	17	4	39	55
Total Investment	$2,500[1]	$4,600[2]	$5,200	$4,970[3]	$10,000
Average Per Acre Investment	$ 31	$ 38	$ 32	$ 63	$ 62

[1]Sixty-two acres were graded with an average cost of $15 per acre.
[2]One hundred and twenty-five acres were graded with an average cost of $104 per acre.
[3]Twenty acres were graded with an average cost of $20 per acre.

These three categories were used also in testing the difference between average capacity for different types of irrigation systems. Category I, II, and III systems had average capacities of 118, 217, and 93 acres, respectively.

The null hypothesis of no difference between the type of irrigation system and average capacity per farm was tested. A "t" value of 1.33 was obtained when differences between the means of categories I and III were tested. The "t" value was not statistically significant at the .05 probability level. Therefore, the null hypothesis was not rejected.

The "t" values, when the differences between the means of categories I and II and categories II and III were tested, were -3.30 and -3.35 respectively. Both "t" values were statistically significant at the .01 probability level. The null hypotheses were rejected in both tests. Average capacity per farm differed significantly between category II and category I and III systems.

As shown previously, the average capacity of the irrigation systems was 128 acres. The average fixed investment was $7,122. Therefore, the average fixed investment per capacity acre was approximately $56. The modal class of total fixed investment was $3,000 to $5,999. Twenty-six of the 65 farmers were in this group, as shown in Table 21.

The relationship between fixed investment in irrigation equipment and total acres operated was analyzed. When the hypothesis of independence was tested, the chi square of 24.98 obtained was not significant at the .05 probability level. A chi square of this magnitude suggests a probability of .21 of obtaining a larger chi square. The hypothesis was not rejected.

The relationship between fixed investment in irrigation per farm and whether the farmer irrigated or did not irrigate in 1959 was not statistically significant. When the hypothesis of independence was tested, a chi square of 7.32 was obtained. The probability of obtaining a larger chi square was about .12, which is relatively close to the zone of rejection.

Other things being equal, the assumption can be made that farmers with large investments in irrigation equipment will attempt to recover their fixed investment at a faster rate than farmers with smaller investments. In other words, farmers with larger investments are more responsive to irrigation opportunities than farmers with small investments. As shown above, the data do not support this assumption statistically.

The 65 farmers had made investments in irrigation equipment which ranged from $1,900 to $19,000 per farm (Table 22). Forty percent of the 65 had investments within the $3,000 to $5,999 class. Sixty, 38, and 26 percent of the owners, part owners, and tenants, respectively, were in this class. However, 35, 54, and 68 percent of the owners, part owners, and tenants respectively had investments of $6,000 or more.

The relationship between fixed investment in irrigation equipment and tenure of operator was analyzed. When the hypothesis of independence was tested, a chi square of 10.0 was obtained, which was not statistically significant at the .05 probability level. The hypothesis was not rejected. The probability of obtaining a chi square larger than 10.0 was approximately .27.

TABLE 21-FIXED INVESTMENT IN IRRIGATION EQUIPMENT, BY TOTAL ACRES OPERATED, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Fixed Investment	Total Acres Operated										
	1-119	120-239	240-359	360-479	480-599	600-719	720-839	840-1,059	1,060-1,279	Over 1,280	Total
(Dollars)											
1,000-2,999											
Irrigated	1	---	1	---	---	---	---	---	---	---	2
Did Not Irrigate	---	---	---	---	1	---	1	---	---	---	2
3,000-5,999											
Irrigated	---	6	3	2	---	3	---	---	---	---	14
Did Not Irrigate	1	2	3	2	---	---	1	1	---	---	12[1]
6,000-8,999											
Irrigated	3	6	1	1	2	2	1	---	---	---	16
Did Not Irrigate	---	---	---	---	1	1	---	1	---	---	3
9,000-11,999											
Irrigated	---	---	2	3	---	---	---	---	---	---	5
Did Not Irrigate	---	---	1	---	1	---	---	---	---	---	2
12,000-14,999											
Irrigated	---	---	2	2	---	---	---	---	---	1	5
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
15,000-17,999											
Irrigated	---	1	---	1	---	---	---	---	1	---	3
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
18,000-20,999											
Irrigated	---	---	---	---	1	---	---	---	---	---	1
Did Not Irrigate	---	---	---	---	---	---	---	---	---	---	---
Total											
Irrigated	4	13	9	9	3	5	1	---	1	1	46
Did Not Irrigate	1	2	4	2	3	1	2	2	---	---	19[1]

[1]Includes two farmers who did not report total acres operated.

TABLE 22-FIXED INVESTMENT IN IRRIGATION EQUIPMENT, BY TENURE OF OPERATOR, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Tenure	Fixed Investment (Dollars)							
	1,000-2,999	3,000-5,999	6,000-8,999	9,000-11,999	12,000-14,999	15,000-17,999	18,000-20,999	Total
Owner-Operator								
Irrigated	1	6	4	1	1	---	---	13
Did Not Irrigate	---	6	1	---	---	---	---	7
Part Owner								
Irrigated	1	5	5	3	3	---	---	17
Did Not Irrigate	1	5	1	2	---	---	---	9
Tenant								
Irrigated	---	4	6	1	1	3	1	16
Did Not Irrigate	1	1	1	---	---	---	---	3
Total								
Irrigated	2	15	15	5	5	3	1	46
Did Not Irrigate	2	12	3	2	---	---	---	19

As shown in Table 23, the average investment in irrigation equipment per farm was $7,122. Costs of wells, pumps, power units, and distribution systems were classed as fixed investment. The average investment per farm in the distribution system was $3,671, or 52 percent of the total amount. The average investment per farm in wells was $1,379, or 19 percent. Cost of power units averaged 15 percent, or $1,094 per farm. Investments in pumps averaged $978 or 14 percent of the total.

The investment on farms operated by tenants averaged $8,817, which was the largest of the tenure groups (Table 23). Distribution systems, wells, power units, and pumps accounted for 54, 20, 14, and 12 percent, respectively, of the average investment per farm.

The fixed investment in irrigation equipment on the farms of part owners averaged $6,859. The cost of the distribution system accounted for 50 percent of the total. The investment in wells was second with 19 percent. Power units and pumps accounted for 16 and 15 percent, respectively.

TABLE 23-FIXED INVESTMENT IN IRRIGATION WELLS, PUMPS, POWER UNITS, AND DISTRIBUTION SYSTEMS, BY TENURE OF OPERATOR, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of Equipment	Owner Operator	Part Owner	Tenant	Total
Wells:				
Number	34	50	38	122
Average Cost Per Well	$ 667	$ 683	$ 864	$ 735
Average Investment Per Farm	$1,134	$1,313	$1,727	$1,379
Percent of Total Investment	19	19	20	19
Pumps:				
Number	25	40	28	93
Average Cost Per Well	$ 740	$ 643	$ 693	$ 684
Average Investment Per Farm	$ 925	$ 988	$1,021	$ 978
Percent of Total Investment	16	15	12	14
Power Units:[1]				
Number	24	33	27	84
Average Cost Per Power Unit	$ 729	$ 885	$ 904	$ 846
Average Investment Per Farm	$ 875	$1,123	$1,285	$1,094
Percent of Total Investment	15	16	14	15
Distribution Systems:				
Number	20	26	19	65
Average Investment Per Farm	$2,920	$3,435	$4,784	$3,671
Percent of Total Investment	50	50	54	52
Total Investment	$5,854	$6,859	$8,817	$7,122

[1]Excludes power unit investment on two farms using the farm tractor as a source of power.

The fixed investment of owner operators averaged $5,854 per farm, the smallest investment among the three tenure groups. The proportion of the total in the four items was similar to the part owners (Table 23).

Characteristics of Irrigation Equipment Loans

Twenty-nine of the 65 farmers had purchased irrigation equipment on credit, as shown in Table 24. The average amount borrowed was $5,291, but the amount per farm ranged from $1,500 to $15,550. Credit was obtained from irrigation equipment dealers, commercial banks, Farmers Home Administration, production credit associations, Federal land bank associations and insurance companies. In terms of number of loans, commercial banks and irrigation-equipment dealers

TABLE 24-AMOUNT, SOURCE, INTEREST RATE, AND TERM OF LOAN USED TO PURCHASE IRRIGATION EQUIPMENT, BY TENURE OF OPERATOR, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1953-58

Item	Owner Operator	Part Owner	Tenant	Total
Number of Farmers	8	14	7	29
Average Amount Borrowed	$4,500	$ 4,550[1]	$ 6,348	$ 5,291
Range	$2,500-7,700	$ 1,500-10,000	$ 3,440-13,550	$ 1,500-15,550
Source:				
Irrigation Dealer	1	4	3	8
Commercial Bank	1	5	4	10
Farmers Home Administration	2	2	---	4
Production Credit Administration	---	1	---	1
Insurance Company	3	1	---	4
Federal Land Bank	1	1	---	2
Average Interest Rate (percent)	5.0	5.58	6.28	5.59
Range	4.0-7.0	4.0-8.0	5.0-8.0	4.0-8.0
Average Length of Loan (years)	15.1	8.8	4.6	9.5
Range (years)	3-30	1-30	3-10	1-30
Year Borrowed:				
1953	---	2	---	2
1954	1	3	3	7
1955	2	2	1	5
1956	2	4	2	8
1957	2	3	1	6
1958	1	---	---	1

[1] Does not include two loans obtained by the land owners to purchase irrigation equipment.

were the major sources of funds. The average interest rate was 5.6 percent, with a range from 4.0 to 8.0 percent. The average length of loan was 9.5 years, with a range from 1 to 30 years. Most of the loans were executed in 1954 and 1956.

The proportion of irrigators who used credit was used to establish confidence limits for the population. The 0.95 confidence interval ranged from .325 to .567. The universe proportion has a .95 chance of being within this interval.

The loans obtained by tenants were larger, had a higher rate of interest, and a shorter average length than those obtained by owners and part owners. The average amount borrowed by tenants was $6,348, the interest rate averaged 6.28 percent and the term, 4.6 years. The sources were commercial banks and irrigation-equipment dealers.

Owner-operators obtained the smallest loans and their annual costs of financing the credit were lower than for other borrowers. The average amount borrowed was $4,500, and the interest rate was 5.0 percent. The average length of loan was 15.1 years. Fifty percent of the loans were obtained from insurance companies and the Federal land bank with farmland given as security. Availability of land for security was the main reason for the superior credit terms obtained by owners as compared with tenants.

The average amount borrowed by part owners was $4,550 and the average term was 8.8 years. The average rate of interest was 5.58 percent, which is between the rates for the other tenure groups. A majority of part owners obtained loans from commercial banks and irrigation-equipment dealers; however, the longer term, lower rate loans from insurance companies and the Federal land bank lowered the average rate of interest and increased the average time allowed for repayment.

IRRIGATION IN 1959

Number of Farmers Applying Water

Forty-six of the 65 farmers from whom data were obtained applied water to crops in 1959. This was 71 percent of the number interviewed. The proportion of farmers who did not irrigate was designated as "q", which was 1-p or 29 percent. The sample statistic, "p" was considered the best estimate of the proportion of irrigating farmers in the population. The 0.95 confidence interval for the population proportion of irrigators was between .597 and .818.

The relationship between the type of irrigation system and whether or not the operator irrigated in 1959 was tested. The chi square of 1.73 obtained was not statistically significant at the .05 probability level. The hypothesis was not rejected. The probability of obtaining a chi square larger than 1.73 was .44.

Irrigated Acres

"Acres irrigated" were defined as the area to which water was applied, regardless of the number of water applications. An acre application was defined as

the application of water to one acre one time. For example, 10 acres watered four times would equal 10 irrigated acres and 40 acre applications. However, if the 10 acres were watered only one time, both the irrigated acres and acre applications would equal 10.

The 46 irrigating farmers applied water to 2,637 acres of land. The average number of irrigated acres per farm was 57. The range was from 11 to 232 acres. The average number of irrigated acres by the respondents was considered to be the best estimate of the average number of irrigated acres per farm in the population. The 0.95 confidence interval for the average number of irrigated acres in the population was from 44 to 71 acres per farm. This interval has a 0.95 chance of including the universe mean.

It was estimated that 7,546 total acres were irrigated by the 186 farmers in the population. The formula, $\frac{1}{f}(X)$ = estimate of total acres irrigated, was used. X equaled the total number of acres irrigated by the 65 sample members, and "f" was the sampling fraction. The 0.95 confidence interval for the total irrigated acres by the 186 population members was from 4,883 to 10,210 acres.

The total capacity of the irrigation systems within the population was estimated to be 23,445 acres, using the irrigated acres concept. No attempt was made to estimate the number of acre applications that could have been made by the 186 farmers.

The proportions of total irrigation capacity employed in 1959 was estimated to be 20 to 44 percent. These percentages were estimated from the sample proportion of irrigated acres. Based on this analysis, it was evident that the irrigation systems were not used to capacity in 1959.

Acre Applications

The 46 farmers irrigating in 1959 made 4,486 acre applications of water. The average number per farm was 97.5, with a range from 11 to 522. The probability was 0.95 that the universe mean of acre applications per farm was between 69 and 126. Since 2,637 acres were irrigated, and 4,486 acre applications of water were made, each acre was watered an average of 1.7 times.

Crops Irrigated

Cotton, corn, and soybeans were the major irrigated crops. Other crops were strawberries, sweet corn, pasture, cabbage, and wheat. The detailed analysis covers only cotton, corn, and soybeans because of the limited number of irrigators and irrigated acreage of other crops. The irrigated acreage of cotton, corn, and soybeans made up 94.7 percent of the total to which water was applied.

Cotton—Cotton was the major irrigated crop. Thirty-five farmers applied water to 1,523 acres. Four hundred and eleven acres were irrigated twice and 273 acres three times. An average of 2.89 inches of water was applied per acre. The farmers believed that they were actually getting 2.89 inches of water on the

ground. The loss from evaporation, wind, and seepage had been taken into consideration. The 0.95 confidence interval for the universe mean was between 2.38 and 3.41 inches of water per acre.

An average of 43.5 acres of cotton was irrigated per farm by the 35 farmers. It was estimated that the average number of acres of cotton irrigated by all farmers with equipment was from 34 to 53 acres.

The irrigated acreage of cotton made up 58 percent of the total acreage to which water was applied. Based on the sample statistics from the records obtained, it was estimated that cotton was between .45 and .70 of the total acres irrigated by all of the farmers who had equipment.

Cotton-Yield response from irrigation—Fifteen, or 43 percent, of the 35 farmers obtained a yield response from irrigation. One reason for the limited results was time of application. Immediately after planting, 10 of the 35 farmers applied a limited quantity of water to germinate the seed. Most of these growers made no further applications. Thus it was not surprising that no yield response could be attributed to irrigation.

The average yield response attributed to irrigation was 66 pounds of lint per acre, even though 57 percent of the cotton irrigators received no increase in yield. The range was from 0 to 300 pounds of lint per acre.

Yield responses for all crops were estimated by the farmers. No field checks were made. In many instances, the farmer actually had two fields of the crop on comparable soils and with production techniques comparable except for irrigation. Other farmers, however, did not have comparable crops. In the latter case, the farmer's estimate was his opinion of the yield increase or a check of the difference between a neighbor's yield and his own.

Corn—Sixteen farmers applied water to 659 acres of corn. Of the total, 397 acres were irrigated twice, and 235 acres, three times. An average of 5.25 inches of water was applied per acre. It was estimated that the average amount of water applied per acre by all farmers who irrigated corn was between 4.2 and 6.3 inches.

The 16 farmers irrigated an average of 41 acres per farm. The universe mean was estimated to be between 21 and 62 acres per farm.

Corn-yield response—Ten, or 62.5 percent, of the 16 farmers reported a yield response from irrigation. Six, or 37.5 percent obtained no yield response. The increase in yield averaged 30 bushels, and ranged from 0 to 50 bushels per acre. It was estimated that the average increase in yield for all corn irrigators in the area was between 21 and 40 bushels per acres.

Soybeans—Thirteen farmers who contributed data for the analysis irrigated 316 acres of soybeans. The number of acres irrigated per farm ranged from 5 to 70 and averaged 24. It was estimated that the average number of acres irrigated per farm by the soybean irrigators was between 14 and 34. One hundred and sixty-four acres were irrigated twice. The remaining acreage received water only once. Water applied per acre ranged from one to 10 inches and averaged 4.4 inches.

Soybeans-yield response—Yield responses from irrigation were reported by 9, or

69.2 percent of the 13 farmers. The average was 8.5 bushels per acre and the range was from 0 to 19 bushels. It was estimated that the average yield increase for soybean irrigators in the Delta Area was from 5 to 12 bushels per acre.

Other irrigated crops—Four farmers irrigated 51 acres of strawberries, and four applied water to 34 acres of pasture. Thirty-five, 15, and four acres of sweet corn, wheat, and cabbage were irrigated. Because of the small number of irrigators, no detailed analysis was made of these crops.

Statistical Test-Difference Between Average Amounts of Water Applied to Different Crops

As stated earlier, water applied per acre to corn, cotton, and soybeans averaged 5.25, 2.89, and 4.37 inches respectively, in 1959. The null hypothesis of no difference between the average for the three crops was tested.

A "t" value of 4.5 was obtained when the difference between the means of corn and cotton was tested. A "t" value of this magnitude was statistically significant at the .001 probability level. The null hypothesis was rejected. In 1959, corn received more water per acre than cotton.

When the difference between the means of corn and soybeans was tested, a "t" value of .95 was obtained. The "t" value was not statistically significant at the .05 probability level. The null hypothesis was not rejected.

A "t" value of 2.26 was obtained when the difference between the means of cotton and soybeans was tested. The "t" value was statistically significant at the .05 probability level. The null hypothesis was rejected. Soybeans received more water per acre than cotton.

The difference between the average amount of water applied per acre to corn and cotton and to soybeans and cotton in 1959 was significant. Cotton received the smallest amount of water per acre.

Statistical Test-Difference Between the Average Gross Return Per Acre Attributable to Irrigation

The average physical product attributable to irrigation was 30 bushels of corn, 8.5 bushels of soybeans, and 66 pounds of lint cotton per acre. In September, October, November, and December 1959, Missouri farmers averaged $1.00 per bushel for corn; .322¢ per pound for lint cotton, and $1.95 per bushel for soybeans. The price per unit of output multiplied by the average physical product per acre equaled the average gross return per acre attributable to irrigation in 1959. The average gross return per acre was $30.36 for corn; $21.24 for cotton, and $16.66 for soybeans.

The difference between the average gross return per acre of the three crops was tested. A "t" value of 1.06 was obtained when the difference between the means of corn and cotton was tested. This value was not statistically significant at the .05 probability level. The null hypothesis was not rejected.

A "t" value of 2.23 was obtained when the difference between the means of corn and soybeans was tested. A value of this magnitude was statistically sig-

nificant at the .05 probability level. The null hypothesis was rejected. There was a significant difference between the average gross return per acre of corn and soybeans. Corn received the higher return.

When the difference between the means of cotton and soybeans was tested, a "t" value of .50 was found. It was not statistically significant at the .05 probability level, and the null hypothesis was not rejected.

The analysis revealed a significant difference between the average gross return per acre of corn and soybeans in 1959. The average irrigated acre of corn returned $13.70 more than the average irrigated acre of soybeans.

Statistical test-difference between adjusted gross return per acre attributable to irrigation—The average gross return per acre minus the cost of harvesting the additional yield was assumed to equal the adjusted gross return per acre attributable to irrigation. The harvesting cost per bushel of corn was .15¢; per pound of seed cotton, .02¢; and per bushel of soybean, .30¢.[11] The average physical output per acre multiplied by the unit harvest cost equaled the average harvest cost per irrigated acre. The adjusted gross return per acre was $25.81 for corn, $17.28 for cotton, and $14.10 for soybeans.

The difference between the adjusted gross return per acre of the three crops was tested. The computed "t" values, when the differences between corn and cotton, corn and soybeans, and cotton and soybeans were tested, were .99, 2.25, and .35, respectively. The "t" value of 2.25 was statistically significant at the .05 probability level. Irrigated corn had a higher adjusted gross return per acre than soybeans. The difference between the adjusted gross return per irrigated acre in 1959 was not significant for corn and cotton nor for cotton and soybeans.

IRRIGATION COSTS AND RETURNS

Production costs are important to decision makers in all firms. Irrigation costs are no exception. The farm operator needs to have the best available data showing the cost of applying water. The decision as to whether or not to irrigate his crops in a given year depends upon the information that is available concerning costs in relation to expected returns. The amount of investment in equipment has been pointed out. In a humid region such as the Delta of Missouri, profitable crops can be grown in most years without irrigation. This analysis is addressed to the question of whether or not more profit can be made by applying water. Many variables of indeterminate magnitude must be considered. They include the amount and distribution of rainfall, the yield response from irrigation, and the price of the product.

The costs involved in the purchase and use of irrigation systems are of two general types—fixed and variable. Annual fixed costs reflect the amount of capital invested in irrigation equipment and the length of time in the investment period. Variable or operating costs reflect prices of such variable inputs as labor, fuel, oil, and other supplies required to pump and distribute the water and to harvest the increased yield.

[11]An acre application is an acre irrigated one time.

Annual Fixed Cost

The annual fixed cost per irrigation system included depreciation, interest, taxes, and insurance. The following procedures were used in computing the individual items:

$$\text{Depreciation} = \frac{\text{Original Value}}{\text{Years of Useful Life}}$$

The useful life of wells and siphon tubes was estimated to be 20 years. The depreciation schedule for pumps, power units, and distribution systems other than siphon tubes was 15 years. The annual interest charge was equal to half the original value of the equipment multiplied by 5.0 percent

$$\text{Annual Interest} = \frac{\text{Original Value}}{2} \text{ X } .05.$$

The tax charge was the assessed value multiplied by 30 cents per $100 valuation (Taxes = assessed value X $0.30). The annual charge for insurance was obtained by taking 80 percent of the original value of the pump, power unit, and distribution system dividing it by 1000 and multiplying the result by $5.80.

$$\left(\text{Insurance Charge} = \frac{\text{Original Value X .80 X \$5.80}}{\$1000}\right).$$

Depreciation charges made up 69 percent of the annual fixed cost for the three different types of systems as shown in Table 25. Interest charges were second in importance at 27 percent, and taxes and insurance last at four percent.

In 1959, fixed charges averaged 80 percent of the total irrigation costs for the surface and portable pipe and sprinkler systems, and 65 percent for the trailer boom—giant sprinkler systems (Table 25). The relative proportion of fixed costs depended upon the amount the system was used. The more use, or the higher the variable costs, the lower the percentage of fixed charges in relation to the total. The trailer boom-giant sprinkler systems were used more extensively than the other two types, and the percentage of fixed costs, in relation to total costs, was smaller. The range in fixed costs as a percentage of total cost was 59-91, 48-91, and 38-98 percent for the surface, trailer boom-giant sprinkler, and portable pipe and sprinkler systems, respectively. These ranges show that one of the portable pipe and sprinkler systems was used more and one was used less than any other type of system. In general, portable pipe and sprinkler systems used in irrigating strawberries received more use in 1959 than systems used exclusively for field crops.

Variable Costs

After a farm operator has invested in irrigation equipment and can apply supplemental water to crops, variable costs must be considered. The annual fixed costs must be borne as long as the equipment is owned or until the cost has been charged off regardless of the annual use. If the production functions were

TABLE 25-FIXED COSTS AS PERCENTAGE OF FIXED AND TOTAL IRRIGATION COSTS, BY TYPE OF IRRIGATION SYSTEM, 46 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Percent of Fixed Costs		Percent of Total Costs	
	Average	Range	Average	Range
Gated Pipe and Ditches and Furrows:[1] (III)				
Depreciation	69	67-76	55	40-66
Interest	27	21-29	21	16-25
Taxes and Insurance	4	3- 5	4	3- 6
Total Fixed Costs			80	59-91
Giant Sprinkler and Trailer Boom:[2] (II)				
Depreciation	69	64-71	45	31-62
Interest	27	25-31	18	13-24
Taxes and Insurance	4	4- 5	3	2- 5
Total Fixed Costs			65	48-91
Portable Pipe and Sprinkler:[3] (I)				
Depreciation	69	66-70	55	27-68
Interest	27	26-29	21	10-27
Taxes and Insurance	4	4- 5	3	2- 6
Total Fixed Costs			80	38-98

[1]Nine irrigators.
[2]Nine irrigators.
[3]Twenty-eight irrigators.

known and accurate cost data were available, the decision maker could apply water up to the point at which the marginal cost was equal to the marginal revenue from the last unit applied in order to maximize profit. However, knowledge is not perfect in the real world and many uncertainties must be faced. Therefore, on a given farm in a given year, the decision maker should consider the variable costs of applying water in relation to the expected returns from its use. If he expects the return from irrigation to equal or exceed the variable cost, water should be applied. Irrigation can be justified, so long as the average variable costs are covered. Any additional return above the average variable cost will reduce the average fixed cost. The decision maker will need to receive a return greater than the average irrigation cost in many years to make up for the years when the system was not used, and those in which the returns did not pay average variable costs, if the practice is to be profitable. It was assumed that farmers who had purchased irrigation equipment expected returns over the time period of the investment which would equal or be greater than those that could be expected from investment in other endeavors. Otherwise, the original investment in irrigation equipment would not have been logical.

TABLE 26-VARIABLE COSTS AS PERCENTAGE OF VARIABLE AND TOTAL IRRIGATION COSTS, BY TYPE OF IRRIGATION SYSTEM, 46 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Percentage of Variable Costs		Percentage of Total Costs	
	Average	Range	Average	Range
Gated Pipe and Ditches and Furrows:[1] (III)				
Labor	36	14-57	7	1-19
Tractor	4	2- 7	1	0- 1
Fuel and Oil	55	33-87	11	4-20
Minor Repairs and Miscellaneous	5	0-15	1	0- 4
Total Variable Costs			20	12-52
Giant Sprinkler and Trailer Boom:[2] (II)				
Labor	32	22-41	11	5-20
Tractor	5	1- 7	1	0- 4
Fuel and Oil	57	43-76	20	6-32
Minor Repairs and Miscellaneous	6	0-24	2	0-12
Total Variable Costs			35	11-52
Portable Pipe and Sprinkler:[3] (I)				
Labor	41	13-69	8	1-34
Tractor	5	1-18	1	0- 4
Fuel and Oil	51	21-70	10	1-40
Minor Repairs and Miscellaneous	3	0-30	1	0- 3
Total Variable Costs			20	2-62

[1]Nine irrigators.
[2]Nine irrigators.
[3]Twenty-eight irrigators.

Variable costs as a percentage of items in this class, and total irrigation costs were analyzed (Table 26). Expenditures for fuel and oil averaged 55, 57, and 51 percent of the variable costs for the surface, trailer boom-giant sprinkler, and portable pipe and sprinkler systems, respectively. Labor costs were second in importance. Thirty-six, 32, and 41 percent of the variable costs were attributed to labor charges for the surface, trailer boom-giant sprinkler, and portable pipe and sprinkler systems, respectively.

Variable costs as a percentage of the total irrigation costs were 20 percent for the surface and the portable pipe and sprinkler systems. The fuel and oil costs were about twice as large for the trailer boom-giant sprinkler as for the other two systems. Labor costs were seven, 11, and eight percent of the total costs for the three systems.

The labor, tractor, fuel and oil, and minor repairs costs per acre application

TABLE 27-VARIABLE COSTS PER ACRE APPLICATION OF WATER BY TYPE OF IRRIGATION SYSTEM, 46 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Variable Costs Average	Range
	Dollars	Dollars
Gated Pipe and Ditches and Furrows:[1] (III)		
Labor	0.58	.12-1.24
Tractor Cost	.06	.02- .11
Fuel and Oil	.87	.39-1.20
Minor Repairs	.08	.00- .38
Total	1.59	1.00-2.60
Giant Sprinkler and Trailer Boom:[2] (II)		
Labor	.83	.45-1.75
Tractor Cost	.11	.04- .18
Fuel and Oil	1.48	.86-2.80
Minor Repairs	.16	.00- .56
Total	2.58	1.70-4.60
Portable Pipe and Sprinkler:[3] (I)		
Labor	1.15	.50-2.81
Tractor Cost	.14	.10- .24
Fuel and Oil	1.44	.42-3.22
Minor Repairs	.09	.00- .83
Total	2.82	1.37-4.95

[1]Nine irrigators.
[2]Nine irrigators.
[3]Twenty-eight irrigators.

of water were determined for the three different systems (Table 27). The average variable cost per acre application for the surface systems was $1.59, the lowest among the three types of systems.[12] The range was from $1.00 to $2.60. The following items were included: labor, $0.58; tractor, $0.06; fuel and oil, $0.87, and minor repairs, $0.08. The variation in the average cost per acre application was very noticeable within a given type of system, as well as among the different types. The average labor cost per acre application ranged from $0.12 to $1.24 for the surface systems. A range of $0.39 to $1.20 per acre application of water was found for the fuel and oil costs.

[12]United States Department of Agriculture, *Agricultural Statistics;* 1960 (Washington D.C., U.S. Govt. Print. Off.) 1961, Page 61.

The variable cost per acre application of water for the trailer boom-giant sprinkler systems averaged $2.58 and ranged from $1.70 to $4.60. All variable costs were higher for the trailer boom-giant sprinkler systems than for the surface systems. The labor, tractor, fuel and oil, and minor repair costs averaged $0.83, $0.11, $1.48, and $0.16 respectively.

The portable pipe and sprinkler systems had an average variable cost of $2.82 per acre application with a range from $1.37 to $4.95. This was the highest average variable cost among the three different types of systems. The labor and tractor costs were greater for the portable pipe and sprinkler systems than for the other two types. However, the trailer boom-giant sprinkler systems had the greatest fuel and oil, and minor repair costs per acre application.

The difference between the average labor, tractor, fuel and oil, and minor repair costs for the three systems was analyzed. The null hypothesis was tested in all cases. The same classification was given to the different irrigation systems as was followed in the preceding analysis. Category I, portable pipe and sprinklers, category II, giant sprinkler and trailer boom combinations, and category III, gated pipe and ditches and furrows, were used.

Average labor cost per acre application—The difference between the means of average labor cost per acre application was tested. The "t" statistic was used. The standard deviations were unknown but were assumed to be equal. A "t" value of 1.23 was obtained when the difference between the means of categories II and III were tested. The "t" value was not statistically significant at the .05 probability level. The null hypothesis was not rejected. When the difference between the means of categories II and I was tested, a "t" value of -1.42 was obtained. This value was not statistically significant.

The average labor cost per acre application of water was $0.58 and $1.15 for categories II and I, respectively. A "t" value of -2.6 was calculated, which was statistically significant at the .05 probability level. The null hypothesis was rejected. There was a significant difference between the average labor cost per acre application between categories III and I. The average labor cost was greater for category I, and users of this type of equipment had difficulty in hiring workers to move the pipe and sprinklers.

Average tractor cost per acre application—The average tractor cost per acre application was $0.14, $0.11, and $0.06 for categories I, II, and III, respectively, as shown in Table 27. The "t" values, when the difference between the means of categories II and III categories III and I was tested, were 2.13 and -4.40, respectively. The former was statistically significant at the .05 probability level, and the latter at the .001 level. The null hypotheses were rejected in both tests. There was a significant difference between the average tractor cost per acre application on farms with category III and category I and II irrigation systems. The average tractor cost was smallest on farms with surface-type systems. A "t" value of 1.28 was obtained when the difference between the means of categories II and I was tested. As the difference was not statistically significant, the null hypothesis was not rejected.

Average fuel and oil cost per acre application—The average fuel and oil cost per acre application was $1.44, $1.48, and $0.87 for categories I, II, and III, respectively. The "t" values, when the difference between the means of categories II and III and categories III and I was tested, were 2.78 and -2.29, respectively. The former was statistically significant at the .02 probability level, and the latter at the .05 probability level. The null hypotheses were rejected in both cases. There was a significant difference between the average fuel and oil costs per acre application on categories III and categories I and II farms. The average fuel and oil cost was the lowest on farms with surface-type systems. On farms with surface irrigation systems, the water was not pumped under pressure as it was on farms with portable pipe and sprinklers and trailer boom-giant sprinkler systems. A "t" value of .16 was obtained when the difference between the means of fuel and oil costs of categories II and I was tested. As the difference was very small, it was not statistically significant, and the null hypothesis was not rejected.

Average minor repair cost per acre application—The average minor repair cost per acre application was $0.09, $0.16, and $0.08 for categories I, II, and III, respectively. The differences between the means were tested. The "t" values were .78, .64, and .06, which were not statistically significant. The null hypotheses were not rejected.

Total Cost of Irrigation

Fixed plus variable costs equal total irrigation costs. The average fixed, variable, and total costs per acre-inch of water applied, per acre irrigated, and per acre application, for the three different types of systems were analyzed, as shown in Table 28. The computations included the cost of all irrigation done on farms from which data were obtained in 1959. However, costs of harvesting the increased yield were not included in order to keep the analysis on a comparable basis between farmers who received a yield response and those who did not. The costs of irrigating individual crops are analyzed in a later section. Data in Table 28 show average fixed, variable, and total costs of applying water in 1959 by use of three different systems based on the estimated amount of water applied. The farmers who used portable pipe and sprinkler systems applied the smallest amount of water to the smallest number of acres, while those with giant sprinkler-trailer boom systems applied the greatest amount. Differences in system use affected costs, but the small number of cases did not permit further breakdown of the data.

Cost per acre-inch of water—Twenty-eight category I irrigators applied an average of 168 acre-inches of water per farm. The range was extremely wide, from 10 to 1,667 inches. The 1,667 acre-inches were applied to strawberries. The average cost was $5.00 with a range from $0.60 to $99.22 per acre-inch. The very low average cost was the result of intensive use of a small system, while the very high average cost resulted from limited use of a large system. The aver-

TABLE 28-COST OF IRRIGATION PER ACRE-INCH OF WATER APPLIED, PER ACRE IRRIGATED AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 46 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Amount of Water Used Per Farm	Costs		
		Fixed	Variable	Total
		Dollars	Dollars	Dollars
Gated Pipe and Ditch and Furrow:[1] (III)				
Per Acre-Inch				
Average	272	2.12	.55	2.67
Range	118-570	.73-4.41	.21-1.11	1.23-5.25
Per Acre Irrigated				
Average	63	9.11	2.34	11.45
Range	34-115	3.61-20.25	1.00-3.52	6.11-21.62
Per Acre Application				
Average	93	6.21	1.59	7.80
Range	34.190	2.19-20.25	1.00-2.60	3.69-21.62
Giant Sprinkler and Trailer Boom:[2] (II)				
Per Acre-Inch				
Average	486	2.18	1.17	3.35
Range	86-1,220	.92-13.21	.69-1.90	1.93-14.68
Per Acre Irrigated				
Average	111	9.52	5.13	14.65
Range	40-232	4.81-28.41	1.84-9.01	10.10-31.56
Per Acre Application				
Average	221	4.80	2.58	7.38
Range	60-522	2.13-18.94	1.70-4.60	4.48-21.04
Portable Pipe and Sprinkler:[3] (I)				
Per Acre-Inch				
Average	168	4.00	1.00	5.00
Range	10-1,667	.23-97.28	.37-2.43	.60-99.22
Per Acre Irrigated				
Average	38	17.62	4.39	22.01
Range	4-120	4.41-252.95	1.37-56.00	7.23-260.95
Per Acre Application				
Average	59	11.29	2.82	14.11
Range	8-176	2.01-97.28	1.37-4.95	4.18-99.22

[1]Nine irrigators.
[2]Nine irrigators.
[3]Twenty-eight irrigators.

age fixed cost was $4.00 with a range from $0.23 to $97.28. The wide range re- resulted from the same factors that affected the average cost figure. The average variable cost was $1.00 with a range of $0.37 to $2.43. The difference between the high and low average variable cost was $2.06, which was the greatest differ-

ence in cost items among the three systems. Category I farmers had the largest average fixed and total cost per acre-inch of water, but category II farmers had the largest average variable cost.

Nine category II farmers applied an average of 486 acre-inches of water per farm with a range from 86 to 1,220. The average farm in this group received 2.9 times as much water as was applied to category I farms. The average cost per acre-inch was $3.35 with a range from $1.93 to $14.68. The narrower range indicated less variation in system use than among the category I farms. The average fixed and variable costs per acre-inch were $2.18 and $1.17, respectively. The average fixed cost ranged from $0.92 to $13.21, while the average variable cost ranged from $0.69 to $1.90.

An average of 272 acre-inches of water per farm was applied to nine category III farmers. The amount per farm ranged from 118 to 570. The average fixed, variable, and total costs per acre-inch were $2.12, $0.55, and $2.67, respectively. The average farm received 62 percent more water than category I farms, but only 56 percent as much as category II farms. The range was smaller for all three cost groups on category III farms than on farms with the other two types of systems. One reason for the smaller variation was the design of the system. Water can be applied effectively by surface methods only after the land has been graded. The land area that can be irrigated by this method is limited. Also, surface irrigation is not practiced for strawberries or seed germination in most instances. As a result, when applied to graded land, the entire area will receive water, unless rainfall makes the irrigation unnecessary. Field crops normally will require no more than three applications of water during the growing season, so the range in acre-inches applied per farm usually will be narrower than with the other two systems.

Cost per acre irrigated—Category I, II, and III farms average 38, 111, and 63 irrigated acres, respectively. The range per farm was smallest in category III. The average cost per irrigated acre varied from $22.01 on category I farms to $11.45 on category III farms. The average fixed and total costs were largest on category I farms, but the average variable costs were largest on category II farms. Category III farms averaged $9.11, $2.34, and $11.45 for the average fixed, variable, and total costs, which were the lowest among the three types of systems (Table 28).

Cost per acre application—Nine category II farmers averaged 221 acre applications of water per farm, the largest among the three systems. Each irrigated acre received two water applications on the average on category II farms compared with 1.6 and 1.5 on category I and III farms, respectively. As a result, the average fixed and total costs were $4.80 and $7.38 for category II farms, the smallest averages among the three systems. The smallest average variable cost was $1.59 on category III farms.

Irrigation costs per farm—The absolute dollar cost of irrigation per farm was studied to gain an insight into the difference in magnitude of total costs among the three systems (Table 29). The average fixed cost per farm was $671,

TABLE 29–IRRIGATION COSTS PER FARM, BY TYPE OF IRRIGATION SYSTEM, 46 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Irrigation Costs Per Farm	Type of Irrigation System		
	III Gated Pipe and Ditches and Furrows	II Giant Sprinkler and Trailer Boom	III Portable Pipe and Sprinkler
Number of Farms	9	9	28
Average Fixed Cost	$578	$1,059	$671
Percent of Total Cost	80	65	80
Average Variable Cost	$148	$ 570	$167
Percent of Total Cost	20	35	20
Average Cost	$726	$1,629	$838
Percent of Total Cost	100	100	100

$1,059, and $578 on category I, II, and III farms, respectively. These data reflected differences in the investment in irrigation equipment among the three systems.

The average variable cost per farm was $167, $570, and $148 for category I, II, and III farms, respectively. The absolute variable cost in 1959 on category II farms was 285 percent greater than on category III farms, and 241 percent greater than on category I farms.

When a farm operator decides to apply water, the risk involved per farm approximates the expected variable cost of irrigation. The magnitude of cash loss per farm does not seem large in light of the average variable cost in 1959. The breakeven point required to cover average variable cost per acre-inch of water, per irrigated acre, and per acre application is analyzed later.

Cost of Irrigating Specific Crops

The Average fixed, variable, and total cost of irrigating corn, cotton, and soybeans was determined. Because of the limited number of irrigators, the cost of applying water to other crops was not computed. The proportion of the annual fixed cost assigned to each crop was determined by the following procedure:

$$\text{Irrigated acres of one crop} \times \frac{\text{annual fixed cost}}{\text{Total irrigated acres}} = \text{Fixed cost assigned to that crop}$$

If the irrigation system was used to water one crop exclusively, all of the fixed costs were assigned to that crop. Consequently, when a relatively small acreage of one crop only received water, the average cost per unit analyzed was very large.

Corn

Cost per acre-inch of water—Eight category I farmers applied an average of 66 acre-inches of water per farm to corn (Table 30). The range was from 24 to 212

TABLE 30-CORN: ESTIMATED COST OF IRRIGATION PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION; AND YIELD RESPONSE, BY TYPE OF IRRIGATION SYSTEM, 16 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Amount of Water Used Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Dollars
Portable Pipe and Sprinkler:[1] (I)					
Per Acre-Inch					
Average	66	4.97	1.16	6.13	12
Range	24-212	2.15-17.93	.46-2.20	2.66-17.75	0-23
Per Acre Irrigated					
Average	25	12.97	3.04	16.01	31
Range	5-85	4.41-53.78	.92-10.20	5.32-55.40	0-50
Per Acre Application					
Average	27	11.96	2.81	14.77	28
Range	8-85	4.41-53.78	.92-5.10	5.32-55.40	0-50
Giant Sprinkler and Trailer Boom:[2] (II)					
Per Acre-Inch					
Average	398	1.21	.98	2.19	5
Range	72-1,020	.75-4.01	.68-1.76	1.77-4.69	0-7
Per Acre Irrigated					
Average	66	7.33	5.87	13.20	32
Range	15-160	4.81-12.03	2.04-8.47	11.26-20.47	0-40
Per Acre Application					
Average	167	2.89	2.32	5.21	13
Range	25-440	1.75-12.03	2.04-3.02	4.10-14.07	0-16
Surface System:[3] (III)					
Per Acre-Inch					
Average	233	1.05	.47	1.52	5
Range	28-551	.94-2.50	.44-1.11	1.38-3.61	0-6
Per Acre Irrigated					
Average	42	5.79	2.59	8.38	26
Range	7-80	3.61-10.01	1.43-4.43	5.04-14.44	0.40

TABLE 30 Continued

Type of System	Amount of Water Used Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
Per Acre Application					
Average	77	3.17	1.42	4.59	14
Range	7-185	2.82	1.30-	4.12	0-20
		10.01	4.43	14.44	

[1]Eight farmers applied an average of 2.6 inches of water per acre. Each acre was irrigated the equivalent of 1.1 times.
[2]Five farmers applied an average of 6.0 inches of water per acre. Each acre was irrigated the equivalent of 2.5 times.
[3]Three farmers applied an average of 5.5 inches of water per acre. Each acre was irrigated the equivalent of 1.8 times.

inches. The average fixed, variable, and total costs were $4.97, $1.16, and $6.13, respectively.

The estimated yield response was 12 bushels per acre-inch of water applied. The range was from no increase to 23 bushels. The net return attributed to irrigation and the effect of irrigation on farm income is discussed in later sections.

Five category II farmers applied an average of 398 acre-inches of water per farm (Table 30): The average fixed, variable, and total costs per acre-inch were $1.21, $0.98, and $2.19, respectively.

The estimated yield response was five bushels of corn per acre-inch of water. The range was from no increase to seven bushels.

Three category III farmers applied an average of 233 acre-inches of water per farm. The range was from 28 to 551 acre-inches. The average fixed, variable, and total costs per acre-inch of water were lower on farms with category III systems than on farms with other types of systems.

Cost per acre irrigated—Farmers with category II systems applied water to an average of 66 acres of corn, while farmers with category III and I systems irrigated 42 and 25 acres, respectively. The average fixed, variable, and total costs per acre were $5.79, $2.59, and $8.38, respectively, for category III systems, the smallest among the three systems (Table 30). The average application of water per acre was 2.6, 6.0, and 5.5 inches with category I, II, and III systems, respectively. The average yield increase per acre ranged from 0 to 50 bushels, but the average yield increase for category I, II, and III systems was 31, 32, and 26 bushels, respectively.

Cost per acre application—Water was applied an average of 1.1, 2.5, and 1.8 times per acre on farms with category I, II, and III systems, respectively. The estimated yield response per acre application ranged from 0 to 50 bushels, but the average for category I, II, and III systems was 28, 13, and 14 bushels, respectively. The category I system had average fixed, variable, and total costs per

acre application of $11.96, $2.81, and $14.77, respectively, the largest average cost among the three systems. The close relationship between the cost per irrigated acre and the cost per acre application with category I systems reflected limited use compared with the other two systems.

Cotton

Cost per acre-inch of water—Nineteen farmers with category I systems applied an average of 77 acre-inches per farm. The amount ranged from 10 to 255 acre-inches. The average cost per acre-inch was $8.92. Fixed cost represented $7.60 of the average cost (Table 31). The average fixed cost was high and the average cost range wide because of limited use of large-capacity systems. Eight of the 19 farmers applied 1 to 1.5 inches of water per acre on a limited number of acres to germinate the cottonseed. As this was the extent of irrigation on most of the farms, the entire annual fixed cost was charged to cotton irrgation.

The estimated yield response averaged 23 pounds of lint cotton per acre-inch of water and ranged from 0 to 100 pounds of lint. An increase in yield was not expected on the eight farms on which only seed-germination irrigation was applied. In all instances, the total acreage of cotton that could have been irrigated, received no application, and the seed-germination irrigation was halted because of rain.

An average of 214 acre-inches of water per farm was applied by eight farmers with category II systems. The average fixed, variable, and total cost were $3.42, $1.45, and $4.87, respectively. The average yield response per acre-inch of water was 21 pounds of lint cotton. The range was from 0 to 46 pounds.

The average number of acre-inches of water applied per farm was 154 on farms with category III systems. The amount per farm ranged from 26 to 450 acre-inches. The average fixed, variable, and total costs were $2.67, $0.69, and $3.36, respectively. The estimated yield response averaged 13 pounds of lint cotton per acre-inch of water. The range was from 0 to 112 pounds.

Cost per acre irrigated—Farmers with category I systems irrigated 34 acres per farm. Farmers who operated categories II and III systems averaged 65 and 45 acres, respectively. The average fixed, variable, and total costs were $17.30, $3.01, and $20.31 for category I systems, and $9.23, $2.38, and $11.61, respectively, for category III systems.

The average water application per acre was 2.3, 3.3, and 3.5 inches of water for category I, II, and III systems, respectively. The farmers applied less water to cotton than to corn. The greatest differences were on farms with category II and III systems. Farmers with category II systems averaged an increase of 68 pounds of lint cotton per acre, a larger increase than was obtained by users of category I and III systems.

Cost per acre application—Water was applied an average of 1.3, 1.7, and 1.4 times per acre with category I, II, and III systems, respectively. The farmers using category III systems had the lowest cost per acre application, $6.72, $1.73, and $8.45 for the average fixed, variable, and total costs respectively.

TABLE 31-COTTON: ESTIMATED COST OF IRRIGATION PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION; AND YIELD RESPONSE, BY TYPE OF IRRIGATION SYSTEM, 35 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Amount of Water Used Per Farm	Costs			Yield Response
		Fixed	Variable	Total	
		Dollars	Dollars	Dollars	Pounds of Lint
Portable Pipe and Sprinkler:[1] (I)					
Per Acre-Inch					
Average	77	7.60	1.32	8.92	23
Range	10-255	1.42-97.28	.75-2.38	2.18-99.22	0-100
Per Acre Irrigated					
Average	34	17.30	3.01	20.31	53
Range	8-82	4.21-97.28	1.37-4.98	7.81-99.22	0-300
Per Acre Application					
Average	44	13.50	2.34	15.84	42
Range	8-93	2.63-97.28	1.38-4.35	4.95-99.22	0-300
Giant Sprinkler and Trailer Boom:[2] (II)					
Per Acre-Inch					
Average	214	3.42	1.45	4.87	21
Range	20-458	1.56-13.22	.80-1.90	2.70-14.68	0-46
Per Acre Irrigated					
Average	65	11.21	4.75	15.96	68
Range	8-102	4.81-28.41	1.61-9.50	7.50-31.56	0-240
Per Acre Application					
Average	111	6.56	2.79	9.35	40
Range	8-254	2.65-18.94	1.61-4.75	5.57-21.04	0-240
Surface System:[3] (III)					
Per Acre-Inch					
Average	154	2.67	.69	3.36	13
Range	26-450	.60-8.92	.26-1.11	1.11-9.95	0-112
Per Acre Irrigated					
Average	45	9.23	2.38	11.61	45
Range	14-104	3.61-20.25	.80-3.53	6.41-21.05	0-225

TABLE 31 Continued

Type of System	Amount of Water Used Per Farm	Costs			Yield Response
		Fixed	Variable	Total	
		Dollars	Dollars	Dollars	Pounds of Lint
Per Acre Application					
Average	61	6.72	1.73	8.45	33
Range	14-150	1.81-20.25	.80-2.60	3.34-21.05	0-225

[1]Nineteen farmers applied an average of 2.3 inches of water per acre. Each acre was irrigated the equivalent of 1.3 times.
[2]Eight farmers applied an average of 3.3 inches of water per acre. Each acre was irrigated the equivalent of 1.7 times.
[3]Eight farmers applied an average of 3.5 inches of water per acre. Each acre was irrigated the equivalent of 1.4 times.

Farmers operating category I systems averaged an increase of 42 pounds of lint cotton per acre application, the largest increase among the three systems. However, the difference in yield response was smaller for cotton than for corn.

Soybeans

Cost per acre-inch of water—The average cost per acre inch of water was $2.58 for category III systems, the lowest cost among the three systems. However, at $1.87, the average fixed cost was smaller on category II farms than on category III farms (Table 32).

The average yield response per acre-inch of water was two bushels for all three systems. Response ranged from no increase to seven bushels on farms using category II systems.

Cost per acre irrigated—Farmers using category I, II, and III systems averaged 17, 36, and 22 irrigated acres. The averaged fixed, variable, and total costs per acre were $9.02, $4.10, and $13.12, respectively, on farms with category I systems. The highest fixed and total cost system was category III, for which the average fixed and total costs were $13.38 and $15.21, respectively. On farms using category III systems, the average variable cost per acre was $1.83, the lowest cost among the three types.

The estimated yield response per acre ranged from an average of 12 to 4 bushels on farms with category I and III systems, respectively. The widest variation occurred on farms with category II systems, where the range was from 0 to 19 bushels.

Cost per acre application—Water was applied an average of 1.1, 1.7, 1.3 times per acre on farms with category I, and II, and III systems, respectively. The average number of acre applications per farm was 19, 62, and 29 on farms with

TABLE 32-SOYBEANS: ESTIMATED COST OF IRRIGATION PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION; AND YIELD RESPONSE, BY TYPE OF IRRIGATION SYSTEM, 13 IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Type of System	Amount of Water Used Per Farm	Costs			Yield Response
		Fixed	Variable	Total	
		Dollars	Dollars	Dollars	Bushels
Portable Pipe and Sprinkler:[1] (I)					
Per Acre-Inch					
Average	42	3.75	1.63	5.38	2
Range	10-105	1.28	.68-	1.95	0-6
		10.21	3.33	13.28	
Per Acre Irrigated					
Average	17	9.02	4.10	13.12	4
Range	5-40	4.41-	2.40-	7.61-	0-12
		12.06	10.00	22.06	
Per Acre Application					
Average	19	8.06	3.66	11.72	3
Range	5-40	4.41-	2.40-	7.61-	0-12
		12.06	10.00	22.06	
Giant Sprinkler and Trailer Boom:[2] (II)					
Per Acre-Inch					
Average	163	1.87	1.06	2.93	2
Range	22-420	1.44-	.69-	2.13-	0-7
		7.03	1.91	8.94	
Per Acre Irrigated					
Average	36	8.44	4.77	13.21	9
Range	16-70	7.84-	2.06-	9.89	0-12
		8.65	8.03	16.27	
Per Acre Application					
Average	62	4.88	2.76	7.64	5
Range	16-140	4.33	2.06	6.40	0-8
		8.60	4.28	10.93	
Surface System:[3] (III)					
Per Acre-Inch					
Average	130	2.27	.31	2.58	2
Range	43-200	1.34	.19-	1.91-	0-5
		6.06	.58	6.64	
Per Acre Irrigated					
Average	22	13.38	1.83	15.21	12
Range	19-29	5.35-	1.32-	7.63-	0-19
		20.25	1.95	22.20	

TABLE 32 Continued

Type of System	Amount of Water Used Per Farm	Costs			Yield Response
		Fixed	Variable	Total	
		Dollars	Dollars	Dollars	Dollars
Per Acre Application					
Average	29	10.06	1.38	11.44	9
Range	19-58	2.68	1.14	3.81	0-15
		20.25	1.95	22.20	

[1]Five farmers applied an average of 2.5 inches of water per acre. Each acre was irrigated the equivalent of 1.1 times.
[2]Four farmers applied an average of 4.5 inches of water per acre. Each acre was irrigated the equivalent of 1.7 times.
[3]Four farmers applied an average of 5.9 inches of water per acre. Each acre was irrigated the equivalent of 1.3 times.

category I, II, and III systems, respectively. The lowest average cost was $7.64, which occurred on farms with category II systems. The average variable cost on farms with category III systems was $1.38, which was lower than those for farmers with the other two systems.

The estimated yield response per acre application ranged from three bushels on farms with category I systems to nine bushels on farms with category III systems.

Returns From Irrigation

In general, returns attributable to irrigation result from increased yields or increased quality of product. Since this study was concerned primarily with field crops, additional returns reflected increased yields.

The variation in yield response from irrigation was extremely wide in 1959. Yields on irrigated land were substantially higher than on nonirrigated fields in several cases. In other instances, no yield increase was obtained from irrigation. The variation was a result of many factors. Among them were differences in soil types, planting rates, planting dates, time of irrigation, fertilizer applications, and cultural practices. If all of the farming practices except irrigation had been controlled, the effect of irrigation could have been determined precisely. Since this procedure was not practical for this study, the effect of irrigation was estimated under general farming conditions. An estimate for one year limits the reliability of the data.

In addition to these factors, normal variations in temperature and amount and distribution of rainfall affect the yield response from irrigation. In general, 1959 was a near normal year in regard to amount and distribution of rainfall (Table 33). The amount was slightly above the longtime average in May and September and below normal in June and August. In June, the rainfall was 1.07 inches less than the longtime average. This was the greatest deficit in the five

TABLE 33-AVERAGE TEMPERATURE AND PRECIPITATION, FOUR SOUTHEASTERN MISSOURI COUNTIES, MAY TO SEPTEMBER, 1959

	May	June	July	August	Septmeber
			Precipitation (Inches)		
Delta Area					
Average	4.39	2.85	3.10	2.95	4.44
Departure from Normal	.18	-1.07	.00	- .15	1.18
Normal	4.21	3.92	3.10	3.10	3.26
Six Stations[1]					
Average	4.09	2.99	3.03	3.10	4.57
Departure from Normal	- .13	- .93	- .07	.00	1.31
			Temperature (Degrees Fahrenheit)		
Delta Area					
Average	72.2	75.1	77.9	77.9	72.9
Departure from Normal	4.3	- 2.3	- 2.7	.4	1.0
Normal	67.9	77.4	80.6	79.2	71.9
Six Stations[1]					
Average	72.5	75.3	78.2	79.7	73.3
Departure from Normal	4.6	- 2.1	- 2.4	.5	5.4

[1]Kennett, Malden, Caruthersville, Portageville, Sikeston Experimental Farm, and Charleston.

Source: Climatological Data, Missouri, Volume LXIII, Number 4-9 United States Department of Commerce, Weather Bureau, 1959.

month period. Rainfall distribution also has an important effect on yield responses from irrigation. The amount and distribution of rainfall at six selected stations in the sample area were analyzed (Table 34). In May, the Malden Station reported only a trace of precipitation up to May 11, while the Portageville Station recorded .67 of an inch during this same period. Precipitation was limited throughout the area the first ten days.

The relationship between time of application of irrigation water and the estimated yield increase per acre was studied in an effort to explain some of the variation in yield. The estimated increase in the yield of corn and the time of application were plotted (Figure 4). In general, the highest yield increase resulted from water applications near June 15 and July 1. The data in Table 34 show that precipitation from June 16 to June 20 and from June 26 to June 30 was low. Therefore, it would appear that the crop needed moisture during this period.

Figure 5 indicates that irrigators who applied water to cotton early in May got no yield increase from the one application. A majority of those who applied water around July 15 received a substantial increase.

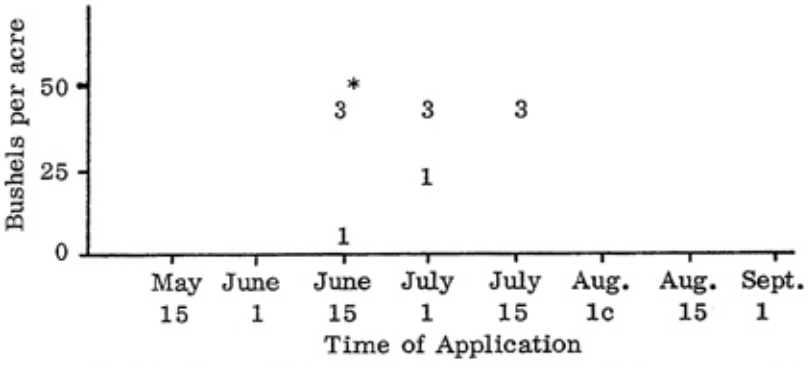
TABLE 34-PRECIPITATION AT SIX LOCATIONS FOUR SOUTHEASTERN MISSOURI COUNTIES, MAY TO AUGUST, 1959

Localities	Precipitation (Inches) 1-5	6-10	11-15	16-20	21-25	26-30(31)	Total
				May			
Caruthersville	.02	.10	1.85	.75	.35	.89	3.96
Charleston	---	.46	1.37	.95	.56	1.00	4.34
Kennett	---	.04	.66	.54	.65	1.74	3.63
Malden	---	T[1]	1.20	.52	.87	.34	2.93
Portageville	.10	.57	1.33	.64	.34	1.93	4.91
Sikeston[2]	.18	---	1.71	.71	.49	1.00	4.77
Total	.30	1.17	8.12	4.11	3.26	6.90	24.54
Average	.05	.19	1.35	.69	.54	1.15	4.09
				June			
Caruthersville	.95	.85	1.37	---	.64	.45	4.16
Charleston	.03	.75	1.25	---	.73	.08	2.84
Kennett	.07	1.01	.12	---	1.19	---	2.39
Malden	.67	1.26	T	---	1.24	.06	3.23
Portageville	.02	2.03	.04	---	.49	.01	2.59
Sikeston[2]	.05	1.36	.11	---	1.20	.03	2.75
Total	1.69	7.26	2.89	---	5.49	.63	17.96
Average	.28	1.21	.48	---	.91	.11	2.99
				July			
Caruthersville	.06	1.01	.20	---	.66	.03	1.96
Charleston	.91	---	---	.63	1.00	.49	3.03
Kennett	.88	---	.05	---	1.50	.09	2.52
Malden	.69	---	---	.24	3.87	.24	5.04
Portageville	1.58	---	.05	.23	.57	.03	2.46
Sikeston[2]	.52	---	---	.86	1.80	.02	3.20
Total	4.64	1.01	.30	1.96	9.40	.90	18.21
Average	.77	.17	.05	.33	1.56	.15	3.03
				August			
Caruthersville	---	.43	---	.53	---	1.30	2.26
Charleston	.13	.15	---	.08	---	1.23	1.59
Kennett	.73	.04	.12	.42	---	2.50	3.81
Malden	.08	.47	---	1.89	---	1.00	3.44
Portageville	.50	1.08	---	1.35	---	1.16	4.09
Sikeston[2]	.37	.37	---	.49	---	2.21	3.44
Total	1.81	2.54	.12	4.76	---	9.40	18.63
Average	.30	.42	.02	.79	---	1.57	3.10

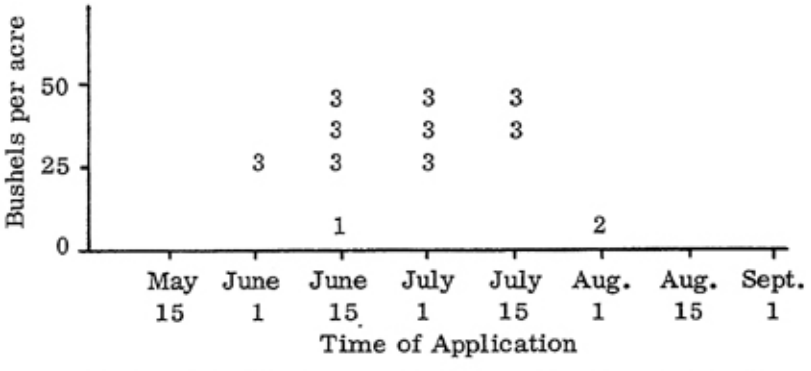
[1]T represents trace of precipitation
[2]Sikeston Experimental Farm.

Source: Climatological Data, Missouri, Volume LXIII, Number 4-9, United States Department of Commerce, Weather Bureau, 1959.

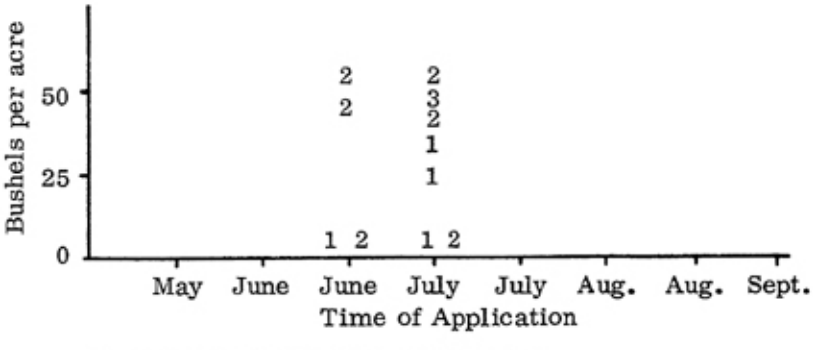
FIGURE 4-CORN: YIELD INCREASE PER ACRE IRRIGATED AND TIME OF APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 16 FARMS FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959



A. Surface - Gated Pipe and Ditches and Furrows (III)



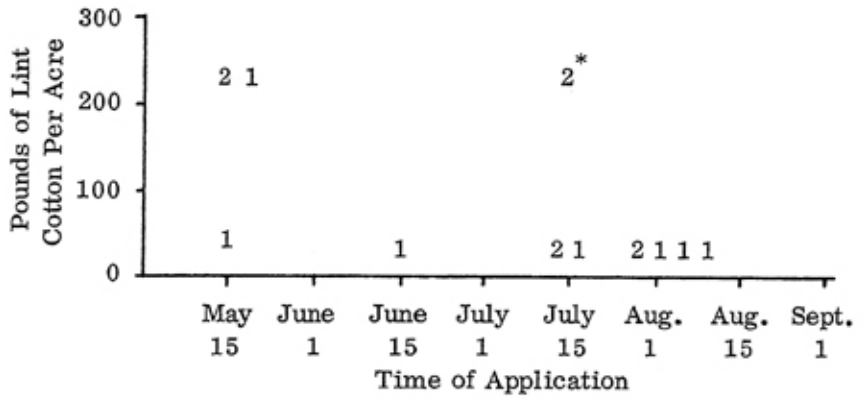
B. Sprinkler - Trailer Boom and Giant Sprinkler (II)



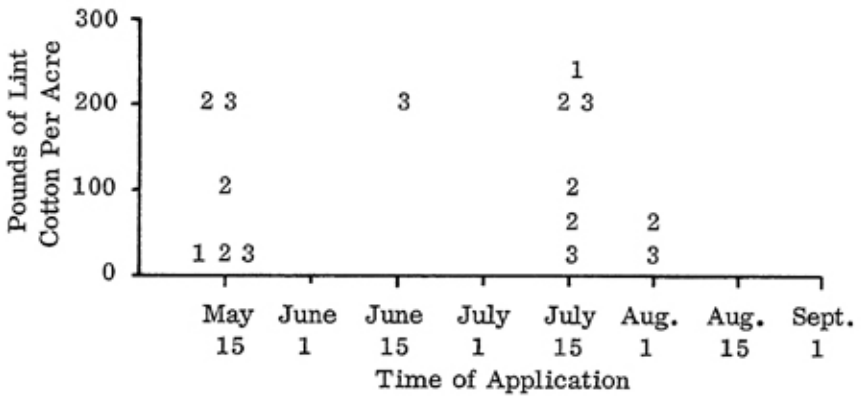
C. Portable Pipe and Sprinklers (I)

*Number indicates number of applications of water

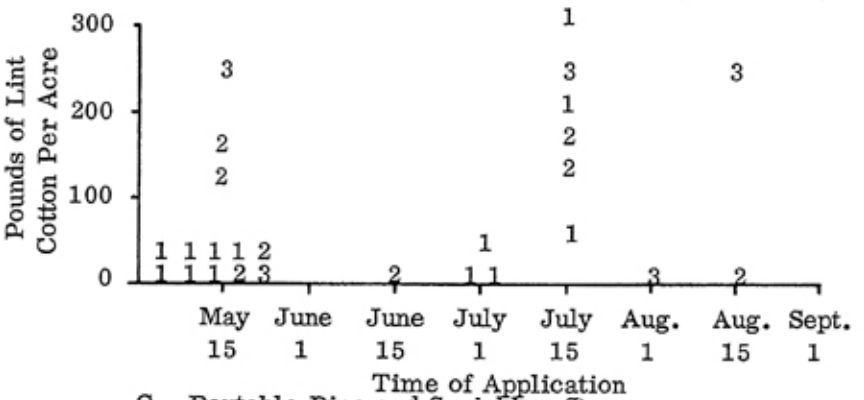
FIGURE 5-COTTON: YIELD INCREASE PER ACRE IRRIGATED AND TIME OF APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959



A. Surface - Gated Pipe and Ditches and Furrows (III)



B. Sprinkler - Trailer Boom and Giant Sprinkler (II)



C. Portable Pipe and Sprinkler (I)

*Number indicates number of application.

Figure 6 indicates that water applied to soybeans around July 1, and July 15 resulted in substantial yield increases. The farmers who applied water around August 15 also received yield increases, but smaller than those received by farmers who irrigated earlier in the growing season.

Procedures Used to Determine Net Returns and Returns Above Variable Cost

The average fixed, variable, and total cost computations, shown in Tables 29, 30, 31, and 32, did not include the expenses of harvesting the increased yield attributable to irrigation. In that section of the report, the cost of applying water by different types of systems was estimated. Here, the relationship between total costs and total returns attributable to irrigation is shown. Harvesting costs are included.

The average estimated yield response, shown in the above tables, was multiplied by the average prices received for the products from September to December, 1959, to compute the gross returns attributable to irrigation. The prices used were $1.00 a bushel for corn; $1.95 a bushel for soybeans, and $0.322 a pound for lint cotton.

The adjusted gross returns were equal to gross returns minus harvesting costs, which were $0.15 a bushel for picking and shelling corn; $0.30 a bushel for combining soybeans, and $2.00 a hundredweight for picking seed cotton.

The net returns and returns above average variable costs per acre-inch, per acre irrigated, and per acre application of irrigation water were computed for the three different systems. Net returns to irrigation were equal to total revenue minus total costs, or to adjusted gross returns minus average costs. The returns above average variable costs were equal to the adjusted gross returns minus the average variable costs. Greater insight into the relation between costs of and returns from irrigation in 1959 was obtained by analyzing together net returns and returns above average variable costs than if either had been analyzed alone.

IRRIGATION RETURNS FROM SPECIFIC CROPS

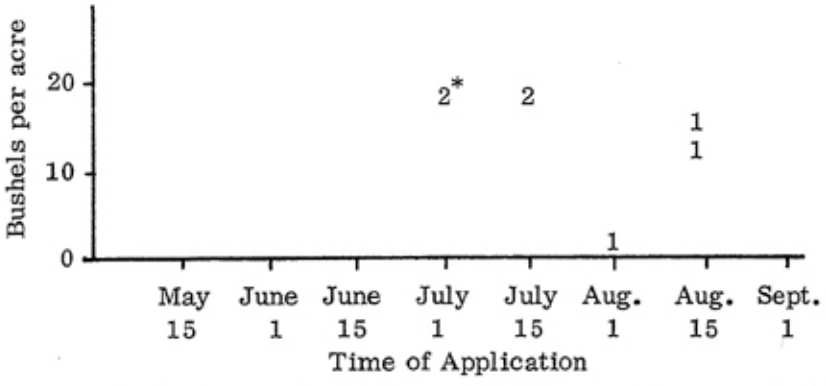
In this analysis net return over total and variable costs per acre-inch of water used and per acre irrigated are determined; then the yield of each crop required to meet these costs is presented.

Corn (upper & lower)

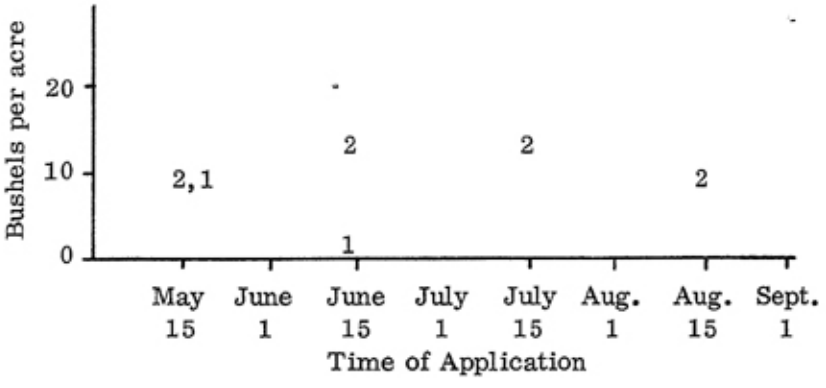
Per acre-inch of water—Average net returns were positive for the three different systems of water distribution used in the area. The average per acre-inch of water applied ranged from $4.07 for category I to $2.06 for category II systems (Table 35).

The net returns per acre-inch of water applied on individual farms ranged from -$18.47 to $13.91 (Figure 7 and Appendix Table 2). Fifty, 60 and 67 percent of the farmers who used category I, II, and III systems received positive net

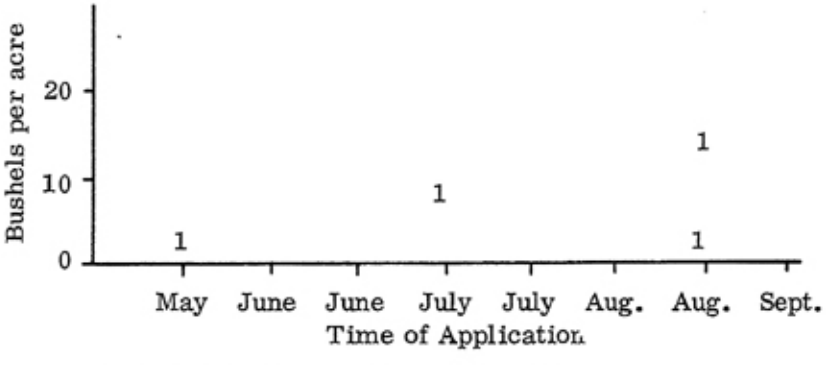
FIGURE 6-SOYBEANS: YIELD INCREASE PER ACRE IRRIGATED AND TIME OF APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959



A. Surface - Gated Pipe and Ditches and Furrows (III)



B. Sprinkler - Trailer Boom and Giant Sprinkler (II)



C. Portable Pipe and Sprinkler (I)

*Number indicates number of applications of water

TABLE 35-CORN: NET RETURN AND RETURN ABOVE AVERAGE VARIABLE COST PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

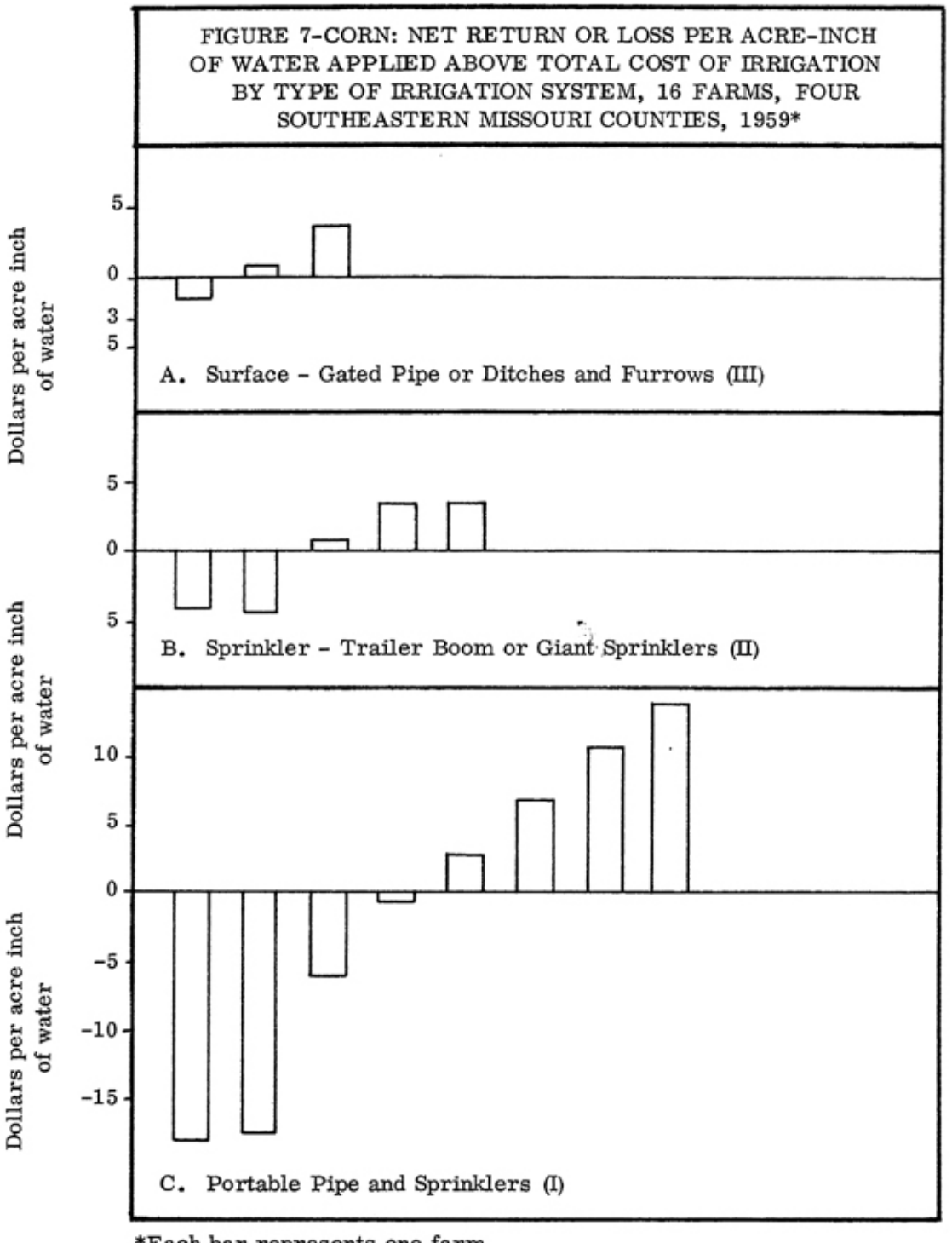
Irrigation Cost and Return	Irrigation System (III) Surface System[1]	(II) Giant Sprinkler and Trailer Boom[2]	(I) Portable Pipe and Sprinkler[3]
	Dollars	Dollars	Dollars
Per Acre-Inch of Water:			
Adjusted Gross Return	4.25	4.25	10.20
Average Cost	1.52	2.19	6.13
Net Return	+ 2.73	+ 2.06	+ 4.07
Average Variable Cost	.47	.98	1.16
Return Above Average Variable Cost	+ 3.78	+ 3.27	+ 9.04
Per Acre Irrigated:			
Adjusted Gross Return	22.10	27.20	26.35
Average Cost	8.38	13.20	16.01
Net Return	+13.72	+14.00	+10.34
Average Variable Cost	2.59	5.87	3.04
Return Above Average Variable Cost	+19.51	+21.33	+23.31
Per Acre Application:			
Adjusted Gross Return	11.90	11.05	23.80
Average Cost	4.59	5.21	14.77
Net Return	+ 7.31	+ 5.84	+ 9.03
Average Variable Cost	1.42	2.32	2.81
Return Above Average Variable Cost	+10.48	+ 8.73	+20.99

[1]Three farmers.
[2]Five farmers.
[3]Eight farmers.

returns from corn irrigation. Forty-four percent of the corn irrigators did not receive responses that were large enough to pay the total irrigation costs. (Table 36). Thirty-seven percent received net returns from $0.01 to $4.99 per acre-inch of water above costs. The positive net returns were from $5.00 to $14.99 for 19 percent of the corn irrigators.

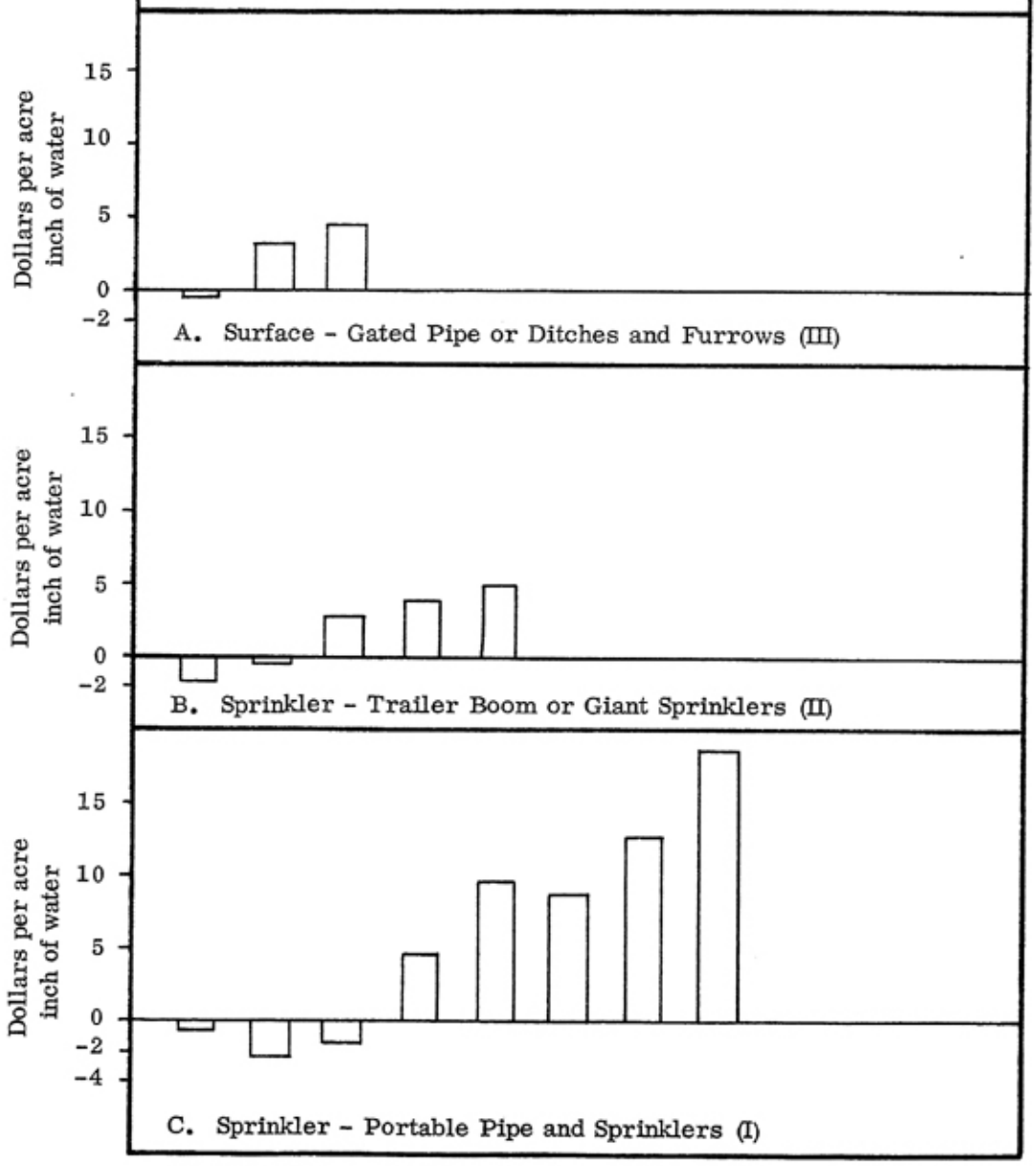
The returns above average variable costs per acre-inch of water were $9.04, $3.27, and $3.78 for farmers using category I, II, and III systems respectively (Table 35). On individual farms, the returns above variable costs ranged from -$2.20 to $18.13 (Figure 8 and Appendix Table 2). Sixty-three, 60, and 67 percent of the farmers using category I, II, and III systems received positive returns.

FIGURE 7-CORN: NET RETURN OR LOSS PER ACRE-INCH OF WATER APPLIED ABOVE TOTAL COST OF IRRIGATION BY TYPE OF IRRIGATION SYSTEM, 16 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

FIGURE 8-CORN: ADDITIONAL RETURN OR LOSS PER ACRE INCH OF WATER APPLIED ABOVE VARIABLE COSTS OF IRRIGATION BY TYPE OF IRRIGATION SYSTEM, 16 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 36-CORN: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COSTS PER ACRE-INCH OF WATER, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre Inch				
-15.00 to -19.99	2	---	---	13
-10.00 to -14.99	---	---	---	---
- 5.00 to - 9.99	1	---	---	6
- 0.01 to - 4.99	1	2	1	25
+ 0.01 to + 4.99	1	3	2	37
+ 5.00 to + 9.99	1	---	---	6
+10.00 to +14.99	2	---	---	13
Total	8	5	3	100

Thirty-eight percent of the corn irrigators did not cover their variable costs per acre-inch of water (Table 37). An additional 38 percent received returns above variable costs ranging between $0.01 and $4.99. Returns above variable costs were between $5.00 and $9.99 for 12 percent of the corn irrigators and between $10.00 and $19.99 for an additional 12 percent.

The increase in output required to pay total irrigation costs per acre-inch of water, including a charge for harvesting the additional yield of corn, varied from 4.3 to 18.5, 2.6 to 4.7, and 1.7 to 4.4 bushels per acre for users of category I, II, and III systems respectively. If only variable costs were considered, the additional yield needed ranged from 0.5 to 4.4, 0.7 to 1.9 and 0.5 to 1.9 bushels per acre for the three types of systems (Appendix Table 2).

Per Acre Irrigated

Average net returns over total cost per acre irrigated were $10.34, $14.00 and $13.72 for users of category I, II, and III systems respectively (Table 35).

The net returns per acre irrigated on individual farms ranged from -$55.41 to $27.82, -$20.48 to $21.24 and -$5.04 to $24.47 for category I, II, and III systems respectively. The net returns were negative for 44 percent of the corn irrigators (Table 38). Positive returns over total costs ranged from $0.01 to $19.99 for 25 percent of the farmers. Almost one-third (31 percent) received positive returns of $20.00 to $29.99 over total irrigation cost per acre.

Thirty-seven percent of the corn irrigators did not get enough increase in yield to pay their variable costs per acre. Nineteen percent got positive returns over variable costs ranging from $0.01 to $19.99. Forty-four percent received from $20.00 to $30.00 or more per acre over variable cost. The highest return was $36.25 (Table 39).

TABLE 37-CORN: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER ACRE-INCH WATER, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre Inch				
- 0.01 to - 4.99	3	2	1	38
+ 0.01 to + 4.99	1	3	2	38
+ 5.00 to + 9.99	2	---	---	12
+10.00 to +14.99	1	---	---	6
+15.00 to +19.99	1	---	---	6
Total	8	5	3	100

TABLE 38-CORN: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Cost	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre				
-25.00 or more	2[1]	---	---	13
-20.00 to -24.99	1	1	---	13
-15.00 to -19.99	---	---	---	---
-10.00 to -14.99	---	1	---	6
- 5.00 to - 9.99	---	---	1	6
- 0.01 to - 4.99	1	---	---	6
+ 0.01 to + 4.99	---	---	1	6
+ 5.00 to + 9.99	1	1	---	13
+10.00 to +14.99	1	---	---	6
+15.00 to +19.99	---	---	---	---
+20.00 to +24.99	---	2	1	18
+25.00 to +29.99	2	---	---	13
Total	8	5	3	100

[1] -$35.50 and -$55.41.

TABLE 39-CORN: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinklers	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre				
- 5.00 to - 9.99	1	1	---	12
- 0.01 to - 4.99	2	1	1	25
+ 0.01 to + 4.99	---	---	---	---
+ 5.00 to + 9.99	---	---	---	---
+10.00 to +14.99	---	---	1	7
+15.00 to +19.99	1	1	---	12
+20.00 to +24.99	1	1	---	12
+25.00 to +19.99	---	1	---	7
+30.00 or Over	3[1]	---	1[2]	25
Total	8	5	3	100

[1] +$31.32, +$32.30, and +$36.25.
[2] +$30.99.

The yields of corn required to pay total irrigation cost per acre, including a charge for harvesting the additional output varied from 8.6 to 55.4, 14.1 to 21.7 and 5.0 to 17.4 bushels per acre for users of category I, II, and III systems respectively. The yield increase required to pay variable costs ranged from 1.6 to 17.7, 2.0 to 12.0 and 1.4 to 9.0 bushels for the three types of systems (Figures 9 and 10 and Appendix Table 3).

Summary of Corn Irrigation

In 1959, net returns from irrigating corn averaged $10.34, $14.00 and $13.72 for farmers using category I, II, and III systems respectively. If only variable costs were considered, the average returns were $23.31, $21.33 and $19.51 for the three types of systems (Table 35).

The yield increases required to pay total cost per acre irrigated varied from 8.6 to 55.4, 14.1 to 21.7 and 5.0 to 17.4 bushels per acre for users of category I, II, and III systems respectively. The additional yield required to pay variable costs ranged from 1.6 to 17.7, 2.0 to 12.0 and 1.4 to 9.0 for the three types of systems.

When returns on individual farms were analyzed, it was found that 44 percent of the operators did not receive enough increase from irrigation to pay the total cost of applying water. However, 62 percent obtained returns that equaled or exceeded average variable costs. Since only 62 percent obtained yield increases

FIGURE 9-CORN: PER ACRE YIELD INCREASE REQUIRED TO PAY VARIABLE COSTS OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 16 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*

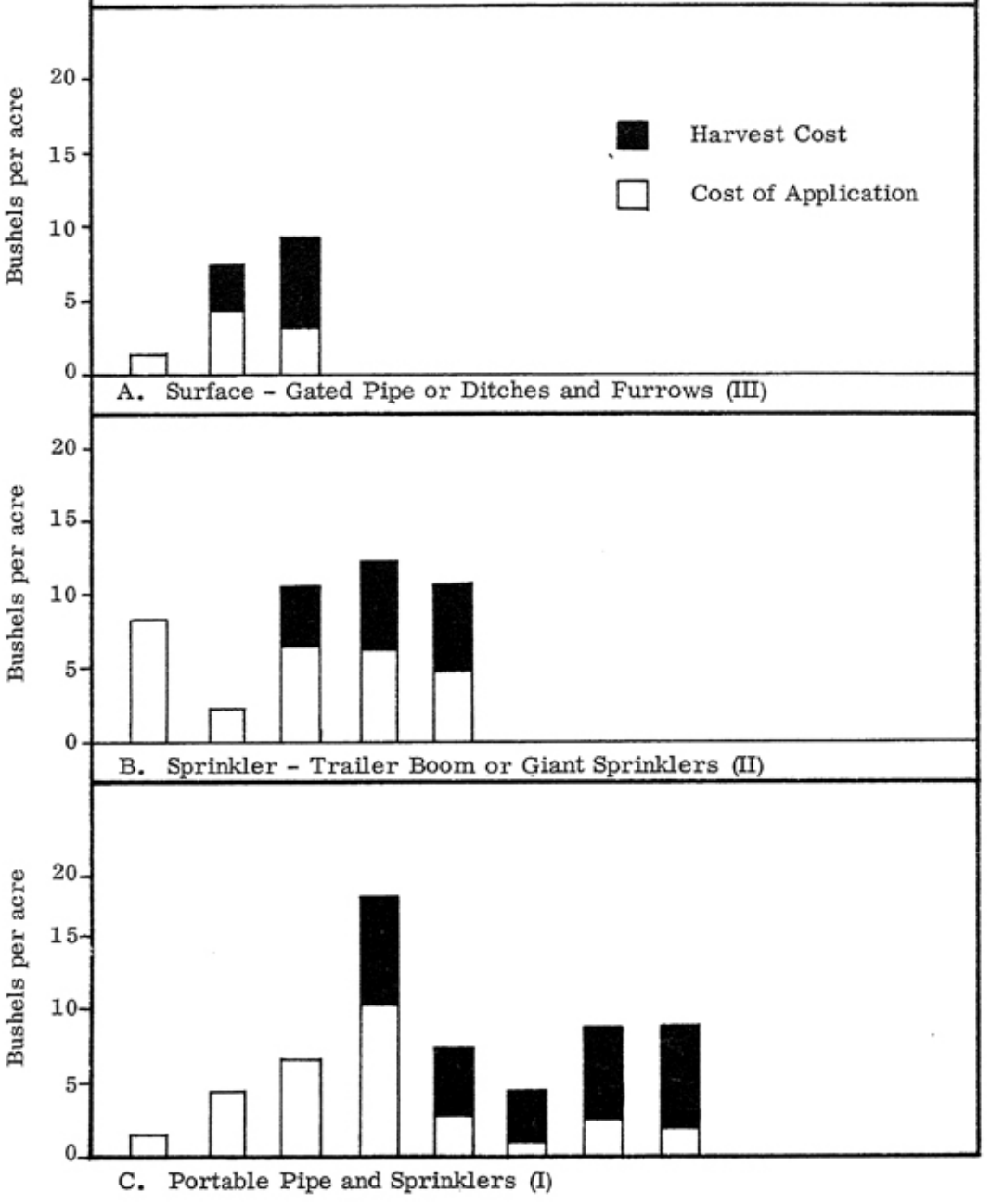
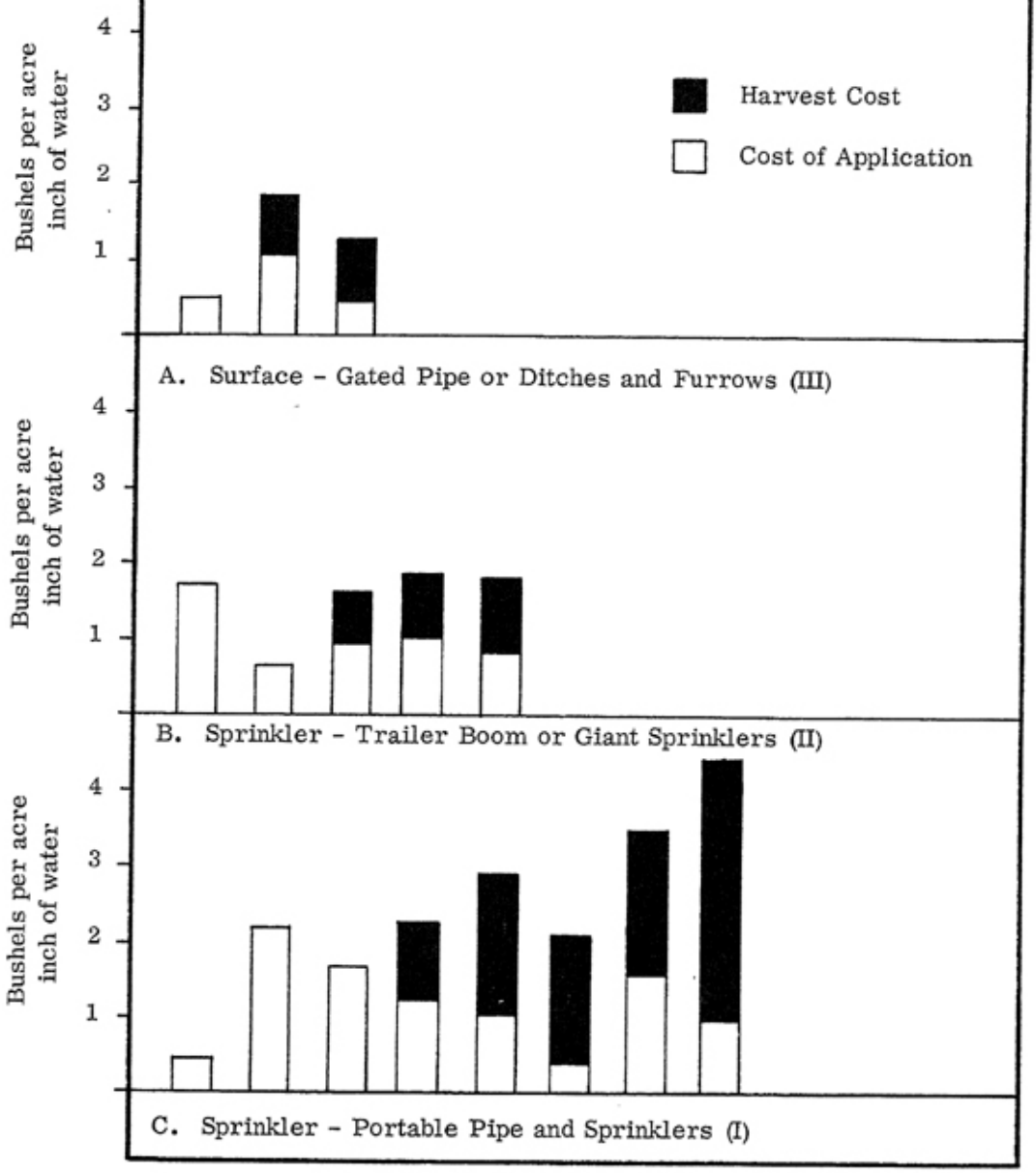


FIGURE 10-CORN: YIELD INCREASE NEEDED PER ACRE-INCH OF WATER APPLIED TO PAY VARIABLE COST OF IRRIGATION, INCLUDING HARVESTING COST, BY TYPE OF IRRIGATION SYSTEMS, 16 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

large enough to pay variable costs, the conclusion was reached that the actual yield increase was less than expected on 38 percent of the farms. Otherwise, the 38 percent would not have applied water to corn in 1959.

Cotton

Per acre-inch of water—Net returns averaged -$1.93, $1.33 and $0.74 for farmers using category I, II, and III systems respectively (Table 40). Average net returns per acre-inch of water used were smaller for cotton than for corn. In 1959, average returns to farmers using category I systems were negative. This means that the average farmer using a category I system in 1959 had a loss of $1.93 per acre-inch of water applied to cotton. The chief reason for this result was limited use of the system during the year. In many instances, a small acreage of cotton was charged with a large share of the annual fixed costs. In fact, eight of the 22 cotton irrigators made only one application of water to a limited cotton acreage during the first part of May. None of these men obtained a yield response.

The net returns per acre-inch of water on individual farms ranged from -$99.22 to $25.61 (Figure 11 and Appendix Table 4). Sixty-five percent of the cotton irrigators did not obtain a yield increase sufficient to pay total irrigating costs per acre-inch of water applied (Table 41). Thirty-five percent obtained a positive net return. Twenty-six percent received returns between $0.01 and $19.99, and 9 percent between $20.00 and $29.99 per acre-inch of water applied.

Returns above variable costs averaged $5.67, $4.75 and $3.41 for farmers employing category I, II, and III systems respectively (Table 40). When average fixed costs were not considered, average returns from irrigation more than paid the average variable costs for the three systems. On individual farms the returns above variable costs ranged from -$2.38 to $32.17 (Figure 12 and Appendix Table 4). Thirty-seven, 62, 37 percent of the farmers using category I, II, and III systems respectively obtained positive returns above average variable costs. For all types of equipment, 57 percent of the cotton irrigators had losses between $0.01 and $4.99 an acre on their variable costs. Twenty-nine percent had positive returns ranging from $0.01 to $19.99 and 14 percent from $20.00 to $30.00 or more per acre-inch of water applied. The highest return over variable cost was $32.17 (Table 42).

Aside from additional harvesting expenses, the yield increase needed to pay total irrigation costs per acre-inch of water ranged from 3.4 to 308.1 pounds of lint cotton on individual farms (Figure 13 and Appendix Table 4). The required increase for farmers with different types of equipment was from 5.4 to 308.1, 8.4 to 45.6 and 3.4 to 30.9 pounds of lint for category I, II, and II systems respectively.

The yield increase needed to pay operating or variable costs (with harvesting costs included) ranged from 2.6 to 24.2 pounds of lint cotton. An increase of 1 to 8 pounds would have paid average variable costs per acre-inch of water applied by all systems, if harvesting costs were excluded (Figure 14 and Appendix Table 4).

TABLE 40-COTTON: NET RETURN AND RETURN ABOVE AVERAGE VARIABLE COST PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Irrigation Cost and Return	Irrigation System (III) Surface System[1]	(II) Giant Sprinkler and Trailer Boom[2]	(I) Portable Pipe and Sprinkler[3]
Per Acre-Inch of Water:			
Adjusted Gross Return	4.10	6.20	6.99
Average Cost	3.36	4.87	8.92
Net Return	+ .74	+ 1.33	- 1.93
Average Variable Cost	.69	1.45	1.32
Return Above Average Variable Cost	+ 3.41	+ 4.75	+ 5.67
Per Acre Irrigated:			
Adjusted Gross Return	14.18	20.08	15.65
Average Cost	11.61	15.96	20.31
Net Return	+ 2.57	+ 4.12	- 4.66
Average Variable Cost	2.38	4.75	3.01
Return Above Average Variable Cost	+11.80	+15.33	+12.64
Per Acre Application:			
Adjusted Gross Return	10.40	11.81	12.39
Average Cost	8.45	9.35	15.84
Net Return	+ 1.95	+ 2.46	- 3.45
Average Variable Cost	1.73	2.79	2.34
Return Above Average Variable Cost	+ 8.67	+ 9.02	+10.05

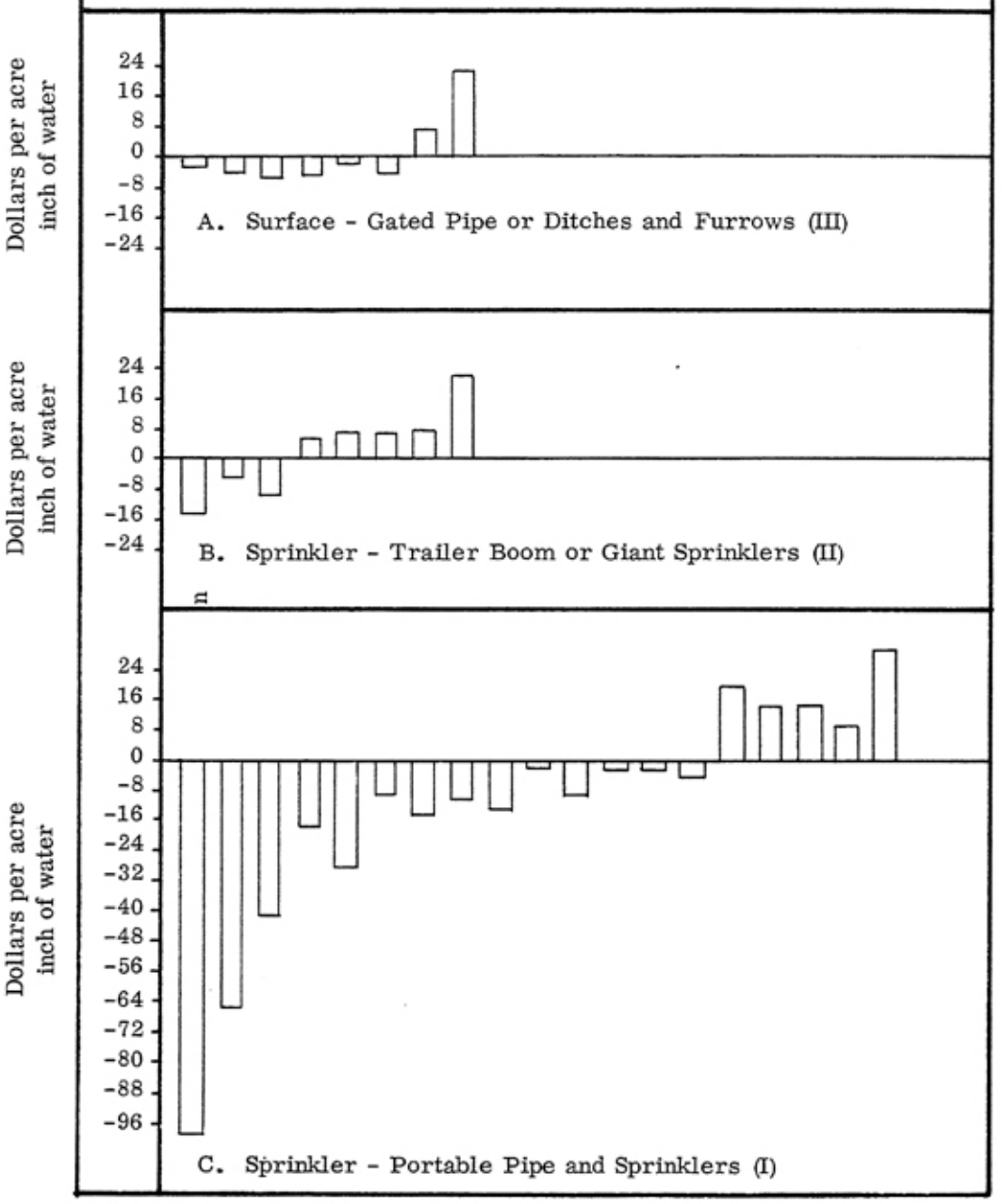
[1]Eight farmers.
[2]Eight farmers.
[3]Nineteen farmers.

Per acre irrigated—Average net returns over total cost per acre irrigated were -$4.66, $4.12 and $2.57 for users of category I, II, and III systems respectively (Table 40).

The net returns per acre irrigated on individual farms ranged from -$99.22 to $55.63, -$31.56 to $51.04, and -$16.38 to $46.50 for category I, II, and III systems respectively (Appendix Table 5). The net returns per acre were negative for 65 percent of the cotton irrigators. Positive returns over total costs ranged from $0.01 to $19.99 for 9 percent of the farmers, and from $20.00 to $30.00 or more an acre for 26 percent. The highest return over cost was $55.63 (Table 43).

Sixty percent of the cotton irrigators did not get enough increase in yield to pay their variable costs per acre. Nine percent got positive returns over vari-

FIGURE 11-COTTON: NET RETURN OR LOSS PER ACRE-INCH OF WATER APPLIED ABOVE TOTAL COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 41-COTTON: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COSTS PER ACRE-INCH OF WATER, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre-Inch				
-30.00 or more	3[1]	---	---	8
-25.00 to -29.99	1	---	---	3
-20.00 to -24.99	---	---	---	---
-15.00 to -19.99	2	---	---	6
-10.00 to -14.99	2	1	---	8
- 5.00 to - 9.99	3	1	1	14
- 0.01 to - 4.99	3	1	5	26
+ 0.01 to + 4.99	---	---	---	---
+ 5.00 to + 9.99	1	4	1	17
+10.00 to +14.99	2	---	---	6
+15.00 to +19.99	1	---	---	3
+20.00 to +24.99	---	1	1	6
+25.00 to +29.99	1	---	---	3
Total	19	8	8	100

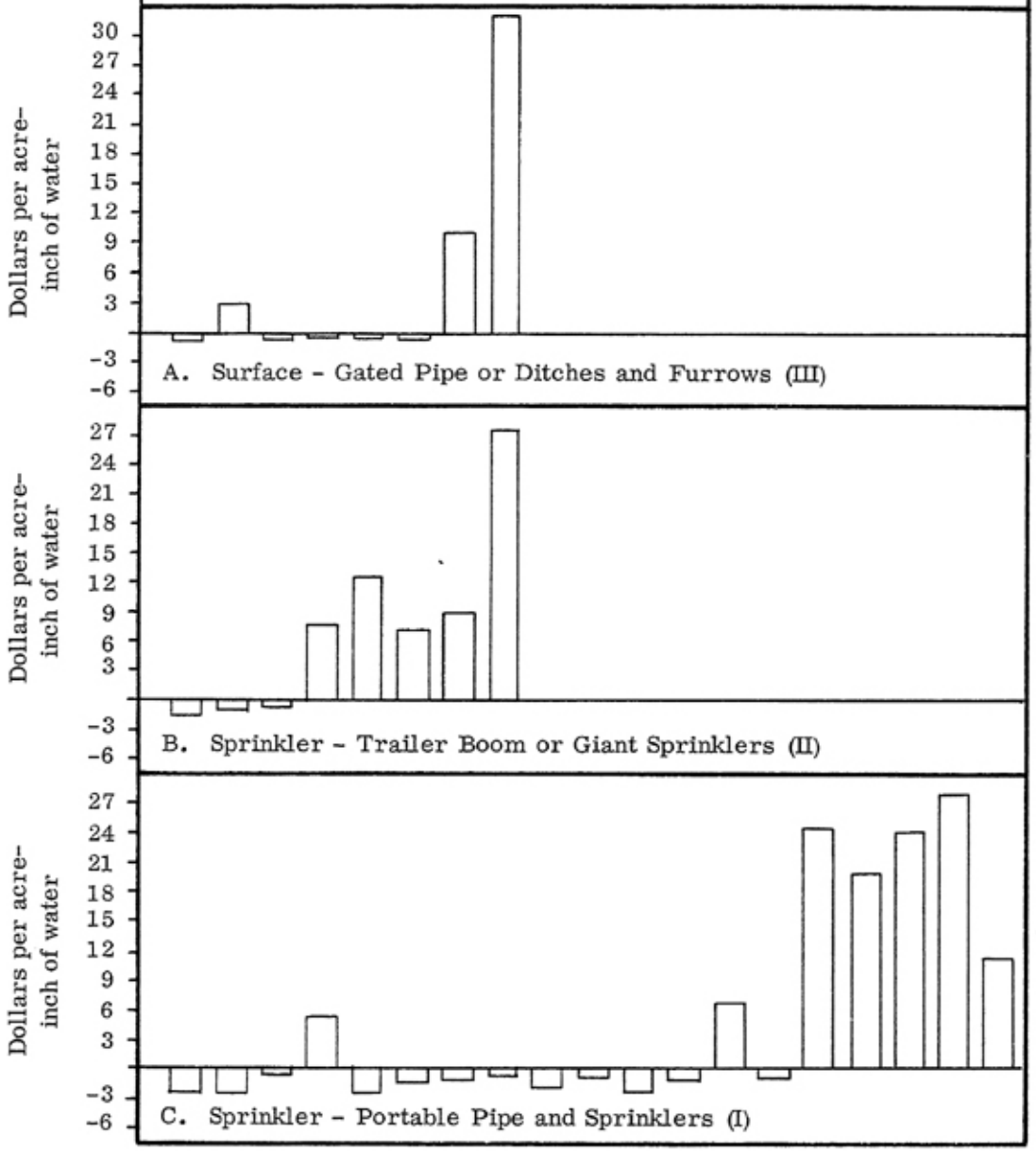
[1] -$41.57, -$65.90, and -$99.22.

TABLE 42-COTTON: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER ACRE-INCH OF WATER, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre-Inch				
- 0.01 to - 4.99	12	3	5	57
+ 0.01 to + 4.99	1	---	1	6
+ 5.00 to + 9.99	1	3	1	14
+10.00 to +14.99	1	1	---	6
+15.00 to +19.99	1	---	---	3
+20.00 to +24.99	1	---	---	3
+25.00 to +29.99	2	1	---	8
+30.00 or Over	---	---	---[1]	3
Total	19	8	8	100

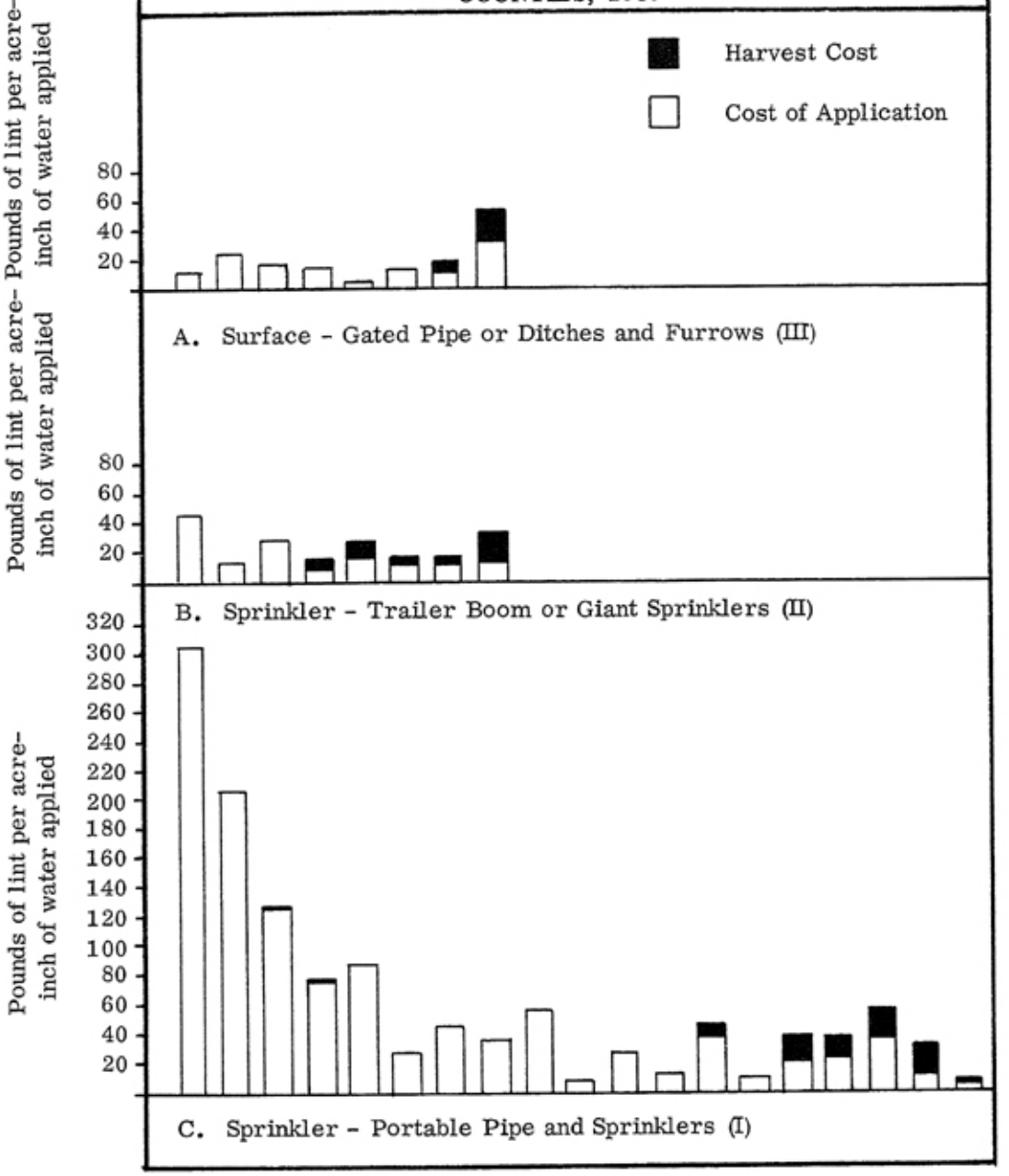
[1] +$32.17.

FIGURE 12-COTTON: ADDITIONAL RETURN OR LOSS PER ACRE-INCH OF WATER APPLIED ABOVE VARIABLE COSTS OF IRRIGATION BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



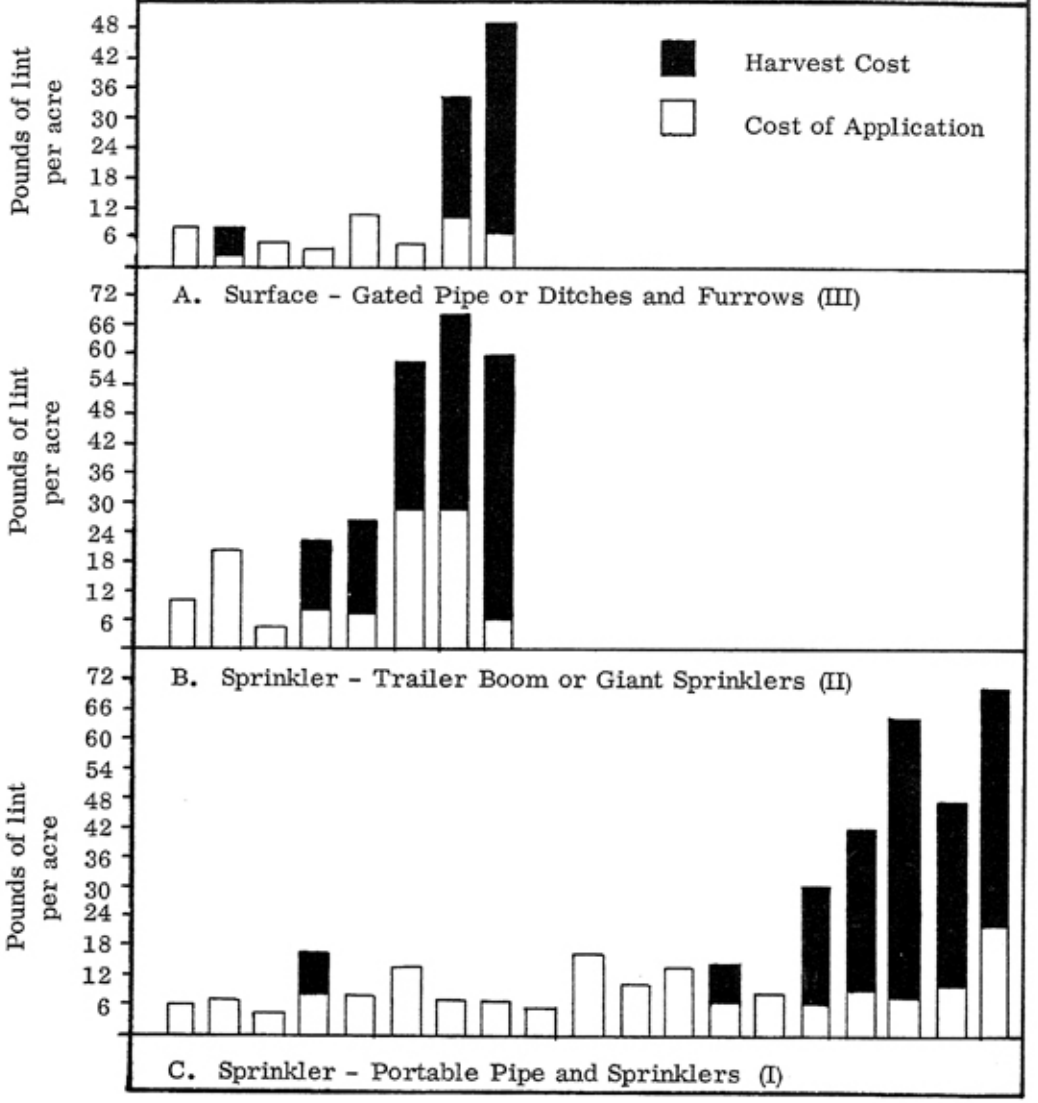
*Each bar represents one farm.

FIGURE 13-COTTON: YIELD INCREASE NEEDED PER ACRE-INCH OF WATER APPLIED TO PAY TOTAL COST OF IRRIGATION, INCLUDING HARVESTING COST, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

FIGURE 14-COTTON: PER ACRE INCREASE IN YIELD REQUIRED TO PAY VARIABLE COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 43-COTTON: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre				
-30.00 or more	4[1]	1[2]	---	14
-25.00 to -29.99	2	---	---	8
-20.00 to -24.99	1	---	---	3
-15.00 to -19.99	2	1	1	11
-10.00 to -14.99	3	1	3	20
- 5.00 to - 9.99	1	---	2	9
- 0.01 to - 4.99	---	---	---	---
+ 0.01 to + 4.99	---	---	---	---
+ 5.00 to + 9.99	1	---	---	3
+10.00 to +14.99	---	1	---	3
+15.00 to +19.99	---	1	---	3
+20.00 to +24.99	---	---	1	3
+25.00 to +29.99	1	1	---	6
+30.00 or more	4[3]	1[4]	1[5]	17
Total	19	8	8	100

[1]-$37.15, -$62.40, and -$65.90.
[2]-$31.56.
[3]+$33.38, +49.38, +51.22, +$55.63.
[4]+$51.04.
[5]+$46.50.

able costs ranging from $0.01 to $19.99 and 31 percent received from $20.00 to $30.00 or more an acre. The highest return over variable cost was $86.05 an acre (Table 44).

The additional production required to pay total irrigation costs, including a charge for harvesting the increased yield where a response was obtained, varied from 40.3 to 308.1, 37.3 to 93.5, and 20.7 to 103.7 pounds of lint per acre for users of category I, II, and III systems respectively (Figure 15 and Appendix Table 5).

The increase required to pay variable costs per acre irrigated, including a harvesting charge, ranged from 5.7 to 66.8, 5.0 to 66.8, and 3.1 to 48.3 pounds of lint per acre for users of category I, II, and III systems respectively (Figure 16 and Appendix Table 5).

An increase in yield of 2.5 to 29.5 pounds of lint cotton would have covered average variable costs except the expense of harvesting the additional yield. Farmers using category I, II, and III systems needed from 6.0 to 22.1, 5.0 to 29.5

TABLE 44-COTTON: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

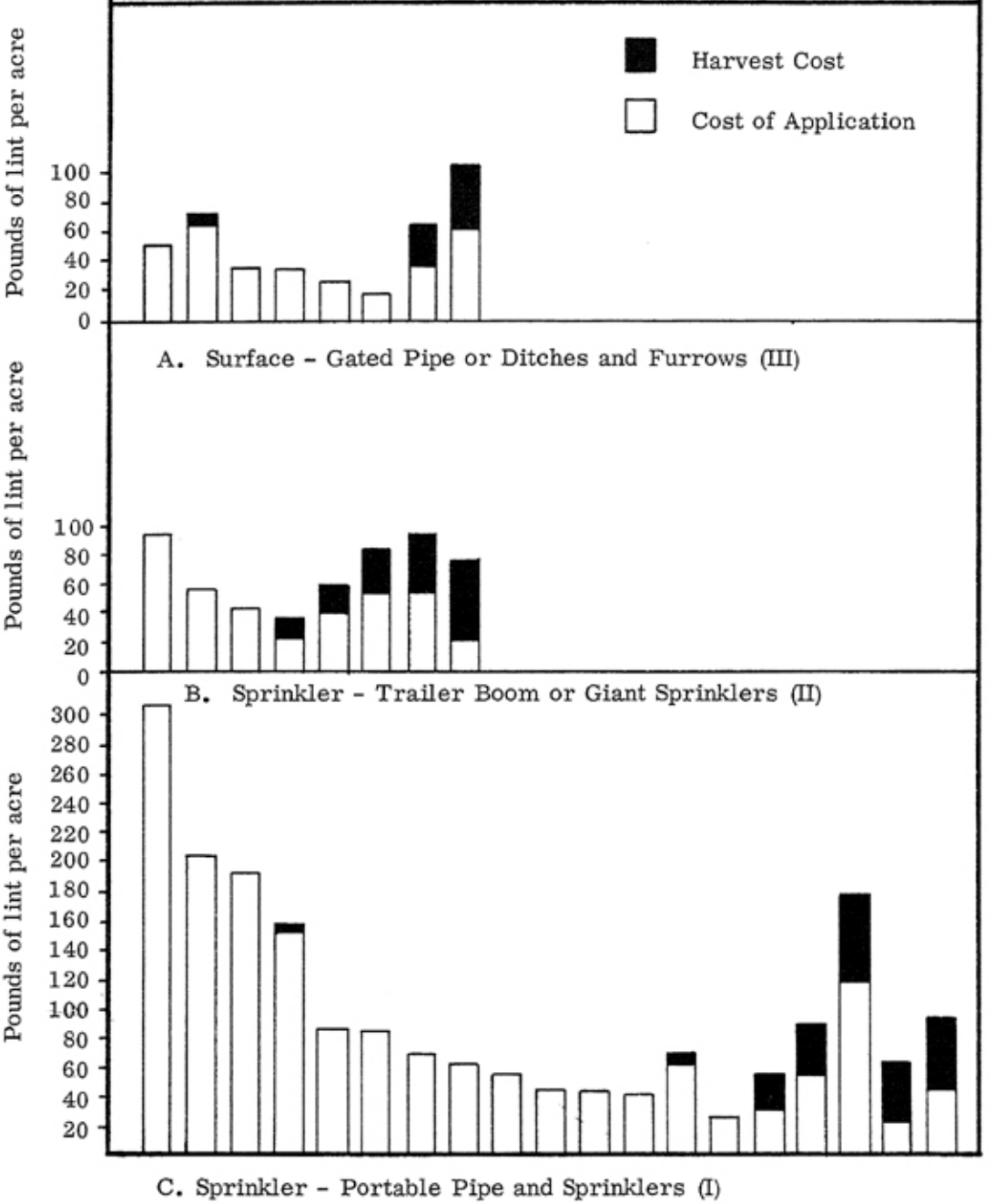
Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
(Dollars Per Acre)				
- 5.00 to - 9.99	1	1	---	6
- 0.01 to - 4.99	12	2	5	54
+ 0.01 to + 4.99	---	---	---	---
+ 5.00 to + 9.99	1	---	1	6
+10.00 to +14.99	---	---	---	---
+15.00 to +19.99	---	1	---	3
+20.00 to +24.99	---	---	---	---
+25.00 to +29.99	---	1	---	3
+30.00 or More	5[1]	3[2]	2[3]	28
Total	19	8	8	100

[1] +$34.81, +$48.73, +$55.63, +$63.73, and +$86.05.
[2] +$34.78, +$49.53, and +$68.84.
[3] +$31.41 and $64.34.

and 2.5 to 10.9 pounds of lint respectively. These are modest increases and would not be hard to obtain in an average crop year. Even without irrigation, 1959 was an excellent cotton year in the Delta. The average yield was 610 pounds of lint per acre, which was 164 pounds greater than in 1958.

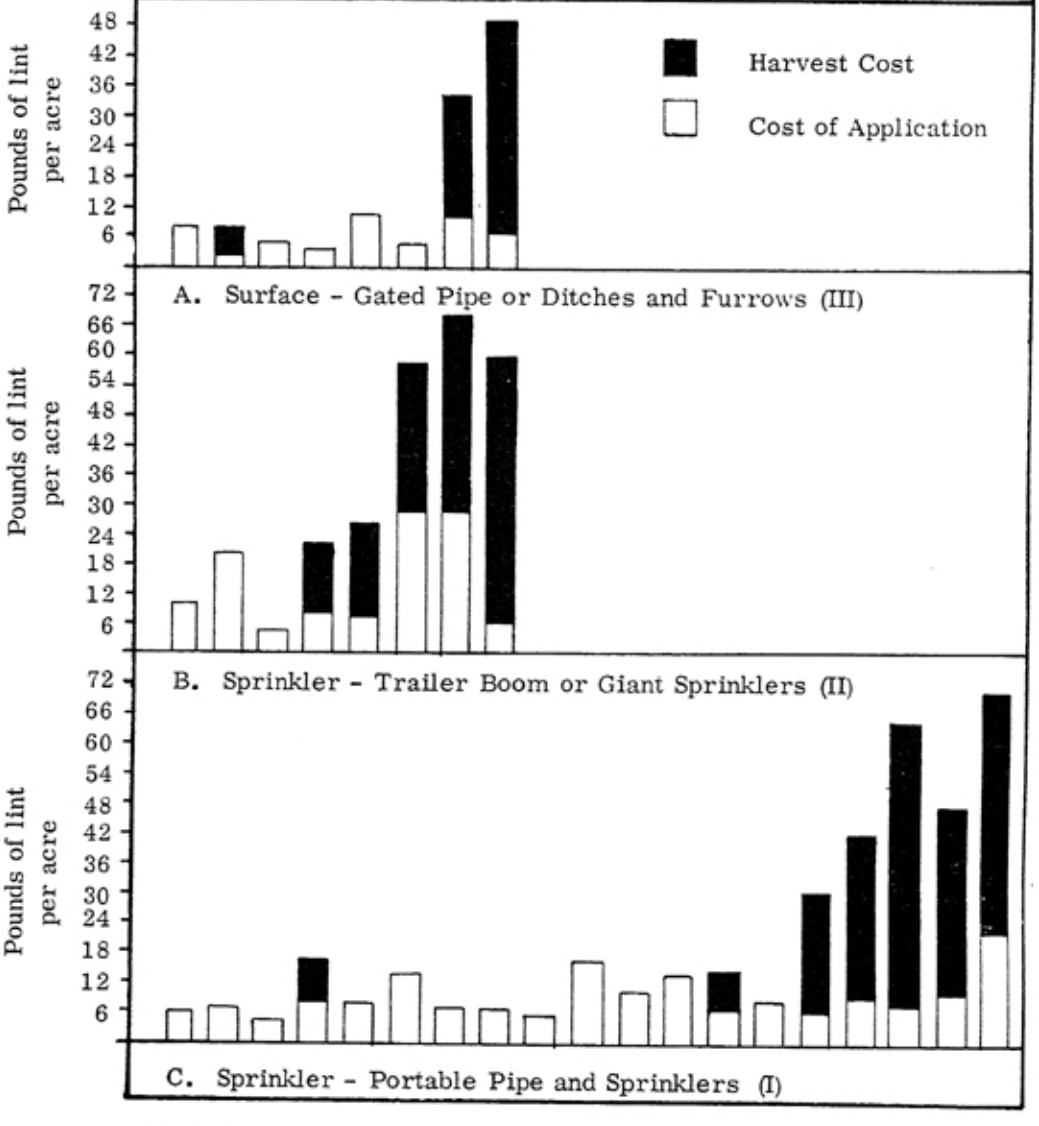
Summary of cotton irrigation—Applying water to cotton was not as profitable as irrigating corn in 1959. The average net return per acre was $4.12 on farms using category II systems and $2.57 for farms with Category III systems, but those with category I systems averaged a net loss per acre of $4.66 (Table 40). The net return or loss per acre above total irrigation cost is shown graphically in Figure 17.

FIGURE 15-COTTON: PER ACRE INCREASE IN YIELD REQUIRED TO PAY TOTAL COST OF IRRIGATION, INCLUDING HARVESTING COSTS, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



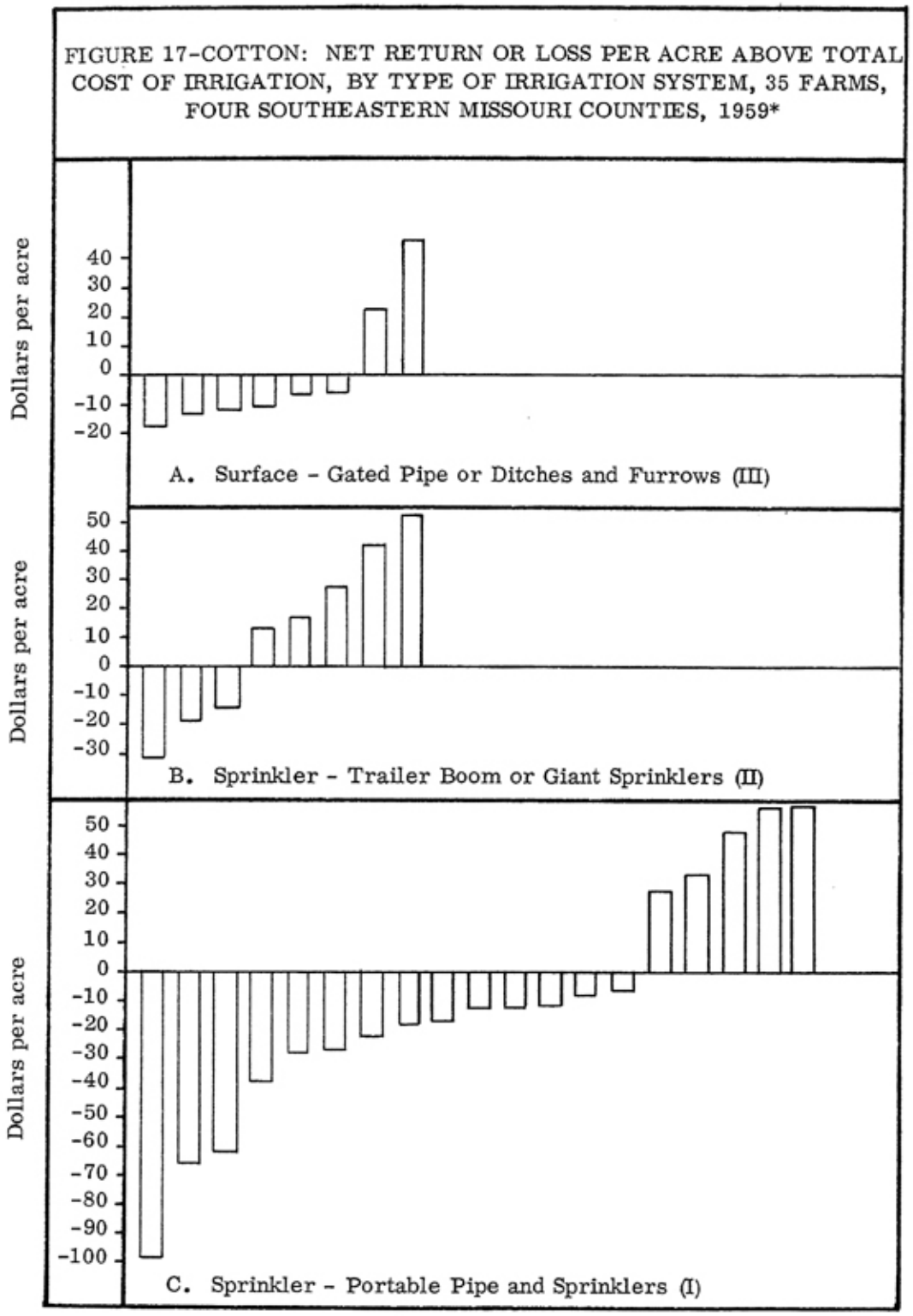
*Each bar represents one farm.

FIGURE 16-COTTON: PER ACRE INCREASE IN YIELD REQUIRED TO PAY VARIABLE COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

FIGURE 17-COTTON: NET RETURN OR LOSS PER ACRE ABOVE TOTAL COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

Soybeans

Per acre-inch of water—Net returns were -$1.90, $0.37, and $0.72 for farmers using category I, II, and III systems respectively (Table 45). Returns

TABLE 45-SOYBEANS: NET RETURN AND RETURN ABOVE AVERAGE VARIABLE COST PER ACRE-INCH OF WATER, PER ACRE IRRIGATED AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

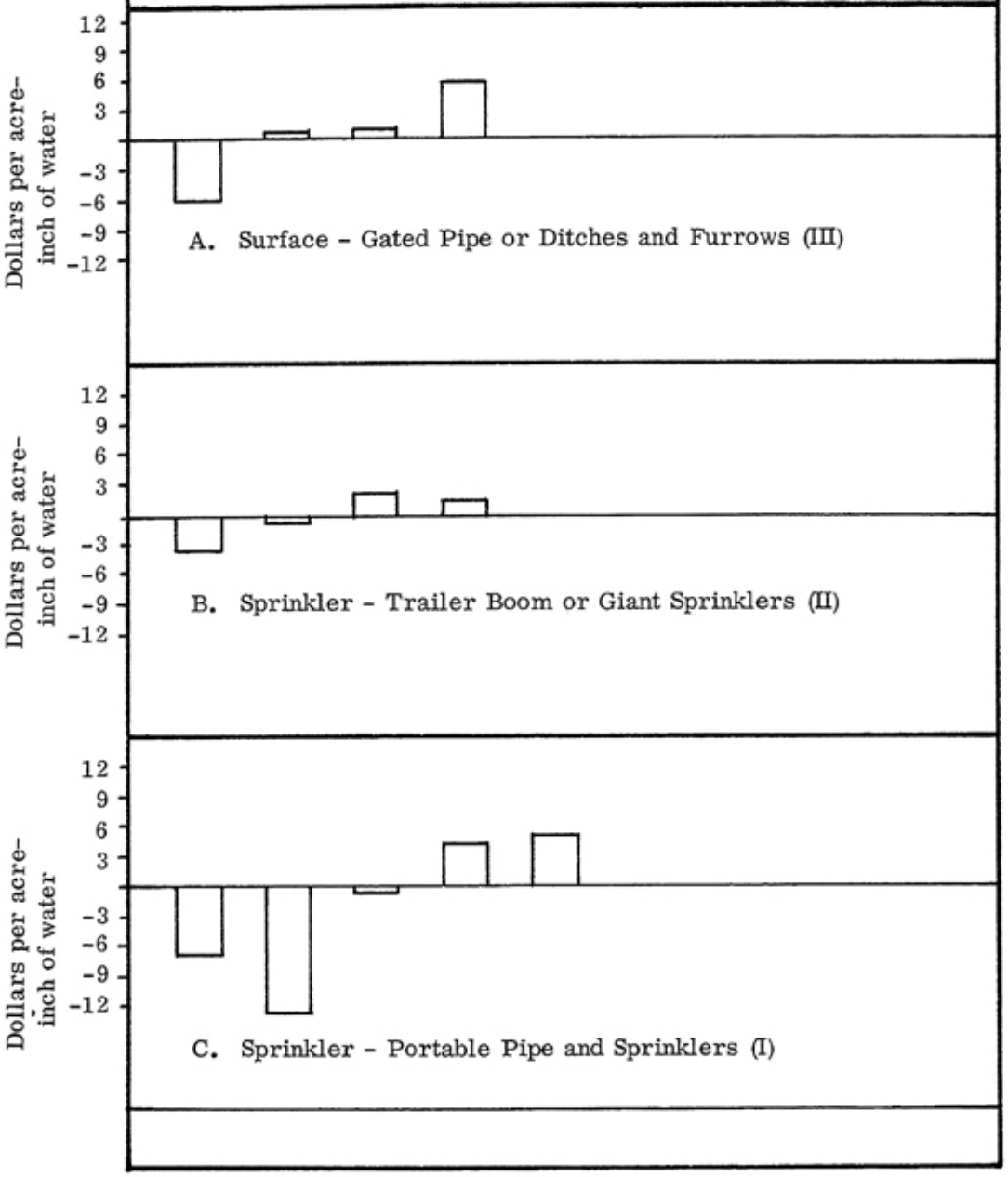
Irrigation Cost and Return	Irrigation System (III) Surface System[1]	(II) Giant Sprinkler and Trailer Boom[2]	(I) Portable Pipe and Sprinkler[3]
	Dollars	Dollars	Dollars
Per Acre-Inch of Water:			
Adjusted Gross Return	3.30	3.30	3.30
Average Cost	2.58	2.93	5.20
Net Return	+ .72	+ .37	- 1.90
Average Variable Cost	.31	1.06	1.63
Return Above Average Variable Cost	+ 2.99	+ 2.24	+ 1.67
Per Acre Irrigated:			
Adjusted Gross Return	19.80	14.85	6.60
Average Cost	15.21	13.21	13.12
Net Return	+ 4.59	+ 1.64	- 6.52
Average Variable Cost	1.83	4.77	4.10
Return Above Average Variable Cost	+17.97	+10.08	+ 2.50
Per Acre Application:			
Adjusted Gross Return	14.85	8.25	4.95
Average Cost	11.44	7.64	11.72
Net Return	+ 3.41	+ .61	- 6.77
Average Variable Cost	1.38	2.76	3.66
Return Above Average Variable Cost	+13.47	+ 5.49	+ 1.29

[1] Four farmers.
[2] Four farmers.
[3] Five farmers.

were less for soybeans than for corn and cotton. On individual farms, they ranged from -$13.28 to $5.92. (Figure 18 and Appendix Table 6).

Net returns per acre-inch of water used on individual farms ranged from -$13.28 to $4.64, -$3.96 to $1.86, and -$4.64 to $5.92 on farms where category

FIGURE 18-SOYBEANS: NET RETURN OR LOSS PER ACRE INCH OF WATER APPLIED ABOVE TOTAL COST OF IRRIGATION BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

I, II, and III systems were used. Forty-six percent of the irrigators had losses ranging up to $14.99 per acre-inch of water used. The remaining 54 percent had gains of $0.01 to $9.99 (Table 46).

If only variable costs were considered, 31 percent of the farmers had losses between $0.01 and $4.99 per acre-inch of water applied. Sixty-nine percent had gains between $0.01 and $9.99 an acre (Table 47). The situation on individual farms by type of system is shown graphically in Figure 19.

TABLE 46-SOYBEANS: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COSTS PER ACRE-INCH OF WATER, BY TYPE OF IRRIGATION SYSTEM, 13 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre-Inch				
-10.00 to -14.99	1	---	---	8
- 5.00 to - 9.99	1	---	1	15
- 0.01 to - 4.99	1	2	---	23
+ 0.01 to + 4.99	2	2	2	46
+ 5.00 to + 9.99	---	---	1	8
Total	5	4	4	100

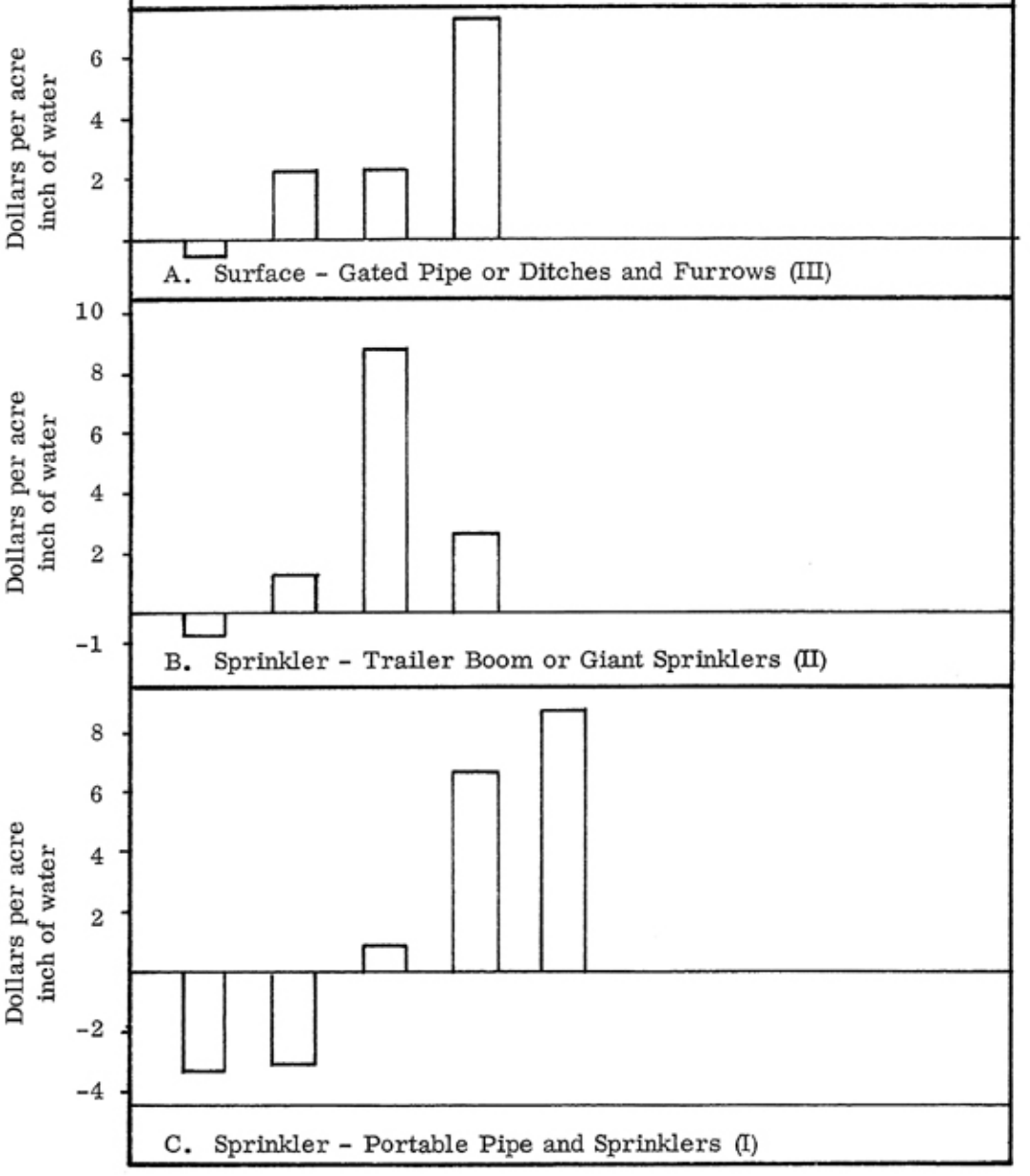
Per acre irrigated—The revenue attributable to irrigation did not pay the total cost for 46 percent of the farmers. Thirty percent had losses between $0.01 and $14.99, and 16 percent between $15.00 and $24.99. Of the 54 percent who had gains, 46 percent received from $0.01 to $14.99 and eight percent from $15.00 to $24.99 (Table 48). On individual farms the range was from -$22.06 to $23.69 per irrigated acre (Figure 20 and Appendix Table 7).

Returns above variable costs per irrigated acre averaged $2.50, $10.08 and $17.97 for users of category I, II, and III systems respectively (Table 45). On individual farms, net returns varied from -$10.00 to $29.04 per acre (Figure 21 and Appendix Table 7).

Yield increases required to pay irrigation costs—The soybean yields required to pay total and variable irrigation costs are shown in Figures 22 and 23 and in Appendix Table 7. For all costs including a charge for harvesting the extra yield, the increase needed ranged from 5.1 to 13.7 bushels per acre. For the variable cost the range was from 0.7 to 5.3 bushels (Figure 22 and 23 and Appendix Table 7).

Thirty-two percent of the farmers failed to obtain increases large enough to pay their variable costs (Table 49). Thirty percent met their variable costs and received additional returns ranging from $0.01 to $14.99 an acre. An additional

FIGURE 19-SOYBEANS: ADDITIONAL RETURN OR LOSS PER ACRE-INCH OF WATER APPLIED ABOVE VARIABLE COSTS OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 47-SOYBEANS: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER ACRE-INCH OF WATER, BY TYPE OF IRRIGATION SYSTEM, 13 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre-Inch				
- 0.01 to - 4.99	2	1	1	31
+ 0.01 to + 4.99	1	2	2	38
+ 5.00 to + 9.99	2	1	1	31
Total	5	4	4	100

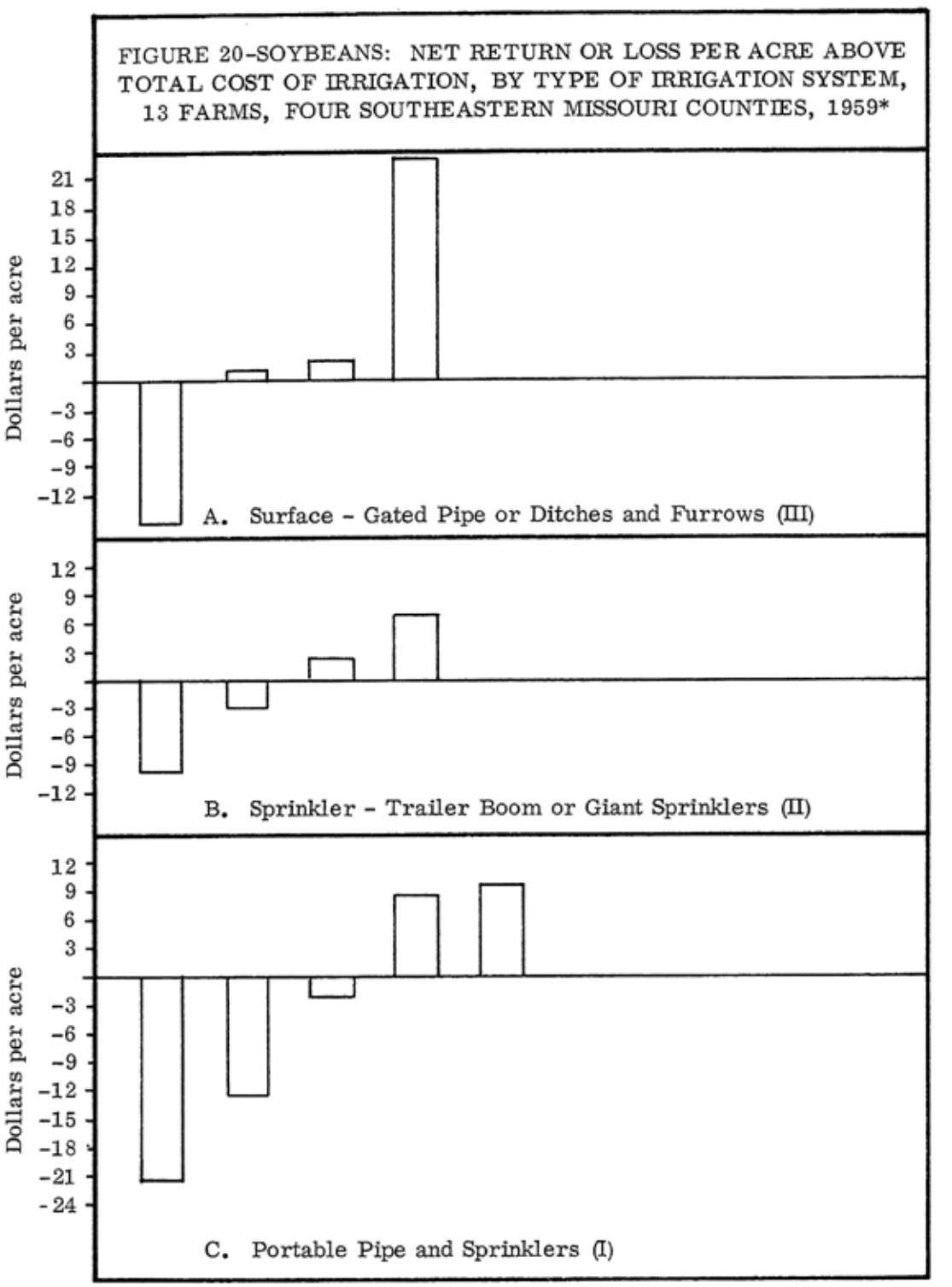
TABLE 48-SOYBEANS: NET RETURN OR LOSS ABOVE TOTAL IRRIGATION COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 13 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Total Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre				
-20.00 to -24.99	1	---	---	8
-15.00 to -19.99	---	---	1	8
-10.00 to -14.99	1	---	---	8
- 5.00 to - 9.99	---	1	---	8
- 0.01 to - 4.99	1	1	---	14
+ 0.01 to + 4.99	---	1	2	23
+ 5.00 to + 9.99	2	1	---	23
+10.00 to +14.99	---	---	---	---
+15.00 to +19.99	---	---	---	---
+20.00 to +24.99	---	---	1	8
Total	5	4	4	100

38 percent obtained returns ranging from $15.00 to $20.00 or over. The highest return over variable cost was $29.04.

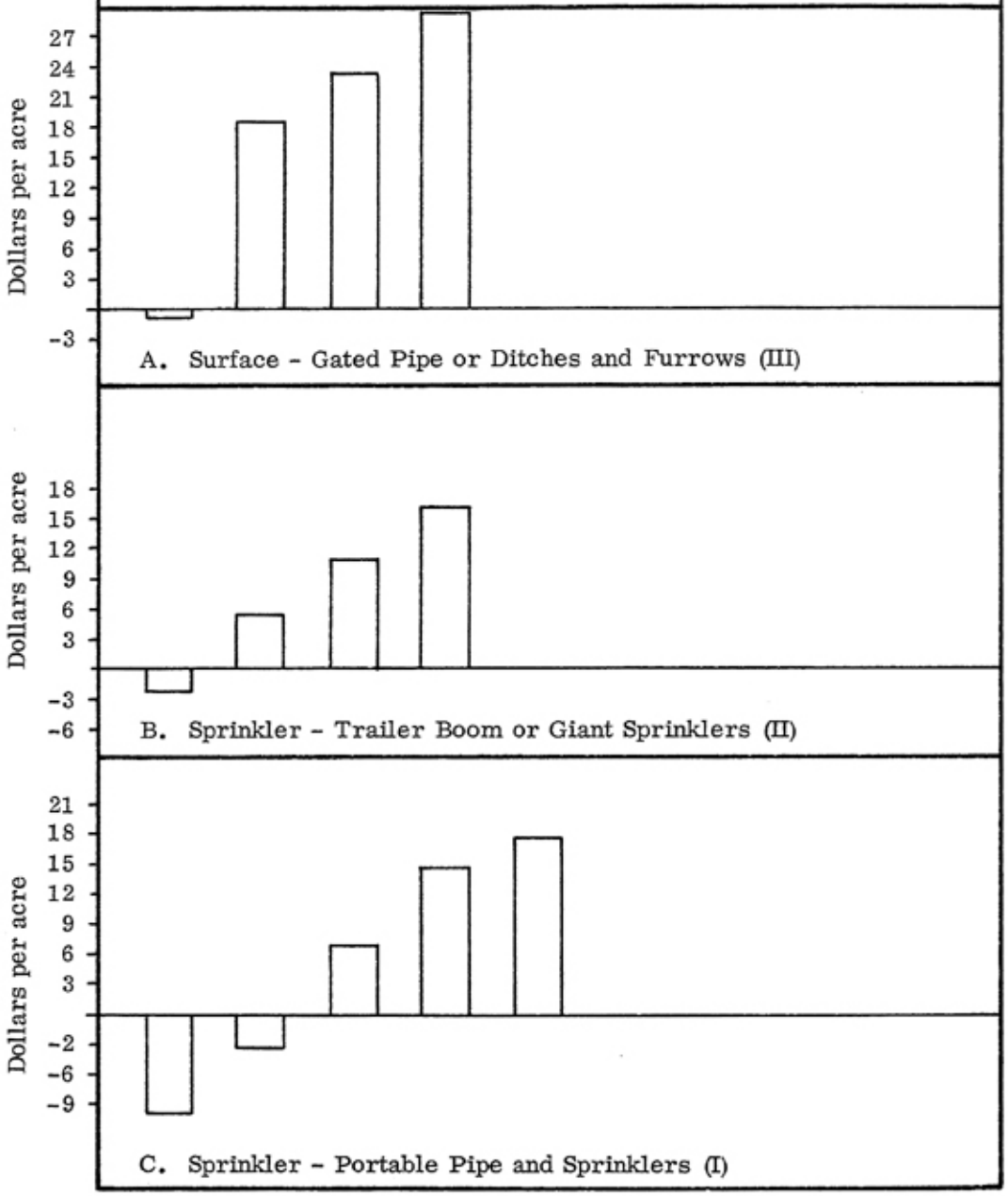
Summary of soybean irrigation—Farmers using category II and III irrigation systems obtained average net returns of $1.64 and $4.59 per acre irrigated, but those using category I systems had losses that averaged $6.52 an acre.

FIGURE 20-SOYBEANS: NET RETURN OR LOSS PER ACRE ABOVE TOTAL COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



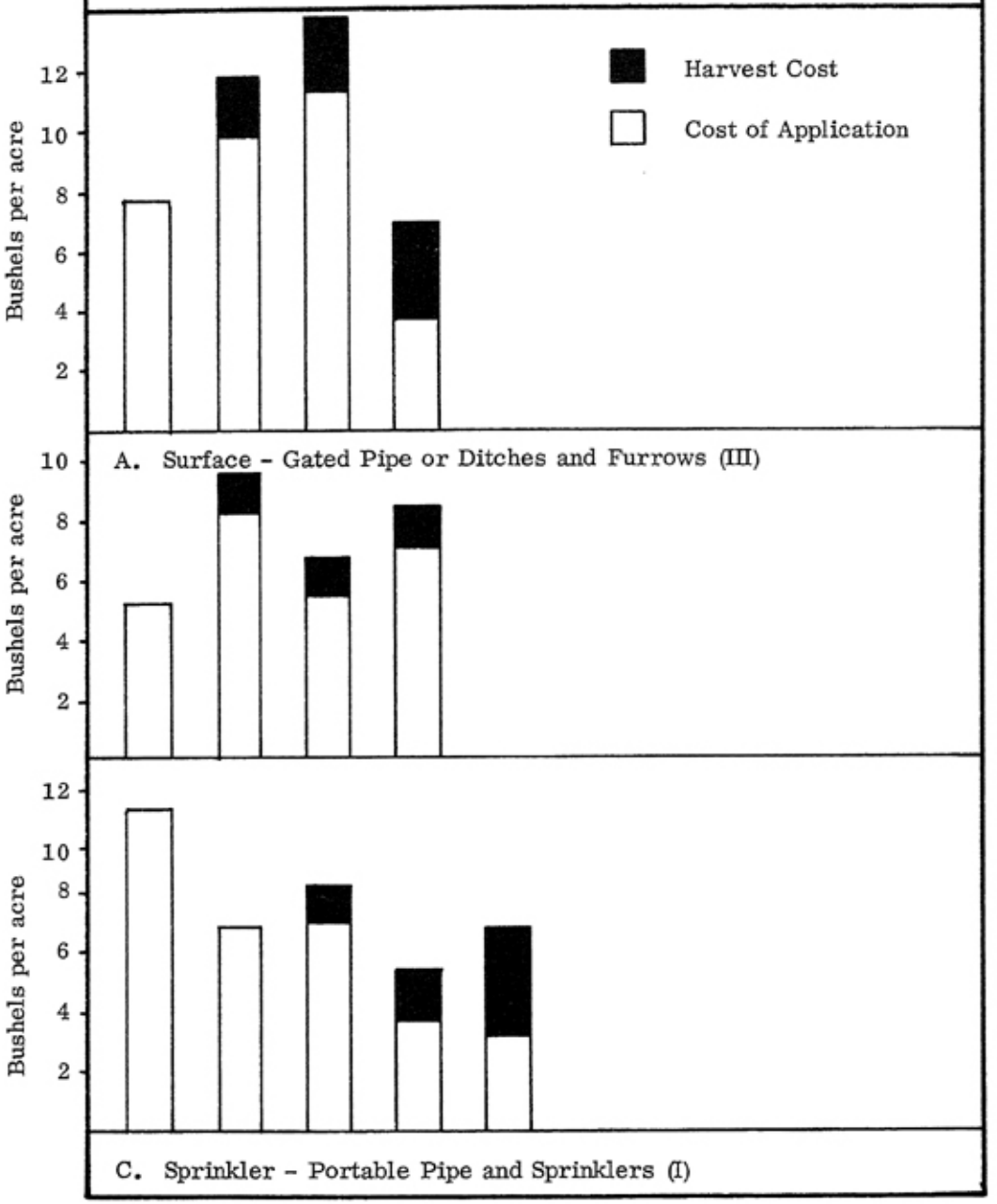
*Each bar represents one farm.

FIGURE 21-SOYBEANS: ADDITIONAL RETURN OR LOSS PER ACRE ABOVE VARIABLE COST OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTH-EASTERN MISSOURI COUNTIES, 1959*



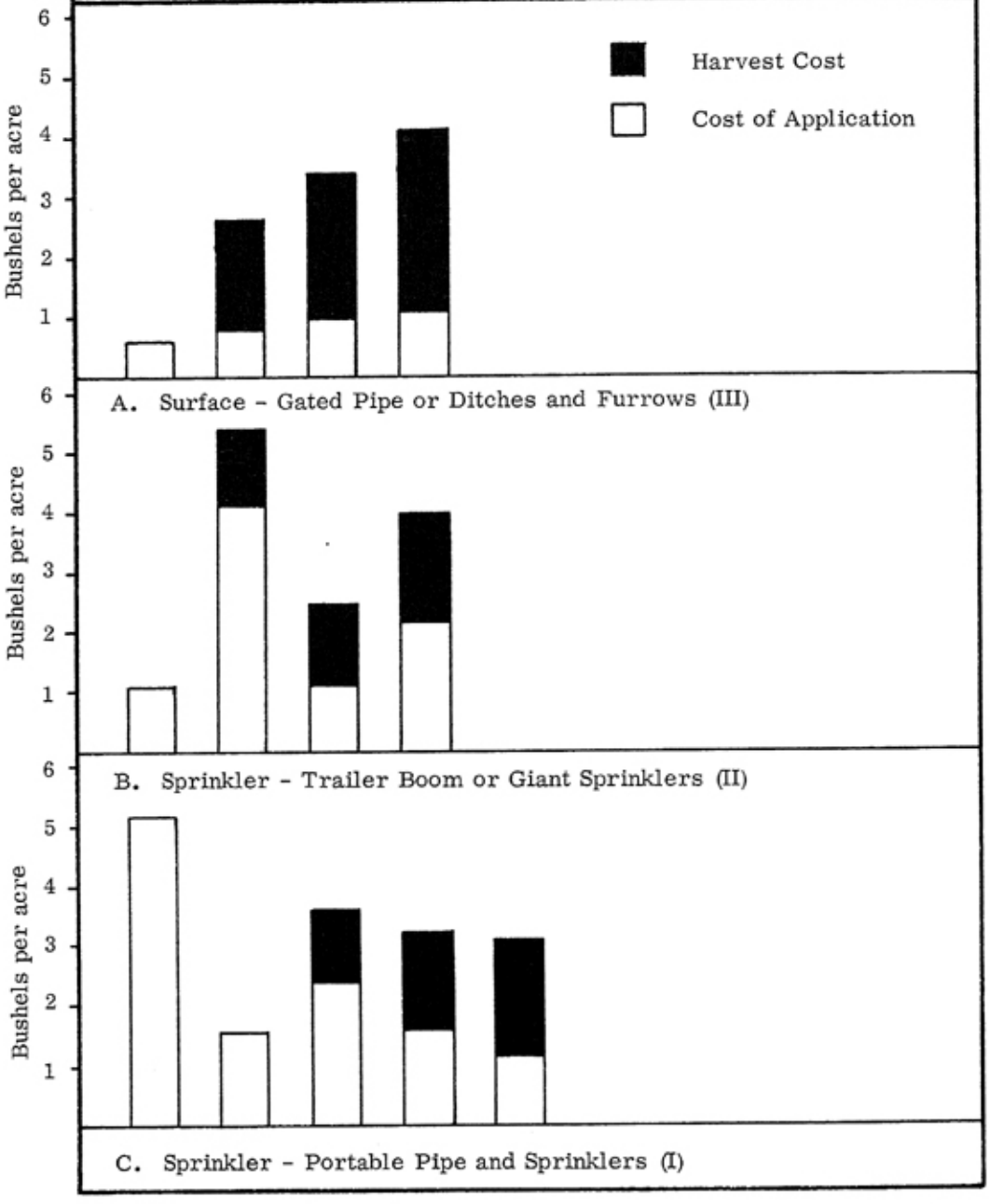
*Each bar represents one farm.

FIGURE 22-SOYBEANS: PER ACRE YIELD INCREASE REQUIRED TO PAY TOTAL COST OF IRRIGATION, INCLUDING HARVESTING COSTS, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

FIGURE 23-SOYBEANS: PER ACRE YIELD INCREASE REQUIRED TO PAY VARIABLE COSTS OF IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 13 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 49-SOYBEANS: ADDITIONAL RETURN OR LOSS ABOVE AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 13 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars Per Acre				
-10.00 to -14.99	1	---	---	9
- 5.00 to - 9.99	---	---	---	---
- 0.01 to - 4.99	1	1	1	23
+ 0.01 to + 4.99	---	---	---	---
+ 5.00 to + 9.99	1	1	---	15
+10.00 to +14.99	1	1	---	15
+15.00 to +19.99	1	1	1	23
+20.00 or Over	---	---	2[1]	15
Total	5	4	4	100

[1] +$22.80 and +$29.04.

Forty-six percent of the soybean irrigators did not obtain yield increases that were sufficient to pay total irrigation costs. However, the additional returns were equal to or larger than variable costs on 68 percent of the farms. Irrigators who used category III systems had higher net returns per acre than those using category I and II systems.

EFFECTS OF IRRIGATION ON FARM INCOME, 1959

Crop Yields

One of the principal reasons for irrigating crops is to increase or stabilize yields. In some years yields in the Delta are reduced because of excess rainfall; in others drought periods during the growing season restrict the output. In recent years, yields of all crops have been increasing, not only in the Delta but throughout the state. In 1959, production was exceptionally good on the lowlands. In the four counties from which irrigation records were obtained, corn averaged 59.6 bushels per acre. It was 86 bushels on the irrigated farms. The average yield of cotton in the four counties was 610 pounds of lint and 668 pounds on the irrigated farms. Soybeans yielded 22.5 bushels per acre in the four counties and 29 bushels where water was applied (Table 50).

Net Returns to Corn, Cotton and Soybean Irrigators

Nineteen of the 65 farmers who owned irrigation equipment did not use it in 1959. Six of the nine who irrigated applied water to one or two crops but not

TABLE 50-CORN, COTTON, AND SOYBEANS: EXTIMATED YIELDS PER ACRE, 40 IRRIGATORS AND 19 NONIRRIGATORS, AND AVERAGE YIELDS IN FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

	Corn	Cotton	Soybeans
	Bushels	Pounds of Lint	Bushels
Irrigators:			
Average Yield	86	668	29
Range	55-120	500-900	15-34
Number	16	35	13
Nonirrigators:			
Average	80	655	25
Range	70-90	500-900	17-30
Number	9	15	14
Four County Average	59.6	610	22.5

to all three. For these reasons only 40 of the 65 records were used in the analysis of farm income. The average net gain from cotton, corn and soybeans on the farms where these crops were irrigated was $761 and $316 for category II and III systems respectively. Farmers using category I systems had an average loss of $65 (Table 51). Only 43 percent of the farmers had net gains. Six or 15 percent had net returns ranging from $100 to $1,499 per farm: eight or 20.0 percent had gains varying from $1,500 to $1,999, and three or 78 percent received more than $2,000 (Table 52). This highest net return was $4,284.

Of the 57 percent who had net losses, six or 15.0 percent ranged from $1,000 to $2,499 per farm (Table 52 and Figure 24). The net loss per farm ranged from less than $100 to $999 on 17 or 42 percent of the farms.

The relationship between type of irrigation system and net gain or loss was studied. The hypothesis of independence was tested and a chi square of 3.3 obtained. This value was not statistically significant, and the hypothesis was not rejected.

There was no significant difference between the type of irrigation system used and the number of irrigators obtaining gains or losses. The difference between the average net gain or loss per farm according to type of system used was studied. Null hypotheses were tested in all cases. As stated earlier, average net gains or losses were $761, $316 and -$65 for users of II, III, and I systems respectively. When the difference between the means of categories I and II were tested, a "t" value of 1.34 was obtained. When categories I and II and II and III were tested, "t" values of 0.81 and 0.52 resulted. None of these values were statistically significant. The null hypotheses were not rejected.

Returns Above Variable Costs to Corn, Cotton and Soybean Irrigators

The average gains per farm above variable costs were $629, $1,820 and $880 for farmers using category I, II, and III systems respectively (Table 51). Nine-

TABLE 51-COTTON, CORN, AND SOYBEANS: TOTAL RETURN MINUS TOTAL COST OF IRRIGATION PER FARM AND TOTAL RETURN MINUS TOTAL VARIABLE COST OF IRRIGATION PER FARM, BY TYPE OF IRRIGATION SYSTEM, 40 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Total Return from Irrigation Less Total Cost	Total Return from Irrigation Less Total Variable Cost	Total Return from Irrigation Less Total Cost	Total Return from Irrigation Less Total Variable Cost	Total Return from Irrigation Less Total Cost	Total Return from Irrigation Less Total Variable Cost
Portable Pipe and Sprinkler[1] (I)		Giant Sprinkler and Trailer Boom[2] (II)		Gated Pipe and Ditches and Furrows[3] (III)	
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
+2,231	+2,855	+4,284	+5,399	+2,350	+3,270
+1,926	+2,569	+1,999	+2,989	+1,958	+2,479
+1,830	+2,082	+1,948	+2,763	+ 659	+1,266
+1,629	+3,857	+1,678	+2,177	+ 579	+ 825
+1,493	+1,826	+1,613	+3,071	- 194	+ 617
+ 571	+1,194	+ 489	+1,095	- 503	- 104
+ 47	+ 677	-1,263	- 126	- 629	- 81
- 199	- 90	-1,716	- 212	- 671	- 60
- 409	+ 102	-2,185	- 780	- 702	- 287
- 443	- 29				
- 483	- 198				
- 499	- 11				
- 532	- 66				
- 547	- 87				
- 588	- 97				
- 620	- 66				
- 660	- 21				
- 824	- 78				
- 979	- 81				
-1,041	- 109				
-1,538	- 364				
-1,786	- 35				
Mean	Mean	Mean	Mean	Mean	Mean
- 65	629	761	1,820	316	880

[1]Twenty-two farmers.
[2]Nine farmers.
[3]Nine farmers.

TABLE 52-COTTON, CORN, AND SOYBEANS: NET RETURN PER FARM FROM IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 40 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Net Return Per Farm	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars				
-2,000 to -2,499	---	1	---	3
-1,500 to -1,999	2	1	---	7
-1,000 to -1,499	1	1	---	5
- 500 to - 999	7	---	4	27
- 100 to - 499	5	---	1	15
+ 100 to + 499	1	1	---	5
+ 500 to + 999	1	---	2	7
+1,000 to +1,499	1	---	---	3
+1,500 to +1,999	3	4	1	20
+2,000 to +2,499	1	---	1	5
+2,500 or Above	---	1[1]	---	3
Total	22	9	9	100

[1] +$4,284.

teen or 47.5 percent of the 40 irrigators obtained returns that were larger than the variable costs (Table 53 and Figure 25). Seven or 19 percent had net returns above variable costs that were between $100 and $1,499. Nine or 22 percent received positive net returns between $1,500 and $2,999 and three or 7 percent obtained returns in excess of $3,000. Of the group who did not meet variable costs, 20 or 50 percent had losses between $100 and $499. Only one irrigator had a loss on variable costs in excess of $500.

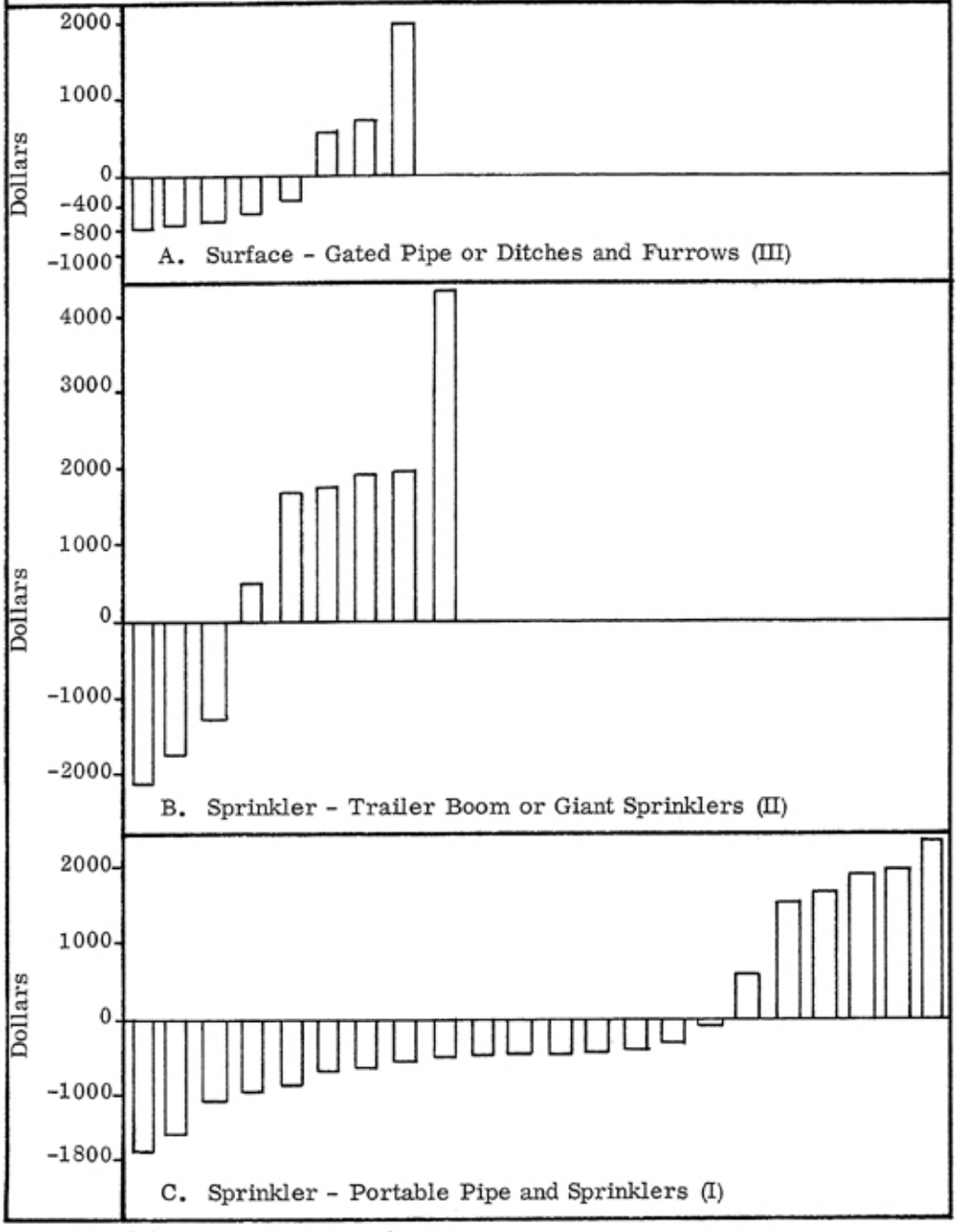
The null hypothesis was used to test the relationship between return above variable cost and type of irrigation system used. The chi squares that were obtained indicated no significant difference between the type of system and the number of irrigators who obtained a return above or below variable costs.

COST OF OWNING UNUSED EQUIPMENT

Annual Fixed Cost of 19 Nonirrigators

The average annual fixed cost of the 19 farmers who did not irrigate in 1959 that were attributable to the investment in irrigation equipment averaged $490. The amount ranged from $178 to $1,103 per farm (Table 54 and Figure 26). The annual fixed cost should be considered a net loss from irrigation. This loss reduced net farm income an average of $490 on the 19 farms.

FIGURE 24-NET RETURN FROM IRRIGATION, BY TYPE OF IRRIGATION SYSTEM USED, 39 FARMS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

TABLE 53-COTTON, CORN, AND SOYBEANS: RETURN ABOVE VARIABLE COSTS PER FARM, BY TYPE OF IRRIGATION SYSTEM, 40 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Return Above Variable Costs	Irrigation System (I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows	Percent of Farms
Dollars				
- 500 to - 999	---	1	---	2
- 100 to - 499	14	2	4	50
+ 100 to + 499	1	---	---	3
+ 500 to + 999	1	---	2	8
+1,000 to +1,499	1	1	1	8
+1,500 to +1,999	1	---	---	2
+2,000 to +2,499	1	1	1	8
+2,500 to +2,999	3	2	---	12
+3,000 to +3,499	---	1	1	5
+3,500 and Above	---	1[1]	---	2
Total	22	9	9	100

[1] +$5,399.

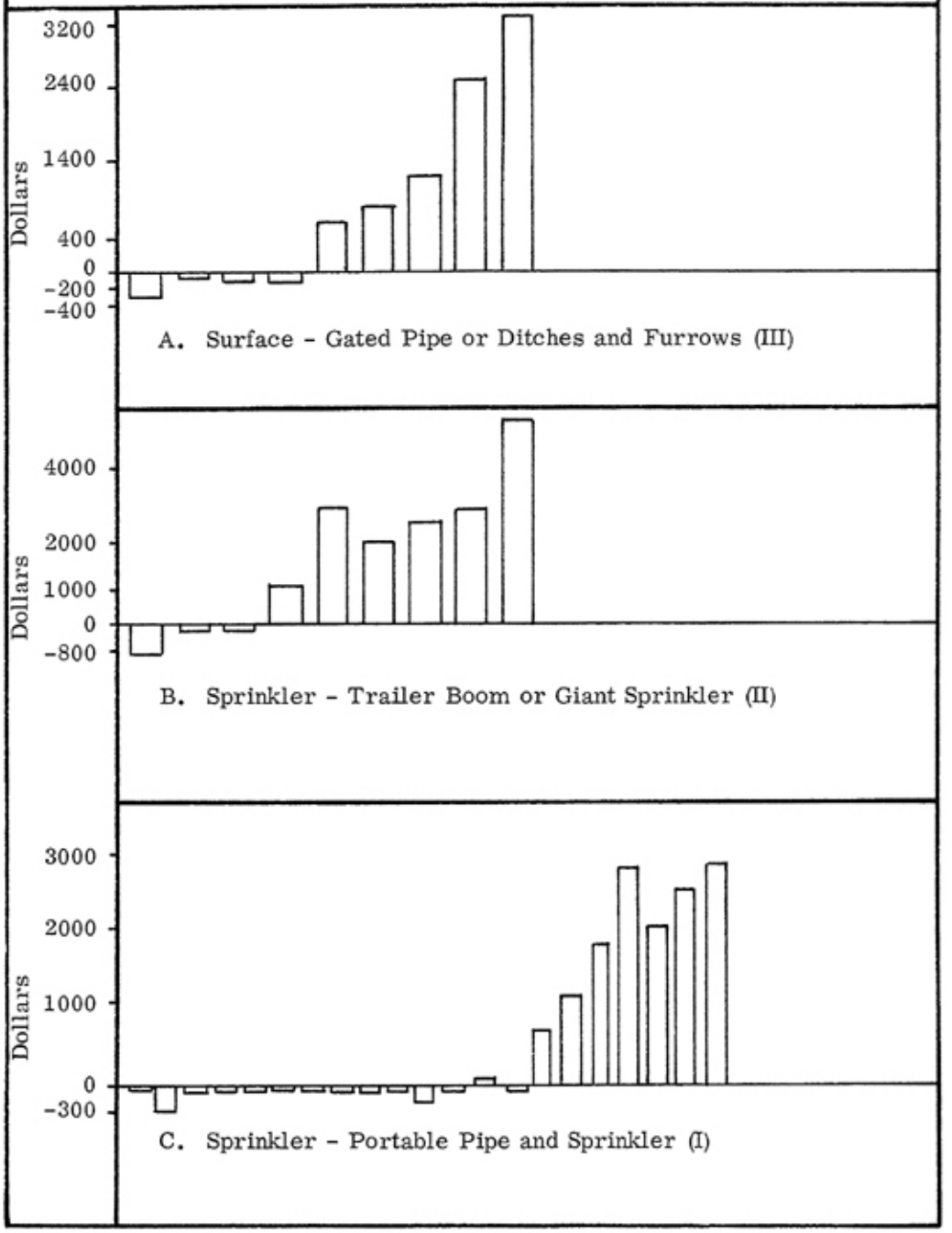
Summary of the effect of irrigation on net farm income—Net income per farm was increased $761 and $316 for farmers using category II and III systems respectively, but farmers using category I systems reduced their net farm incomes by $65.

Twenty-nine percent of the farmers who provided information for the study obtained net returns from irrigation. It was estimated that the universe proportion of irrigators obtaining net returns was between .17 and .41. The conclusion was reached that irrigation was not profitable for a majority of the farmers who had irrigation equipment in 1959. The fact that some did receive positive returns in a very favorable crop year suggests that changes in farming practices might make irrigation profitable for the majority of farmers in most years.

The probability was .95 that the universe proportion of irrigators who obtained a return above variable costs was between .20 and .45. Consequently, it was concluded that less than 50 percent of them obtained a return equal to the variable irrigation costs.

The monetary returns from irrigation in 1959 were below the expectations of a majority of irrigating farmers who had equipment for this practice.

FIGURE 25-COTTON, CORN AND SOYBEAN IRRIGATORS: ADDITIONAL RETURN OR LOSS ABOVE TOTAL VARIABLE COST PER FARM, BY TYPE OF IRRIGATION SYSTEM, 40 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



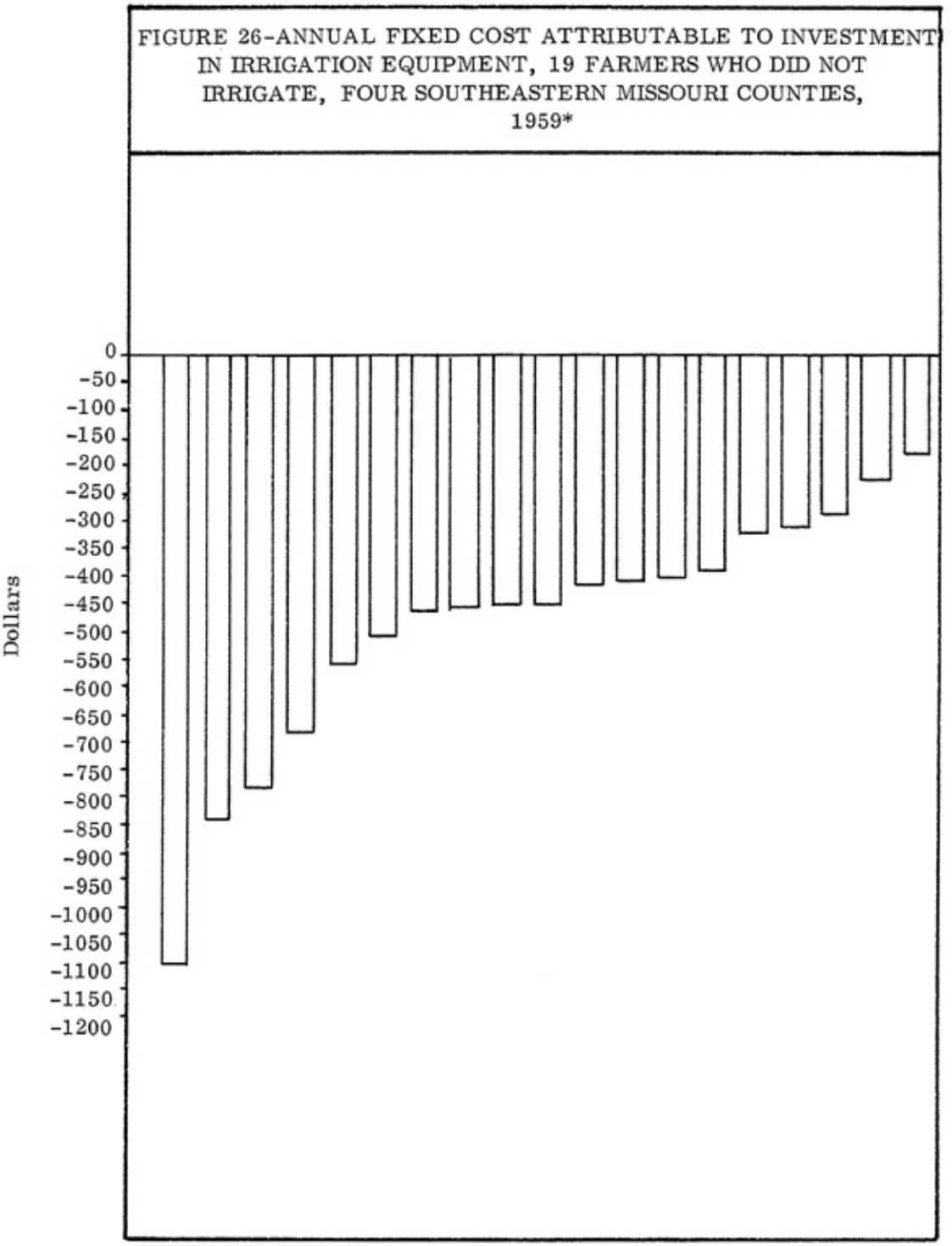
*Each bar represents one farm.

TABLE 54-ANNUAL FIXED COST ATTRIBUTABLE TO INVESTMENT IN IRRIGATION EQUIPMENT BY TYPE OF IRRIGATION SYSTEM, 19 FARMERS WHO DID NOT IRRIGATE, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

	Irrigation System		
	(I) Portable Pipe and Sprinkler	(II) Giant Sprinkler and Trailer Boom	(III) Gated Pipe and Ditches and Furrows
	Dollars	Dollars	Dollars
	1,103	687	411
	847		314
	779		227
	561		178
	517		
	472		
	460		
	456		
	453		
	415		
	413		
	394		
	324		
	295		
Total	7,489	687	1,130
Average	535	687	283
Range	295-1,103		178-411

Overall Mean - 490
Overall Range - 178-1,103

FIGURE 26-ANNUAL FIXED COST ATTRIBUTABLE TO INVESTMENT IN IRRIGATION EQUIPMENT, 19 FARMERS WHO DID NOT IRRIGATE, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959*



*Each bar represents one farm.

SUMMARY OF STATISTICAL TESTS

Test of independence—

Factors tested	Computed Chi Square	Critical Chi Square .05 Level	Significant	Not Significant
Size of farm and				
(1) Whether irrigation was used	4.20	9.49		X
(2) Capacity of irrigation system	23.52	25.00		X
Tenure of farm operator and				
(1) Whether irrigation system was used	2.34	5.99		X
(2) Type of soil	8.31	12.59		X
(3) Type of irrigation system	3.32	9.49		X
(4) Whether type of system has been changed	.68	5.99		X
Old type system	.98	5.99		X
New type system	4.78	5.99		X
Fixed investment in irrigation equipment and				
(1) Size of farm	24.98	31.41		X
(2) Whether irrigation system was used	7.32	9.49		X
(3) Tenure	10.00	15.51		X
Whether irrigation system was used and				
(1) Type of irrigation system	1.72	5.59		X
(2) Capacity of irrigation system	5.29	7.81		X
(3) Year irrigation was started	2.97	5.99		X
(4) Type of soil	5.18	7.81		X

Test of difference between means when standard deviations are unknown, but assumed equal.

Factors tested	Computed "t" Value	Critical "t" Value .05 Level	Significant	Not Significant
Type of irrigation system and				
(1) Fixed investment in irrigation equipment				

Factors tested	Computed Chi Square	Critical "t" Value .05 Level	Significant	Not Significant
Category I and II	3.38	2.021	.01	
Category I and III	1.59	2.021		X
Category II and III	4.34	2.074	.001	
(2) Capacity of irrigation system				
Category I and II	3.30	2.021	.01	
Category I and III	1.33	2.021		X
Category II and III	3.35	2.074	.01	
(3) Average cost per well				
Category I and II	.24	2.021		X
Category I and III	.18	2.021		X
Category II and III	.04	2.074		X
(4) Average cost per pump				
Category I and II	1.26	2.021		X
Category I and III	1.14	2.021		X
Category II and III	.12	2.074		X
(5) Average cost per power unit				
Category I and II	1.03	2.021		X
Category I and III	1.12	2.021		X
Category II and III	.06	2.074		X
(6) Average cost per distribution system				
Category I and II	2.44	2.021	.02	
Category I and III	3.46	2.021	.01	
Category II and III	4.19	2.074	.001	
Kinds of irrigated crop and				
(1) Amount of water applied per acre				
Corn and cotton	4.50	2.021	.001	
Corn and soybeans	.95	2.052		X
Soybeans and cotton	2.26	2.021	.05	
(2) Gross return per acre				
Corn and cotton	1.06	2.021		X
Corn and soybeans	2.23	2.052	.05	
Soybeans and cotton	.50	2.021		X
(3) Adjusted gross return per acre				
Corn and cotton	.99	2.021		X
Corn and soybeans	2.25	2.052	.05	
Soybeans and cotton	.35	2.021		X

Factors tested	Computed "t" Square	Critical "t" Value .05 Level	Significant	Not Significant
Capacity of irrigation system and				
(1) Tenure				
Owner-operator and part-owner	.79	2.021		X
Owner-operator and tenant	1.81	2.042		X
Part-owner and tenant	1.47	2.021		X

Factors tested	Computed Chi Square	Critical Chi Square .05 Level	Significant	Not Significant
Type of irrigation system and				
(1) Net return or loss per farm	3.32	5.99		X
(2) Return above variable cost per farm	2.66	5.99		X

Test of difference between mean when the standard deviations are unknown, but assumed equal.

Factors tested	Computed "t" Value	Critical "t" Value .05 Level	Significant	Not Significant
Type of irrigation system and				
(1) Average labor cost per acre application				
Category I and II	1.42	2.042		X
Category I and III	2.60	2.042	.02	
Category II and III	1.23	2.120		X
(2) Average tractor cost per acre application				
Category I and II	1.28	2.042		X
Category I and III	4.40	2.042	.001	
Category II and III	2.13	2.120	.05	
(3) Average fuel and oil cost per acre application				
Category I and II	.16	2.043		X
Category I and III	2.29	2.045		X
Category II and III	2.78	2.120	.02	

Factors tested	Computed "t" Value	Critical "t" Value .05 Level	Signif-icant	Not Signif-icant
(4) Minor repair cost per acre application				
Category I and II	.64	2.045		X
Category I and III	.06	2.045		X
Category II and III	.78	2.120		X
(5) Net return or loss per farm				
Category I and II	1.34	2.045		X
Category I and III	.81	2.045		X
Category II and III	.52	2.120		X
(6) Return above variable cost per farm				
Category I and II	1.96	2.045		X
Category I and III	.50	2.045		X
Category II and III	1.12	2.120		X

APPENDIX

Characteristics of Sample Farms

The 65 farmers from whom data were obtained operated a total of 25,498 acres. When the sample total was projected to include 186 farmers, the number who owned or controlled irrigation equipment, it was estimated that 75,280 acres in the area might be irrigated. The four counties contain approximately 1,192,726 acres of farmland and 6,686 commercial farms. These facts indicate that farms with irrigation equipment are a very small part of the total agricultural industry in the Delta Area of Missouri. In 1959, only 6.3 per cent of the farmland was irrigated and only 2.8 per cent of the commercial farmers irrigated land.

Forty-six of the 65 farmers applied water to various crops in 1959. The hypothesis of independence between the size of farm and whether or not the farmer irrigated was tested. A chi square of 4.2 was obtained, which suggested that the probability of obtaining a larger chi square was about .50. As a result, the hypothesis was not rejected.

Tenure of Farm Operators

The tenure pattern among the 65 farmers from whom data were obtained varied greatly from that of all farmers in the area. The 1959 Preliminary Census of Agriculture showed the percentage of owners, part owners, and tenants to be 20, 17, and 63 respectively. The proportion of owners and part owners among the farmers included in the analysis was 11 and 23 per cent greater than among

all farmers, while the proportion of tenants was 34 per cent smaller. These facts indicate that owners and part owners are more likely to have irrigation equipment than tenants. Since the cost of irrigation equipment is relatively high, it is not surprising that tenants do not invest in it as readily as owner operators.

The 0.95 confidence interval for the percentage of owners in the universe of irrigators was .22 to .40. This interval has a 0.95 chance of including the universe proportion of owners. The 0.95 confidence intervals for the percentage of part owners and tenants were .302 to .498 and .201 to .279, respectively.

Sixty-five, 65, and 84 percent of the owners, part owners, and tenants, respectively, in the sample applied water to various crops in 1959. The hypothesis of independence between tenure status and whether or not the farmer irrigated was tested. A chi square of 2.20 was obtained, which was not significant at the .05 probability level. A chi square of this magnitude suggests that the probability of obtaining a larger chi square was about .35. The hypothesis was not rejected.

Sixteen, 24, and 11 per cent of the owners, part owners, and tenants, respectively, operated farms in the 360 to 479 acre group (Appendix Table 1). Sixty-three per cent of the owners and tenants and 36 per cent of the part owners operated farms smaller than 360 acres. Forty per cent of the part-owner farms were larger than 479 acres, but only 21 and 26 per cent of the owner and tenant farms were in this category. The part-owner-operated farms were larger than those of owners and tenants.

APPENDIX TABLE 1-FARMERS HAVING IRRIGATION EQUIPMENT, BY SIZE OF OPERATING UNIT AND BY TENURE OF OPERATOR, 63 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Size of Farm	Owner Operator	Part Owner	Tenant	Total
Acres				
1-119	3	1	1	5
120-239	4	3	8	15
240-359	5	5	3	13
360-479	3	6	2	11
480-599	---	4	2	6
600-719	1	4	1	6
720-839	---	2	1	3
840-1,059	2	---	---	2
1,060-1,279	---	---	1	1
Over 1,280	1	---	---	1
Total	19	25	19	63

APPENDIX TABLE 2-CORN: ADDITIONAL RETURN OR LOSS, AND BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER ACRE-INCH OF WATER APPLIED, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre-Inch Above -		Breakeven Point			
			Average Cost		Average Variable Cost	
	Total Cost	Variable Cost	Including Harvest Cost	Excluding Harvest Cost	Including Harvest Cost	Excluding Harvest Cost
	Dollars		Bushels	Bushels	Bushels	Bushels
			Portable Pipe and Sprinkler I			
8	+13.91	+18.13	8.6	5.2	4.4	1.0
	+10.38	+12.53	5.6	3.2	3.5	1.1
	+ 6.69	+ 8.89	4.3	2.7	2.1	.5
	+ 2.94	+ 9.08	9.1	7.3	2.9	1.1
	- .55	+ 4.37	6.8	5.9	2.2	1.3
	- 6.06	- 1.73	---[1]	6.1	---[1]	1.7
	-17.75	- 2.20	---[1]	17.8	---[1]	2.2
	-18.47	- .54	---[1]	18.5	---[1]	.5
			Giant Sprinkler and Trailer Boom II			
5	+ 3.49	+ 4.77	3.5	2.1	1.8	.8
	+ 3.17	+ 3.92	2.6	1.8	1.9	1.0
	+ .93	+ 2.54	3.2	2.6	1.6	1.0
	- 4.69	- .68	---[1]	4.7	---[1]	.7
	- 4.26	- 1.76	---[1]	4.3	---[1]	1.8
			Gated Pipe and Ditches and Furrows III			
3	+ 3.55	+ 4.50	2.3	1.4	1.3	.4
	+ .64	+ 3.14	4.4	3.6	1.9	1.1
	- 1.68	- .48	---[1]	1.7	---[1]	.5

[1] Farmers did not receive a yeild response, therefore, no harvest cost was attributed to irrigation.

APPENDIX TABLE 3-CORN: ADDITIONAL RETURN OR LOSS, AND BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre Above - Total Cost	Extra Return or Loss Per Acre Above - Variable Cost	Breakeven Point: Average Cost, Including Harvest Cost	Breakeven Point: Average Cost, Excluding Harvest Cost	Breakeven Point: Average Variable Cost, Including Harvest Cost	Breakeven Point: Average Variable Cost, Excluding Harvest Cost
	Dollars		Bushels	Bushels	Bushels	Bushels
			Portable Pipe and Sprinkler I			
8	+27.82	+36.25	17.2	10.4	8.8	2.0
	+25.94	+31.32	14.0	8.0	8.7	2.7
	+13.37	+17.78	8.6	5.3	4.2	.9
	+ 7.35	+22.70	22.7	18.1	7.3	2.8
	- 4.37	+32.30	54.4	46.9	17.7	10.2
	-24.22	- 6.92	---[1]	24.2	---[1]	6.9
	-35.50	- 4.40	---[1]	35.5	---[1]	4.4
	-55.41	- 1.63	---[1]	55.4	---[1]	1.6
			Giant Sprinkler and Trailer Boom II			
5	+21.24	+29.06	18.8	12.7	10.9	4.9
	+20.18	+24.99	16.8	11.3	12.0	6.5
	+ 6.28	+17.16	21.7	17.5	10.8	6.6
	-14.07	- 2.04	---[1]	14.1	---[1]	2.0
	-20.48	- 8.47	---[1]	20.5	---[1]	8.5
			Gated Pipe and Ditches and Furrows III			
3	+24.47	+30.99	15.5	9.5	9.0	3.0
	+ 2.56	+12.57	17.4	14.1	7.4	4.4
	- 5.04	- 1.43	---[1]	5.0	---[1]	1.4

[1] Farmer did not receive a yield response, therefore there was no harvest cost attributed to irrigation.

APPENDIX TABLE 4-COTTON: ADDITIONAL RETURN OR LOSS AND BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER ACRE-INCH OF WATER APPLIED, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre-Inch Above -		Breakeven Point			
			Average Cost		Average Variable Cost	
	Total Cost	Variable Cost	Including Harvest Cost	Excluding Harvest Cost	Including Harvest Cost	Excluding Harvest Cost
	Dollars		Pounds of Lint		Pounds of Lint	
			Portable Pipe and Sprinkler (I)			
19	+25.61	+27.83	30.7	12.1	23.9	5.3
	+ 9.76	+11.20	7.2	5.4	3.1	1.2
	+14.83	+25.82	53.3	36.5	19.1	2.3
	+13.63	+19.89	36.5	23.1	17.0	3.7
	+19.03	+24.40	37.4	21.1	20.9	4.5
	- 5.13	+ 6.32	44.7	39.8	9.4	4.5
	- 3.21	- 1.07	---[1]	10.0	---[1]	3.3
	- 3.48	- 1.22	---[1]	10.8	---[1]	3.8
	- 8.95	- 2.13	---[1]	27.7	---[1]	6.6
	- 2.18	- .78	---[1]	6.8	---[1]	2.4
	-17.35	- 1.82	---[1]	53.9	---[1]	5.7
	-11.26	- 1.20	---[1]	35.0	---[1]	3.7
	-14.85	- 1.42	---[1]	46.5	---[1]	4.4
	- 9.12	- 1.45	---[1]	28.3	---[1]	4.5
	-28.79	- 2.38	---[1]	89.4	---[1]	7.4
	-18.57	+ 4.58	79.8	76.0	7.8	4.1
	-41.57	- .92	---[1]	129.1	---[1]	2.9
	-65.90	- 2.10	---[1]	204.7	---[1]	6.5
	-99.22	- 1.94	---[1]	308.1	---[1]	6.0
			Giant Sprinkler and Trailer Boom (II)			
8	+24.31	+27.54	30.4	12.1	20.7	2.5
	+ 7.44	+ 9.00	17.0	10.2	12.1	5.4
	+ 5.31	+ 6.96	16.6	11.0	11.5	5.9

APPENDIX TABLE 4 Continued

Number of Farmers	Extra Return or Loss Per Acre-Inch Above - Total Cost	Extra Return or Loss Per Acre-Inch Above - Variable Cost	Breakeven Point: Average Cost Including Harvest Cost	Breakeven Point: Average Cost Excluding Harvest Cost	Breakeven Point: Average Variable Cost Including Harvest Cost	Breakeven Point: Average Variable Cost Excluding Harvest Cost
	Dollars		Pounds of Lint		Pounds of Lint	
			Giant Sprinkler and Trailer Boom (II) (Continued)			
	+ 7.42	+12.39	27.4	18.9	11.9	3.4
	+ 5.27	+ 7.00	13.4	8.4	8.0	3.0
	- 9.09	- 1.07	---[1]	28.2	---[1]	3.3
	- 4.09	- 1.43	---[1]	12.7	---[1]	4.4
	-14.68	- 1.47	---[1]	45.6	---[1]	4.6
			Gated Pipe and Ditches and Furrows (III)			
8	+23.25	+32.17	51.9	30.9	24.2	3.2
	+ 7.12	+ 9.92	19.1	12.1	10.4	3.5
	- 4.27	- .70	---[1]	13.1	---[1]	2.1
	- 1.11	- .51	---[1]	3.4	---[1]	1.6
	- 4.48	- .40	---[1]	13.9	---[1]	1.2
	- 5.78	- .77	---[1]	18.0	---[1]	2.4
	- 4.04	+ 2.64	23.3	21.4	2.6	.8
	- 3.66	- .60	---[1]	11.3	---[1]	1.9

[1] Farmer did not receive a yield response, therefore, no harvest cost was attributed to irrigation.

APPENDIX TABLE 5-COTTON: ADDITIONAL RETURN OR LOSS, AND BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre Above -		Breakeven Point			
			Average Cost		Average Variable Cost	
	Total Cost	Variable Cost	Including Harvest Cost	Excluding Harvest Cost	Including Harvest Cost	Excluding Harvest Cost
	Dollars		Pounds of Lint		Pounds of Lint	
			Portable Pipe and Sprinkler (I)			
19	+55.63	+63.73	92.0	47.3	66.8	22.1
	+51.22	+55.63	61.5	24.3	47.8	10.6
	+49.38	+86.05	177.7	121.7	63.7	7.8
	+33.38	+48.73	89.4	56.8	41.7	9.1
	+27.21	+34.81	53.4	30.1	29.8	6.5
	- 7.69	+ 9.61	68.0	60.6	14.3	6.8
	- 8.02	- 2.66	---[1]	24.9	---[1]	8.3
	-12.96	- 4.56	---[1]	40.3	---[1]	14.2
	-13.42	- 3.21	---[1]	41.7	---[1]	10.0
	-13.91	- 4.97	---[1]	43.2	---[1]	15.4
	-17.35	- 1.82	---[1]	53.9	---[1]	5.7
	-19.37	- 2.06	---[1]	60.2	---[1]	6.4
	-22.27	- 2.11	---[1]	69.2	---[1]	6.5
	-27.35	- 4.35	---[1]	84.9	---[1]	13.5
	-28.79	- 2.38	---[1]	89.4	---[1]	7.4
	-37.15	- 9.17	159.5	152.0	15.7	8.2
	-62.40	- 1.37	---[1]	193.7	---[1]	4.3
	-65.90	- 2.10	---[1]	204.7	---[1]	6.5
	-99.22	- 1.94	---[1]	308.1	---[1]	6.0
			Giant Sprinkler and Trailer Boom (II)			
8	+51.04	+68.84	75.2	24.5	50.9	6.2
	+40.93	+49.53	93.5	56.2	66.8	29.5
	+26.53	+34.78	83.1	55.1	57.5	29.5
	+16.24	+27.13	59.9	41.2	26.1	7.5

APPENDIX TABLE 5 Continued

Number of Farmers	Extra Return or Loss Per Acre Above - Total Cost	Extra Return or Loss Per Acre Above - Variable Cost	Breakeven Point: Average Cost Including Harvest Cost	Breakeven Point: Average Cost Excluding Harvest Cost	Breakeven Point: Average Variable Cost Including Harvest Cost	Breakeven Point: Average Variable Cost Excluding Harvest Cost
	Dollars		Pounds of Lint		Pounds of Lint	
			Giant Sprinkler and Trailer Boom (II) (Continued)			
	+14.64	+19.45	37.3	23.3	22.3	8.4
	-13.64	- 1.61	---[1]	42.4	---[1]	5.0
	-18.40	- 6.40	---[1]	57.2	---[1]	19.0
	-31.56	- 3.15	---[1]	98.0	---[1]	9.8
			Gated Pipe and Ditches and Furrows (III)			
8	+46.50	+64.34	103.7	61.8	48.3	6.4
	+22.59	+31.41	60.5	38.4	33.0	10.9
	- 6.41	- 1.06	---[1]	19.9	---[1]	3.3
	- 6.68	- 3.07	---[1]	20.7	---[1]	9.5
	-11.19	- 1.00	---[1]	34.7	---[1]	3.1
	-11.56	- 1.55	---[1]	35.9	---[1]	4.8
	-12.12	+ 8.05	71.0	65.4	8.1	2.5
	-16.38	- 2.67	---[1]	50.9	---[1]	8.3

[1] Farmer did not receive a yield response therefore, no harvest cost was attributed to irrigation.

APPENDIX TABLE 6-SOYBEANS: ADDITIONAL RETURN OR LOSS, BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER ACRE-INCH OF WATER APPLIED, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre-Inch Above -		Breakeven Point			
			Average Cost		Average Variable Cost	
	Total Cost	Variable Cost	Including Harvest Cost	Excluding Harvest Cost	Including Harvest Cost	Excluding Harvest Cost
	Dollars		Bushels	Bushels	Bushels	Bushels
			Portable Pipe and Sprinkler (I)			
5	+ 4.64	+ 8.70	3.6	2.7	1.5	.6
	+ 4.45	+ 6.65	2.7	1.9	1.6	.8
	- .30	+ .97	1.2	1.0	.5	.4
	-13.28	- 3.01	---[1]	6.8	---[1]	1.6
	- 7.35	- 3.38	---[1]	3.8	---[1]	1.7
			Giant Sprinkler and Trailer Boom (II)			
4	+ 1.17	+ 2.61	1.4	1.1	.7	.4
	+ 1.86	+ 8.91	5.6	4.6	2.0	1.0
	- .73	+ 1.23	2.3	2.0	1.3	1.0
	- 3.96	- .82	---[1]	2.0	---[1]	.4
			Gated Pipe and Ditches and Furrows (III)			
4	+ 5.92	+ 7.26	1.7	1.0	1.0	.3
	+ .26	+ 2.28	1.4	1.1	.3	.1
	+ .05	+ 2.28	1.5	1.2	.3	.1
	- 6.64	- .58	---[1]	3.4	---[1]	.3

[1] Farmer did not receive a yield response, therefore, no harvest cost was attributed to irrigation.

APPENDIX TABLE 7-SOYBEANS: ADDITIONAL RETURN OR LOSS, AND BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE TOTAL COSTS AND AVERAGE VARIABLE COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

Number of Farmers	Extra Return or Loss Per Acre Above -		Breakeven Point			
			Average Cost		Average Variable Cost	
	Total Cost	Variable Cost	Including Harvest Cost	Excluding Harvest Cost	Including Harvest Cost	Excluding Harvest Cost
	Dollars		Bushels	Bushels	Bushels	Bushels
			Portable Pipe and Sprinkler (I)			
5	+ 9.29	+17.40	7.2	5.4	3.1	1.2
	+ 8.89	+13.30	5.4	3.9	3.2	1.6
	- 2.12	+ 6.82	8.1	7.0	3.5	2.4
	-13.28	- 3.07	---[1]	6.8	---[1]	1.6
	-22.06	-10.00	---[1]	11.3	---[1]	5.1
			Giant Sprinkler and Trailer Boom (II)			
4	+ 6.99	+15.64	8.4	6.6	4.0	2.1
	+ 2.27	+10.87	6.8	5.6	2.4	1.2
	- 3.07	+ 5.18	9.6	8.3	5.3	4.1
	- 9.90	- 2.06	---[1]	5.1	---[1]	1.1
			Gated Pipe and Ditches and Furrows (III)			
4	+23.69	+29.04	6.8	3.9	4.1	1.2
	+ 2.55	+22.80	13.7	11.4	3.3	1.0
	+ .41	+18.25	11.8	9.9	2.6	.8
	-15.03	- 1.32	---[1]	7.7	---[1]	.7

[1] Farmer did not receive a yield response, therefore, no harvest cost was attributed to irrigation.

APPENDIX TABLE 8-AVERAGE YIELD PER ACRE, SPECIFIED CROPS, MISSOURI, 1950-59

Year	Crop		
	Corn	Cotton	Soybeans
	Bushels	Pounds of Lint	Bushels
1950	44	280	23
1951	34	303	20
1952	41	367	19
1953	33	388	14
1954	20	480	15
1955	39	481	17
1956	48	587	20
1957	44	282	21
1958	60	452	26
1959	55	613	23
Average 1950-59	44	420	20

Source: Agricultural Statistics, 1950-1960, United States Department of Agriculture, United States Government Printing Office, Washington, D.C.