Irrigation Practices And Costs In Southeastern Missouri—1960

TED L. JONES AND FRANK MILLER

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TED L. JONES AND FRANK MILLER[1]

SUMMARY

The data for the analysis were obtained from farmers who owned or controlled irrigation equipment in Dunklin, Pemiscot, New Madrid, and Mississippi Counties. A random sample of 65 operators who were known to have irrigating equipment was selected from a population of 186 irrigators in 1959.

The 65 farmers were interviewed three times in 1959 to obtain data on the fixed investment in irrigation equipment, operating costs, and estimated yield response from irrigation. This study is a continuation of the work completed in 1959. Since the reliability of a 1-year study is limited for purposes of projection, irrigation data were obtained from the same 65 farmers in 1960.

Thirty-eight, or 58 percent, of the 65 farmers applied water to 2,783 acres in 1960. The average number of acres per farm was 73. The 38 farmers applied water to 146 more acres in 1960 than did the 46 farmers who irrigated their crops in 1959. The average per farm was 16 acres greater than in 1959.

Cotton was the major irrigated crop in 1960, as well as in 1959. In 1960, an average of 3.9 inches of water was applied to 1,499 acres by 31 farmers. The average number of acres per farm was 48. Cotton accounted for 54 percent of the total irrigated acres. The average yield response was 133 pounds of lint per acre, even though 23 percent of the irrigators obtained no increase in yield.

In 1959, 35 farmers applied an average of 2.9 inches of water to 1,523 acres and received an average yield increase of 66 pounds of lint per acre.

Sixteen farmers applied an average of 5.9 inches of water to 722 acres of corn in 1960. The average increase in yield was 20 bushels per acre. Eighty-one percent of the corn irrigators obtained an increase in yield from applying water.

In 1960, the average number of acres of irrigated corn per farm was 45, or 4 acres greater than in 1959. An average of 5.9 inches of water per acre was applied, 0.7 inch more than in 1959. The average yield increase was 33 percent smaller than in 1959, but the proportion of irrigators obtaining higher yields was 18 percent greater.

Twelve farmers irrigated 394 acres of soybeans. The average amount of water applied per acre was 3.4 inches and the average increase in yield, 12 bushels, or 41 percent greater than in 1959. The average acreage of irrigated soybeans per

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farm was 37 percent greater in 1960, but the average amount of water applied was 23 percent less than in 1959.

Fixed costs averaged 73, 60, and 71 percent of total irrigation costs for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. The fixed costs as a percentage of total costs were lower for all systems in 1960 than in 1959, which indicates that the systems were used more intensively in 1960.

Variable costs averaged 27, 40, and 29 percent of total irrigation costs for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively.

The average cost per irrigated acre of cotton was $17.95, $16.63, and $12.10 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Net returns per irrigated acre averaged $12.74, $30.44, and $20.71, and returns above variable costs, $26.03, $40.73, and $29.57 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. The average net return and return above variable cost per acre was considerably greater in 1960 than in 1959.

The average cost per irrigated acre of corn was $16.34, $17.31, and $12.27 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Net returns per irrigated acre averaged –$8.21, +$0.36, and +$4.55, and returns above variable costs +$3.01, +$10.39, and +$12.35 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. The average net return and return above variable cost per acre was considerably smaller in 1960 than in 1959 because of a 33 percent decrease in average yield.

Average cost per irrigated acre of soybeans was $11.15, $11.11, and $16.98 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Net returns per acre averaged $9.27, +$11.80, and –$0.38, and returns above variable costs, $16.62, $18.04, and $13.08 for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. The average net return and return above variable costs were greater in 1960 than in 1959 for farmers using portable pipe and sprinkler and trailer boom-giant sprinkler systems, but smaller for farmers using surface systems.

Farmers obtained greater returns from applying water to cotton, corn, and soybeans in 1960 than in 1959. Seventy-one percent of the farmers increased their net farm incomes in 1960 as compared with 29 percent in 1959. Eighty-three percent obtained a return that was greater than variable irrigation costs in 1960 as compared with 33 percent in 1959.

Twenty-seven or 42 percent of the 65 farmers did not apply water in 1960. The average fixed cost attributable to investment in irrigation equipment was $552. As a result, net farm income on these farms was reduced by this amount.

INTRODUCTION

Field crop irrigation is a recent innovation in the Delta Cotton and Corn Area of Missouri. Previous studies in this section of the state revealed that ir-

rigation equipment was first used in 1952 to irrigate field crops. Shortage of rainfall during the mid-1950's (1954-56) encouraged the use of supplemental irrigation. Farmers wanted to increase or, at least, to maintain crop yields and farm income during the dry years. Supplemental irrigation was expanded to accomplish this purpose.

Whether or not to irrigate land is a decision that must be made by each farm operator. Several types of information are needed to guide him. They include: (1) the cost of installing and using different types of irrigation equipment; (2) the quantity and quality of available water; (3) the additional yield that can reasonably be expected from different crops; (4) the frequency of need for supplemental water, and (5) the additional returns in relation to costs. This information was not available for Missouri farmers, yet many of them acquired and used irrigation equipment. This and other studies were initiated to make the experiences of these farmers available to other operators who might be contemplating the purchase and use of irrigation equipment.

Objectives of the Study

The investigations were guided by 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 applying water to specific crops;

3. To determine the effect of irrigation on farm income.

Method of Investigation

The work was divided into three phases. The first dealt with the nature and extent of irrigation in Missouri,[2] and second, with costs and returns in southeastern Missouri in 1959.[3]

Data for the second and third phases were obtained from farmers who owned or controlled irrigation equipment in Dunklin, Pemiscot, New Madrid, and Mississippi Counties.

During the second phase of the investigation, 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. A random sample of 65 farmers was selected from the population. Each farm operator in the sample was interviewed three times during 1959 to obtain the fixed investment in irrigation equipment, operating costs, and estimated yield response.

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[2]Ted L. Jones and Frank Miller, *Nature and Extent of Irrigation in Missouri,* University of Missouri Agricultural Experiment Station Research Bulletin 735, April 1960, p. 3.

[3]Ted L. Jones and Frank Miller, *Irrigation Practices and Costs in Southeastern Missouri—1959,* University of Missouri Agricultural Experiment Station Research Bulletin 795, February 1962.

The 1960 data were obtained from the same 65 farmers who furnished data for the 1959 study. Since the initial contact had been made in the fall of 1959, only one call was made in the fall of 1960.

The 1959 study was an analysis of costs and returns from irrigation during one year. It was believed that obtaining data from the same farmers in 1960 would add reliability to the findings, since variation in the amount and distribution of rainfall greatly affects the yield response to application of water.

Description of the Area

The four counties from which data were obtained encompass approximately 1,357,440 acres (Figure 1). 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.[4] Production of crops is the dominant activity in the area. Cotton is the principal money crop, although soybeans and corn each occupy a larger acreage.

The soils are of alluvial origin, but they vary greatly in texture, profile, and drainage. Sandy spots or streaks are common even in the 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 very difficult.[5] The dominant series are Sharkey clay loam, Sarpy fine sandy loam, Lintonia fine sand, and Waverly and Knox silt loams (Figure 2).

The area has a humid continental climate. The average annual precipitation is approximately 50 inches, the highest in the State.[6] Precipitation is greatest in January, March, and April.[7]

The average growing season is 210 days. The first parts of June, July, and August are periods of low, dry weather risk, but frequently dry periods occur in early May, late June, July, and August.[8] From the standpoint of crop production, lack of moisture during the growing season is often critical. Also, the area has more dry periods lasting three and four weeks than other sections of the state, except east-central Missouri.[9]

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[4]United States Bureau of the Census, 1959 *Census of Agriculture Preliminary: Missouri,* United States Government Printing Office, Washington, D.C., September, 1960.

[5]M. F. Miller and H. H. Krusekopp, *The Soils of Missouri,* University of Missouri Agricultural Experiment Station Bulletin 264, January, 1929, pp. 95-98.

[6]*Climate and Man,* Yearbook of Agriculture, 1941, United States Government Printing Office, Washington, D.C., pp. 550-554.

[7]Wayne L. Decker, *Monthly Precipitation in Missouri,* University of Missouri Agricultural Experiment Station Bulletin 650, March 1955, pp. 38-39.

[8]Wayne L. Decker, *Chances of Dry Periods in Missouri,* University of Missouri Agricultural Experiment Station Bulletin 707, June 1959, pp. 10-11.

[9]*Ibid.*

FIGURE 1 – SOUTH EASTERN MISSOURI COUNTIES WHERE IRRIGATORS WERE INTERVIEWED, 1959

The delta area appears to have an unlimited supply of water for irrigation. Wells, from 80 to 125 feet in depth, usually provide sufficient water for all irrigation needs.[10] However, only a small percentage of the farmers have used water for irrigation.

Fixed Investment in Irrigation Equipment

Fixed investments in irrigation equipment by type of system were analyzed in detail in the 1959 study. The average amount per farm was $7,122 or $56 per capacity acre, for the 65 farmers (Appendix Table 1).

IRRIGATION IN 1960

Number of Farmers Applying Water

Thirty-eight of the 65 farmers from whom data were obtained applied water to crops in 1960. This was 58 percent of the number interviewed. It was esti-

[10]Jones and Miller, *Nature and Extent of Irrigation in Missouri, op. cit.,* pp. 29-31.

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

WvS – Waverly silt loam
K – Knox silt loam
LnF – Lintonia fine sand
ShC – Sharkey clay loam
SrF – Sharpy fine sandy loam
WvF – Waverly fine sandy loam
LnL – Lintonia loam
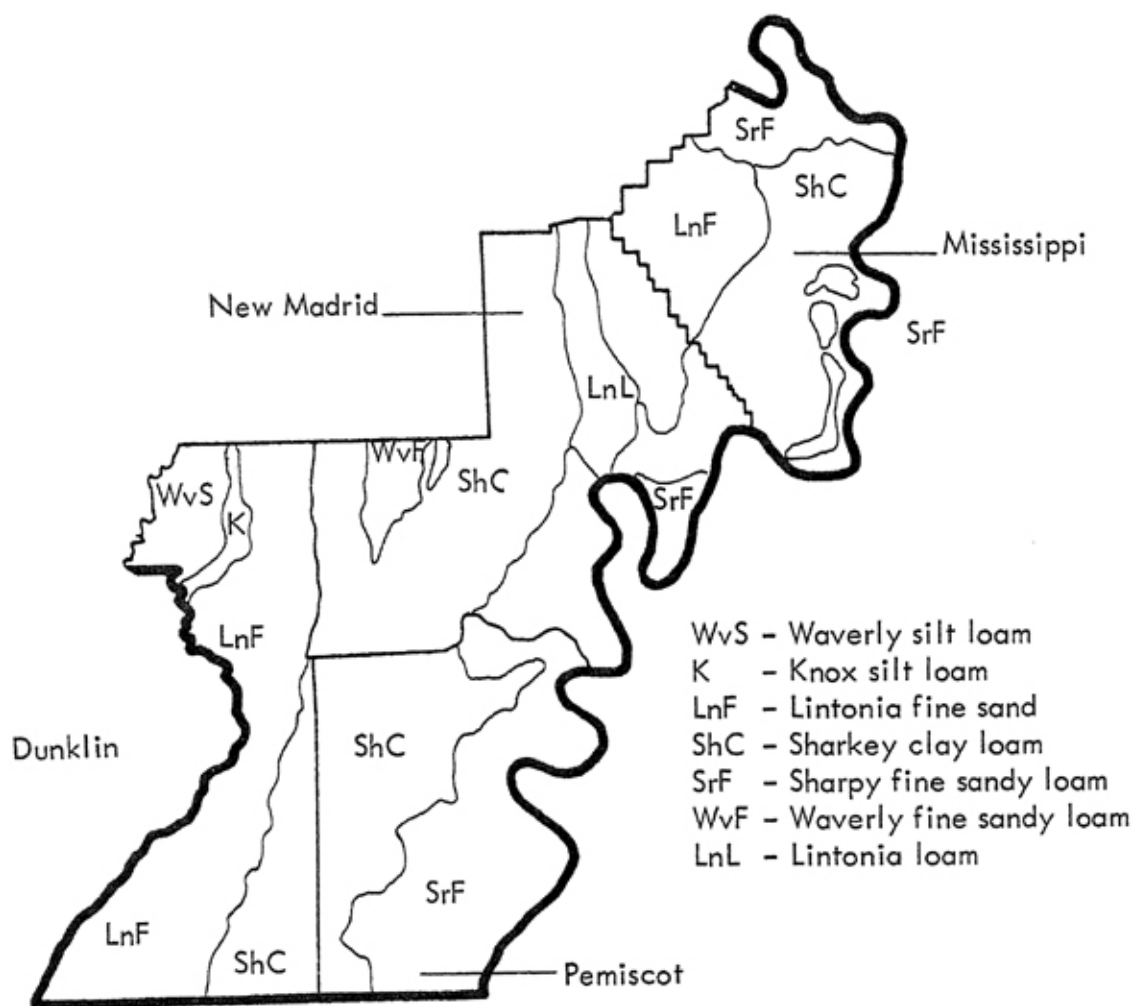
mated that between 46 and 70 percent of all farmers in the area with irrigation equipment applied water to crops in 1960. However, a smaller number irrigated in 1960 than in 1959, when 71 percent of those who furnished data applied water.

Irrigated Acres

The 38 irrigating farmers applied water to 2,783 acres of land. The average per farm was 73 acres. The range was from 6 to 225 acres. It was estimated that the average number of irrigated acres per farmer with equipment was between 55 and 91 acres.

The 38 irrigating farmers applied water to 146 more acres in 1960 than did the 46 farmers who used supplemental water in 1959. The average per farm was 16 acres greater in 1960.

Acre Application

An "acre application" was defined as water on one acre one time. A total of 5,460 acre applications was made in 1960 by the 38 irrigating farmers. The average number per farm was 144, with a range from 6 to 697.

Acre applications in 1960 totaled 974 more than in 1959. The average per farm increased from 97 to 144.

Since 2,783 acres were irrigated, and 5,460 acre-applications of water were applied, each acre was watered an average of 2.0 times. In 1959, each acre received 1.7 applications of water.

Crops Irrigated

In terms of number of acres, cotton, corn, and soybeans were the major irrigated crops. Other irrigated crops included strawberries, pasture, vegetables, and watermelons. The analysis covers only cotton, corn, and soybeans because of the limited number of irrigators and irrigated acres of the other crops. The acreage of cotton, corn, and soybeans combined made up 94.0 percent of the total to which water was applied.

Cotton—Cotton was the major irrigated crop. Thirty-one farmers applied water to 1,499 acres. This was 54 percent of the total acreage to which water was applied. In 1959, 35 farmers applied water to 1,523 acres, or 58 percent of the total irrigated acreage.

An average of 48 acres of cotton was irrigated per farm, 3 acres more than in 1959. An average of 3.9 inches of water was applied per acre, 1.0 inch more than was used in 1959.

Twenty-four, or 77 percent, of the 31 farmers obtained a yield response from irrigation. The average was 133 pounds of lint per acre, even though 23 percent of the cotton irrigators did not receive a yield increase. The range was from 0 to 250 pounds (Table 1).

TABLE 1–ESTIMATED YIELD INCREASE PER ACRE–INCH OF WATER,
PER ACRE IRRIGATED, AND PER ACRE APPLICATION,
ALL IRRIGATION SYSTEMS, BY CROP IRRIGATED, 35 IRRIGATORS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Item	Crop Irrigated		
	Corn	Cotton	Soybeans
	Bushels	Pounds of Lint	Bushels
Per Acre–Inch			
Average	3.4	33.8	3.5
Range	0–13	0–200	.6–7
Per Acre Irrigated			
Average	20.0	133.0	12.0
Range	0–50	0–250	3–20
Per Acre Application			
Average	9.0	82.0	8.0
Range	0–25	0–200	2–15

The average yield response per acre in 1960 was double that of 1959. Each irrigated acre of cotton in 1960 received 34 percent more water than was applied in 1959.

Corn—Sixteen farmers applied water to 722 acres of corn. The average per farm was 45 acres, or four more than in 1959.

An average of 5.9 inches of water was applied per acre, 0.7 inch more than in 1959.

Thirteen, or 81 percent, of the 16 farmers obtained a yield increase from irrigation. The average was 20 bushels per acre. The range was from 0 to 40 bushels. This percentage of irrigators obtaining a yield increase was 17 percent greater than in 1959, but the average increase was 10 bushels, or 33 percent, smaller than in 1959.

Soybeans—Twelve farmers irrigated 394 acres of soybeans. The average number of acres per farm was 33 with a range from 10 to 100. The average number of irrigated acres per farm was nine greater than in 1959.

An average of 3.4 inches of water was applied per acre, 1.0 inch less than the amount applied in 1959.

All 12 farmers reported yield responses from irrigation. The average was 12.00 bushels per acre with a range from 7 to 20 bushels. The percentage of irrigators obtaining a yield increase was 31 percent greater, while the average yield increase per acre was 3.5 bushels, or 41 percent, greater than in 1959.

Gross Return Per Acre Attributable to Irrigation

The average physical product attributable to irrigation was 133 pounds of lint cotton, 20 bushels of corn, and 12 bushels of soybeans per acre. The average prices received by Missouri farmers in September, October, November, and December 1960, were 30.5¢ per pound for lint cotton; 95.5¢ per bushel for corn, and $1.95 per bushel for soybeans. The 1960 average prices received were 1.7¢ and 4.5¢ smaller per unit of cotton and corn, respectively, but 1¢ greater 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. The average gross return per acre was $44.95 for cotton, $19.20 for corn, and $23.42 for soybeans.

Differences between the average gross return per acre of the three crops were tested statistically. Returns were significantly greater for cotton than for corn and soybeans. The average irrigated acre of cotton returned $25.74 and $21.52 more per acre than corn and soybeans, respectively.

The average gross return per acre for cotton and soybeans in 1960 was $23.70 and $6.70 greater than in 1959, but the average gross return per acre of corn was $11.16 smaller. Variations in yield response per acre was the primary reason for the differences in gross returns in the two years.

Adjusted Gross Return Per Acre—The average gross return per acre minus the harvesting cost of the additional yield was assumed to be equal to the adjusted gross return per acre. The harvesting cost used in the analysis was 15¢

per bushel of corn; 2¢ per pound of seed cotton, and 30¢ per bushel of soybeans.[11] The average physical output per acre multiplied by the unit harvesting cost equaled the average cost per irrigated acre. The adjusted gross return per acre was $32.48 for cotton, $16.19 for corn, and $19.83 for soybeans.

The adjusted gross return per acre for cotton was significantly greater than the return from corn and soybeans in 1960.

IRRIGATION COSTS AND RETURNS

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 the investment period. Variable or operating costs reflect prices of variable inputs such as labor, fuel, oil, and other supplies required to pump and distribute the water and to harvest the increased yield.

Annual Fixed Cost

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

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

The useful life of wells and siphon tubes were 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 change was equal to half the original value of the equipment multiplied by 5.0 percent.

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

The tax charge was the assessed value multiplied by 30¢ 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 and multiplying the results in thousands of dollars by $5.80.

$$\text{Insurance Charge} = \frac{\text{Original Value} \times .80 \times \$5.80}{\$1,000}$$

Depreciation charges made up 69 percent of the annual fixed cost for the three different types of systems (Table 2). Interest charges averaged 27 percent, which was second in importance, and taxes and insurance, 4 percent.

Fixed charges in 1960 averaged 73, 60, and 71 percent of the total irrigation costs for the portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively (Table 2). The relative proportion of fixed costs

[11]Albert Hagan, *Missouri Custom Rates* (University of Missouri Department of Agricultural Economics, 1960), pp. 1, 4, and 19. (Mimeographed).

TABLE 2-FIXED COSTS AS PERCENTAGE OF TOTAL IRRIGATION COSTS,
BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Type of System and Cost	Fixed Costs		Fixed Costs as Percent of Total Costs	
	Average	Range	Average	Range
	Percent	Percent	Percent	Percent
Portable Pipe and Sprinkler:[1]				
Depreciation	69	66–70	50	33–64
Interest	27	26–29	20	13–25
Taxes and Insurance	4	4– 5	3	2– 4
Total Fixed Cost			73	48–93
Trailer Boom and Giant Sprinkler:[2]				
Depreciation	69	64–71	41	25–62
Interest	27	25–31	16	10–24
Taxes and Insurance	4	4– 5	3	2– 4
Total Fixed Cost			60	37–90
Gated Pipe and Ditches and Furrows:[3]				
Depreciation	69	67–76	49	32–58
Interest	27	21–29	19	12–23
Taxes and Insurance	4	3– 5	3	2– 4
Total Fixed Cost			71	48–85

[1]Sixteen systems.
[2]Eight systems.
[3]Fourteen systems.

per unit depended upon the amount the system was used. The more use, or the higher the variable costs, the lower was the percentage of fixed charges in relation to the total. The trailer boom-giant sprinkler systems were more widely used in 1960 than the other systems.

Variable Costs

Variable or operating costs are incurred when irrigation systems are used. For purposes of analysis, variable costs were divided into the four following categories: labor, fuel and oil, tractor, minor repairs and miscellaneous (Table 3).

In a given year, the farm operator should consider the estimated variable costs of applying water in relation to the expected returns from its use. If he expects the returns from irrigation to equal or exceed the variable cost, water should be applied. Any additional return above average variable cost will reduce the average fixed cost.

Variable costs as a percentage of items in this class, and total irrigation costs were analyzed (Table 3). Expenditures for fuel and oil averaged 35, 53, and 44 percent of the variable costs for the portable pipe and sprinkler, trailer

TABLE 3-VARIABLE COSTS AS PERCENTAGE OF TOTAL IRRIGATION COSTS,
BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Type of System and Cost	Variable Costs		Variable Costs as Percentage of Total Costs	
	Average	Range	Average	Range
	Percent	Percent	Percent	Percent
Category I (Portable Pipe and Sprinkler):[1]				
Labor	53	22–66	15	2–31
Tractor	4	2– 8	1	0– 3
Fuel and Oil	35	22–50	9	1–16
Minor Repairs and Miscellaneous	8	0–32	2	0– 9
Total Variable Cost			27	3–52
Category II (Trailer Boom and Giant Sprinkler):[2]				
Labor	38	22–53	15	5–33
Tractor	4	3– 5	1	0– 2
Fuel and Oil	53	40–66	22	4–31
Minor Repairs and Miscellaneous	5	4– 8	2	1– 3
Total Variable Cost			40	20–63
Category III (Gated Pipe and Ditches and Furrows):[3]				
Labor	39	10–61	11	2–22
Tractor	4	2– 7	1	0– 3
Fuel and Oil	44	26–73	13	7–25
Minor Repairs and Miscellaneous	13	0–35	4	0–15
Total Variable Cost			29	15–52

[1]Sixteen systems
[2]Eight systems
[3]Fourteen systems

boom-giant sprinkler and surface systems, respectively. Fifty-three, 38, and 39 percent of the variable costs were labor charges for portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively. Variable costs as a percentage of total irrigation costs were 27, 40, and 29 percent for the portable pipe and sprinkler, trailer boom-giant sprinkler, and surface systems, respectively.

Total Cost of Irrigation—Fixed costs 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 (Table 4). The computations include the cost of applying

TABLE 4-FIXED, VARIABLE, AND TOTAL COST OF IRRIGATION
PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE
APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 35 IRRIGATORS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960[1]

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost
		Dollars	Dollars	Dollars
Category I				
(Portable Pipe and Sprinkler)[2]				
Per Acre-Inch				
Average	141	4.52	1.70	6.22
Range	12–705	2.70–38.33	1.13– 4.80	3.56–39.60
Per Acre Irrigated				
Average	52	12.22	4.60	16.82
Range	6–141	6.23–76.62	2.53–7.85	9.86–79.20
Per Acre Application				
Average	72	8.85	3.33	12.18
Range	6–282	2.62–76.62	1.79–5.53	5.26–79.20
Category II				
(Trailer Boom and Giant Sprinkler)[3]				
Per Acre-Inch				
Average	654	1.89	1.27	3.16
Range	96–1394	.80–10.31	.96–2.54	1.93–12.85
Per Acre Irrigated				
Average	127	9.68	6.55	16.23
Range	36–226	4.75–44.46	4.60–11.06	9.75–49.57
Per Acre Application				
Average	287	4.30	2.91	7.21
Range	48–697	1.60–20.62	1.92–5.08	4.37–25.70
Category III				
(Surface System)[4]				
Per Acre-Inch				
Average	287	1.79	.71	2.50
Range	123–960	.54–4.08	.32–1.96	.99–5.13
Per Acre Irrigated				
Average	55	9.38	3.73	13.11
Range	10–80	3.98–29.79	2.02–5.92	6.26–35.17
Per Acre Application				
Average	89	5.77	2.30	8.07
Range	20–240	1.99–16.32	1.12–5.92	3.86–20.53

[1] This data includes the cost of applying water to corn, cotton, and soybeans but excludes the cost of harvesting any increased yields.
[2] Sixteen systems (3 of the 16 farmers also applied water with surface systems).
[3] Eight systems.
[4] Fourteen systems.

water to corn, cotton, and soybeans on the farms where data were obtained in 1960. However, costs of harvesting the increased yields were not included in order to keep the analysis on a comparable basis between the 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 4 show average fixed, variable, and total costs of applying water in 1960 by use of three different systems.[12]

Cost per acre irrigated—Categories I, II, and III farms averaged 52, 127, and 55 irrigated acres, respectively. The range per farm was smallest in category III. The average fixed cost per irrigated acre varied from $12.22 on category I farms to $9.38 on category III farms. The average variable cost was $4.60, $6.55, and $3.73 on categories I, II, and III farms, respectively. Category III farms had the lowest average total cost, $13.11, while category I farms had the highest, $16.82.

An analysis of average fixed, variable, and total costs per acre-inch of water and per acre application is presented in Table 4.

Irrigation costs per farm—The absolute dollar-cost of irrigation per farm was studied to gain insight into the difference in magnitude of total costs among the three systems (Table 5). Fixed costs per farm averaged $635, $1,231, and $513 on categories I, II, and III farms, respectively. These data reflected differences in investment in irrigation equipment among the three systems.

The average variable cost per farm was $239, $834, and $204 for categories I, II, and III farms, respectively. The absolute variable cost in 1960 on category II farms was 249 percent greater than on category I farms, and 309 percent greater than on category III farms.

TABLE 5–AVERAGE FIXED, VARIABLE, AND TOTAL COST OF IRRIGATION PER FARM, BY TYPE OF IRRIGATION SYSTEM, 35 COTTON, CORN, AND SOYBEAN IRRIGATORS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

| Irrigation Cost Per Farm | Type of Irrigation System | | | |
	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom and Giant Sprinkler)	Category III (Surface System)	Total
Fixed Cost				
Average	635	1,231	513	716
Range	246–1,314	815–1,601	209–1,013	209–1,601
Percent of Total Cost	73	60	72	67
Variable Cost				
Average	239	834	204	351
Range	15–795	244–1,166	64–575	15–1,166
Percent of Total Cost	27	40	28	33
Total Cost				
Average	874	2,065	717	1,067
Range	475–1,563	1,234–3,044	291–1,150	291–3,044
Percent of Total Cost	100	100	100	100

[12]The five different types of irrigation systems were combined into three groups: Category I—Portable pipe and sprinkler; category II—Trailer boom-giant sprinkler combination, and category III—Gated pipe and ditch and furrow combination.

The average fixed cost per farm was smaller in 1960 than in 1959 on categories I and III farms, but larger on category II farms. The average variable costs were greater in 1960 than in 1959 for all farms, which reflects greater use of systems.

COST OF IRRIGATING SPECIFIC CROPS

The average, fixed, variable, and total costs of irrigating cotton, corn, and soybeans were 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:

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

If the irrigation system was used exclusively to water one crop, the average cost per unit analyzed was exceedingly large, when a relatively small acreage of one crop received water.

Cotton

The estimated yield response and fixed, variable, and total costs per acre-inch of water, per irrigated acre, and per acre application were determined (Table 6). Only the cost per irrigated acre is discussed here.

Cost per irrigated acre—Farmers with categories I, II, and III systems applied water to 41, 67, and 35 acres of cotton per farm. The average fixed, variable, and total costs per acre were $8.86, $3.24, and $12.10, respectively, for category III, the smallest among the three systems (Table 6). Category I farms had the largest average fixed and total cost, but category II had the highest average variable cost per acre. The average application of water per acre was 2.8, 4.8, and 4.5 inches with categories I, II, and III systems, respectively. The average yield increase per acre ranged from no increase to 250 pounds of lint, but the average yield increases for categories I, II, and III systems were 110, 169, and 118 pounds of lint, respectively.

Farmers using all three types of systems applied more water to a larger number of acres and obtained a greater yield response in 1960 than in 1959. The average fixed cost per irrigated acre was smaller for all systems in 1960 than in 1959, but the average total cost was larger for categories II and III systems because of increased system use. The average fixed cost for category I systems was enough smaller to offset the increased average variable cost, which left the average total cost smaller in 1960 than in 1959.

Corn

Cost per irrigated acre—Farmers with category II systems applied water to an average of 59 acres of corn, while farmers with categories I and III systems irrigated 32 and 39 acres, respectively (Table 7). The average fixed, variable, and total cost per acre was $7.80, $4.47, and $12.27 for category III, the smallest.

TABLE 6-COTTON: ESTIMATED YIELD RESPONSE, FIXED, VARIABLE, AND TOTAL COST OF IRRIGATION PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 33 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Pounds of Lint
Category I					
(Portable Pipe and Sprinkler)[1]					
Per Acre-Inch					
Average	115	4.78	1.68	6.46	40
Range	10–705	1.05–38.33	1.13–4.80	2.18–39.60	0–200
Per Acre Irrigated					
Average	41	13.29	4.66	17.95	110
Range	6–141	5.23–76.67	2.53–7.85	9.86–79.20	0–200
Per Acre Application					
Average	54	10.15	3.56	13.71	84
Range	6–282	2.62–76.67	2.53–5.53	5.44–79.20	0–200
Category II					
(Trailer Boom and Giant Sprinkler)[2]					
Per Acre-Inch					
Average	321	2.13	1.31	3.44	35
Range	14–831	.80–22.23	1.00–2.30	1.81–23.23	0–92
Per Acre Irrigated					
Average	67	10.28	6.34	16.62	169
Range	7–125	4.75–44.46	2.00–11.06	9.80–46.46	0–250
Per Acre Application					
Average	132	5.18	3.20	8.38	85
Range	7–277	2.21–44.47	2.00–4.77	4.99–46.46	0–185
Category III					
(Surface System)[3]					
Per Acre-Inch					
Average	158	1.94	.71	2.65	26

TABLE 6 (continued)

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Pounds of Lint
Range	78–300	.35–4.08	.31–1.96	.68–5.24	0–61
Per Acre Irrigated					
Average	35	8.86	3.24	12.10	118
Range	13–60	3.98–16.32	2.05–4.68	7.28–20.98	0–200
Per Acre Application					
Average	56	5.51	2.02	7.53	73
Range	26–120	1.41–16.32	1.11–4.66	2.72–20.98	0–200

[1] Fifteen farmers applied an average of 2.8 inches of water per acre. Each acre was irrigated the equivalent of 1.3 times.

[2] Eight farmers applied an average of 4.8 inches of water per acre. Each acre was irrigated the equivalent of 2.0 times.

[3] Ten farmers applied an average of 4.6 inches of water per acre. Each acre was irrigated the equivalent of 1.6 times.

TABLE 7-CORN: ESTIMATED YIELD RESPONSE, FIXED, VARIABLE, AND TOTAL COST OF IRRIGATION PER ACRE-INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Bushels
Category I					
(Portable Pipe and Sprinkler)[1]					
Per Acre-Inch					
Average	97	3.67	1.68	5.35	3
Range	20-240	2.22-16.08	1.34-4.61	3.56-20.69	0-12
Per Acre Irrigated					
Average	32	11.22	5.12	16.34	10
Range	5-95	8.90-16.08	4.61-5.50	14.25-20.69	0-12
Per Acre Application					
Average	53	6.66	3.04	9.70	6
Range	10-120	4.45-16.08	2.68-4.61	7.13-20.69	0-12
Category II					
(Trailer Boom and Giant Sprinkler)[2]					
Per Acre-Inch					
Average	356	1.67	1.25	2.92	4
Range	326-1,110	.66-7.41	.94-2.81	1.97-8.37	0-8
Per Acre Irrigated					
Average	59	10.03	7.48	17.51	22
Range	6-135	4.75-44.46	4.23-16.84	8.98-50.19	0-40
Per Acre Application					
Average	168	3.54	2.64	6.18	8
Range	60-555	1.32-14.82	1.91-5.61	3.93-16.73	0-16
Category III					
(Surface System)[3]					
Per Acre-Inch					
Average	262	1.15	.66	1.81	3

TABLE 7 (continued)

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Bushels
Range	40–960	.54–3.11	.32–1.70	1.14–4.59	0–13
Per Acre Irrigated					
Average	39	7.80	4.47	12.27	21
Range	10–80	3.98–29.79	1.43–8.57	5.66–38.36	0–50
Per Acre Application					
Average	71	4.25	2.44	6.69	11
Range	20–240	1.99–12.43	1.42–5.92	3.88–18.35	0–25

[1] Three farmers applied an average of 3.1 inches of water per acre. Each acre was irrigated the equivalent of 1.7 times.

[2] Six farmers applied an average of 6.0 inches of water per acre. Each acre was irrigated the equivalent of 2.8 times.

[3] Seven farmers applied an average of 6.8 inches of water per acre. Each acre was irrigated the equivalent of 1.8 times.

Water applied per acre averaged 3.0, 6.0, and 6.7 inches with categories I, II, and III systems, respectively. Yield increases per acre ranged from 0 to 50 bushels, but the average for categories I, II, and III systems was 10, 22, and 21 bushels, respectively.

Farmers with category I systems increased the average number of irrigated acres of corn by seven over the number in 1959, while the farmers with categories II and III systems decreasd their average irrigated acre by seven and three, respectively. The average application of water per acre was greater on farms using categories I and III systems, but remained the same on category II farms. Average fixed, variable, and total costs were higher in 1960 than in 1959 for all three systems, with exception of the average fixed cost for category I systems. The estimated yield response per irrigated acre was lower for all three systems in 1960 than in 1959.

Soybeans

Cost per irrigated acre—Farmers using categories I, II, and III systems averaged 38, 65, and 21 irrigated acres. The average fixed, variable, and total cost per acre was $6.24, $4.87, and $11.11 on farms with category II systems (Table 8). The lowest average fixed and total cost per acre was on farms with category II systems, but the lowest average variable cost was on farms with category III systems. Farms with category III systems had the highest fixed and total costs per acre.

The quantity of water applied per acre averaged from 2 to 4 inches with category I farmers applying 2 inches. An average of 4 inches of water was applied by farmers using the other two types of systems.

The average yield response per acre was 12, 14, and 10 bushels for farmers using categories I, II, and III systems, respectively (Table 8).

In 1960, farmers with categories I and II systems increased the average number of irrigated acres of soybeans 124 and 81 percent, respectively, while the number of acres irrigated on category III farms was decreased one acre from the number in 1959. The average, fixed, variable, and total costs per irrigated acre were lower on farms with categories I and II systems, but higher on category III farms. Farmers with all systems applied a smaller quantity of water in 1960 than in 1959. The estimated yield response was 200 and 55 percent greater on categories I and II farms, but 17 percent lower on category III farms in 1960.

RETURNS FROM IRRIGATION

In general, returns from irrigation result from increased yields or quality of product. Additional returns reflected increased yields in this study, since attention was centered on field crops.

Response to irrigation varied widely in 1960. Yields on irrigated land were substantially higher than on non-irrigated land in many instances. In other instances, no yield increase was obtained. The variation was caused by many factors. Among them were differences in soil types, planting rates, planting dates,

TABLE 8–SOYBEANS: ESTIMATED YIELD RESPONSE, FIXED, VARIABLE, AND TOTAL COST OF IRRIGATION PER ACRE–INCH OF WATER, PER ACRE IRRIGATED, AND PER ACRE APPLICATION, BY TYPE OF IRRIGATION SYSTEM, 12 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Bushels
Category I					
(Portable Pipe and Sprinkler)[1]					
Per Acre–Inch					
Average	78	3.60	1.86	5.46	6
Range	30–115	3.30–4.95	1.53–2.07	5.26–6.48	5–7
Per Acre Irrigated					
Average	38	7.35	3.80	11.15	12
Range	15–55	6.61–9.89	3.06–4.13	10.74–12.95	10–14
Per Acre Application					
Average	58	4.83	2.50	7.33	8
Range	15–115	3.48–9.89	1.79–4.13	5.26–12.95	6–13
Category II					
(Trailer Boom and Giant Sprinkler)[2]					
Per Acre–Inch					
Average	265	1.53	1.19	2.72	3
Range	90–440	1.52–1.58	.96–1.24	2.54–2.76	3–4
Per Acre Irrigated					
Average	65	6.24	4.87	11.11	14
Range	30–100	4.75–6.68	2.87–5.46	7.62–12.14	10–15
Per Acre Application					
Average	115	3.53	2.75	6.28	8
Range	30–200	3.34–4.75	2.73–2.87	6.07–7.62	7–10
Category III					
(Surface System)[3]					
Per Acre–Inch					
Average	85	3.36	.87	4.23	3

TABLE 8 (continued)

Type of System	Amount Per Farm	Fixed Cost	Variable Cost	Total Cost	Yield Response
		Dollars	Dollars	Dollars	Bushels
Range	30–164	1.33–5.96	.61–2.11	2.63–6.59	1–7
Per Acre Irrigated					
Average	21	13.46	3.52	16.98	10
Range	10–32	3.98–29.79	3.00–4.22	7.88–32.94	3–20
Per Acre Application					
Average	27	10.45	2.73	13.18	8
Range	15–34	1.99–29.79	1.90–4.22	3.94–32.94	2–15

[1] Three farmers applied an average of 2.0 inches of water per acre. Each acre was irrigated the equivalent of 1.5 times.

[2] Two farmers applied an average of 4.1 inches of water per acre. Each acre was irrigated the equivalent of 1.8 times.

[3] Seven farmers applied an average of 4.0 inches of water per acre. Each acre was irrigated the equivalent of 1.3 times.

time of irrigation, quantity of water applied, fertilizer applications, and cultural practices.

In addition to these factors, normal variation in temperature and amount and distribution of rainfall affect the yield response from irrigation. The average temperature was slightly below normal in May, June, and July, and slightly above normal in August and September (Table 9). The average amount of precipitation was above normal for May and June but below normal during July, August, and September at six weather stations in the area (Table 9). The greatest deficit during the growing season was in July, August, and September, when the departure from normal was -.88, -.63, and -1.13 inches at the six stations. The amount and distribution of rainfall in the study area were analyzed (Table 10). Rainfall was extremely short from July 1, through July 20, and from August 21 through August 31.

The relationship between time of application of irrigation water and yield response per acre was analyzed in an effort to explain some of the yield variation. The estimated yield increase of cotton and the time of application were plotted (Figure 3). In general, the farmers who irrigated near July 15 apparently obtained the largest yield increases.

Figure 4 indicates that irrigators who applied water to corn only near June 1 to 15 did not obtain a large yield increase. In most instances, when at least one application of water was applied near July 1 to 15, a substantial yield increase was obtained.

TABLE 9-AVERAGE TEMPERATURE AND PRECIPITATION, FOUR SOUTH-EASTERN MISSOURI COUNTIES, MAY-SEPTEMBER, 1960

Item	Month				
	May	June	July	August	September
	Precipitation in inches				
Delta Area					
Average	5.12	3.57	2.44	3.22	1.94
Departure from Normal	.91	- .35	-. .66	.12	- 1.32
Normal	4.21	3.92	3.10	3.10	3.26
Six Stations[1]					
Average	5.02	4.01	2.22	2.47	2.13
Departure from Normal	.81	.09	- .88	- .63	- 1.13
	Temperature (degrees fahrenheit)				
Delta Area					
Average	66	75.9	77.9	79.2	74.5
Departure from Normal	- 1.9	- 1.5	- 2.7	0.0	2.6
Normal	67.9	77.4	80.6	79.2	71.9
Six Stations[1]					
Average	66.3	76.3	78.3	79.3	74.5
Departure from Normal	- 1.6	- 1.1	- 2.3	.1	2.6

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

Source: Climatological Data, Missouri, Vol. 64, No. 4-9, United States Department of Commerce, Weather Bureau, 1960

TABLE 10-PRECIPITATION AT SIX LOCALITIES, FOUR SOUTHEASTERN
MISSOURI COUNTIES, MAY-AUGUST, 1960

| | Precipitation in inches | | | | | | |
| | May | | | | | | |
Locality	1-5	6-10	11-15	16-20	21-25	26-30(31)	Total
Caruthersville	T	1.85	T	2.10	1.85	.07	5.87
Charleston	.19	1.43	T	2.37	.03	.14	4.16
Kennett	.60	1.59	...	3.07	.02	.35	5.63
Malden	.57	.91	...	2.78	...	.20	4.46
Portageville	.21	1.25	...	3.73	.03	.23	5.45
Sikeston	.42	1.51	T	2.35	...	.29	4.57
Average	.34	1.42	T	2.73	.32	.21	5.02
	June						
Caruthersville	1.20	T	.94	.03	.43	2.42	5.02
Charleston	.46	...	1.07	...	.07	3.01	4.61
Kennett	.60	.42	.31	.04	.21	2.03	3.61
Malden	.22	.29	.06	T	.19	1.09	1.85
Portageville	.41	.75	1.83	.19	.46	1.85	5.49
Sikeston	.50	.13	.45	.01	.15	2.24	3.48
Average	.56	.26	.78	.05	.25	2.11	4.01
	July						
Caruthersville	.87	...	.07	.04	1.69	.22	2.89
Charleston	...	...	.12	...	.47	.37	.96
Kennett	1.12	...	.11	...	1.67	.37	3.27
Malden	.03	...	.62	.14	.36	.10	1.25
Portageville	.07	...	.40	.02	2.21	1.34	4.04
Sikeston	.11	...	...	...	.45	.38	.94
Average	.37	...	.22	.03	1.14	.46	2.22
	August						
Caruthersville	T	.31	.01	.67	.51	...	1.50
Charleston	1.95	.65	...	.92	.17	...	3.69
Kennett	.29	.16	...	.90	.14	...	1.49
Malden	.75	.22	...	1.59	...	...	2.56
Portageville	.72	.31	...	1.29	...	...	2.32
Sikeston	.75	1.13	...	1.28	.12	...	3.28
Average	.74	.46	T	1.11	.16	...	2.47

[1]T represents trace of precipitation

Source: Climatological Data, Missouri Vol. 64, No. 4-8, United States Department of Commerce, Weather Bureau, 1960

Figure 5 shows that all irrigators obtained yield responses from soybeans. Those farmers who applied water from July 1 to 15 and near August 15 obtained the greatest yield response.

FIGURE 3
YIELD INCREASES PER ACRE OF IRRIGATED COTTON AND TIME AND NUMBER OF APPLICATIONS, BY TYPE OF IRRIGATION SYSTEM, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960
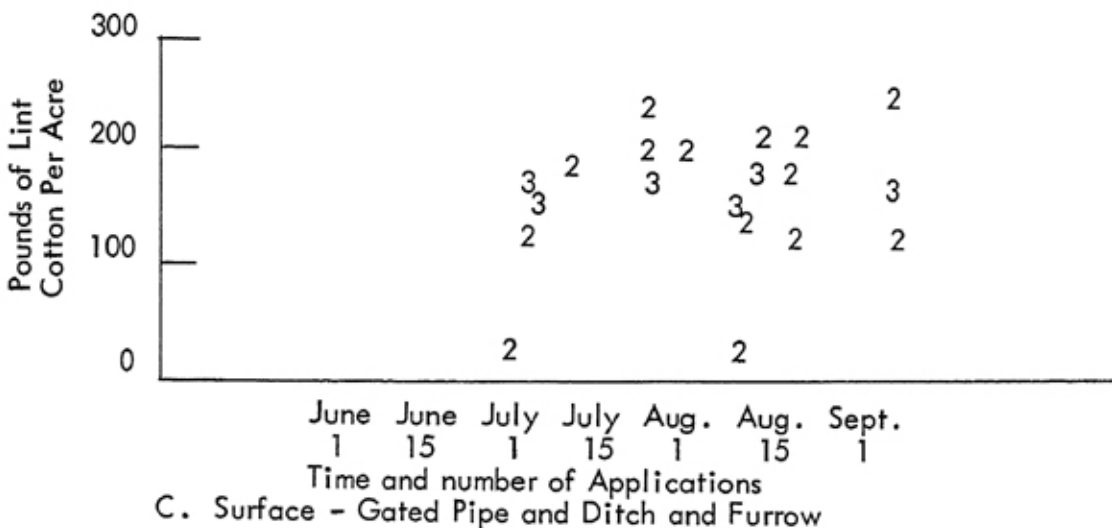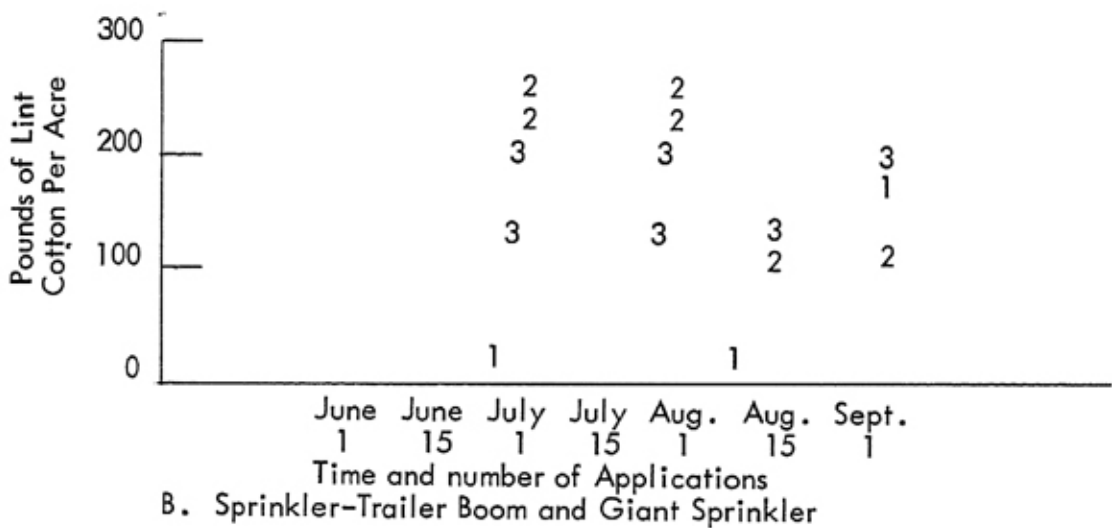

A. Portable Pipe and Sprinkler

B. Sprinkler-Trailer Boom and Giant Sprinkler
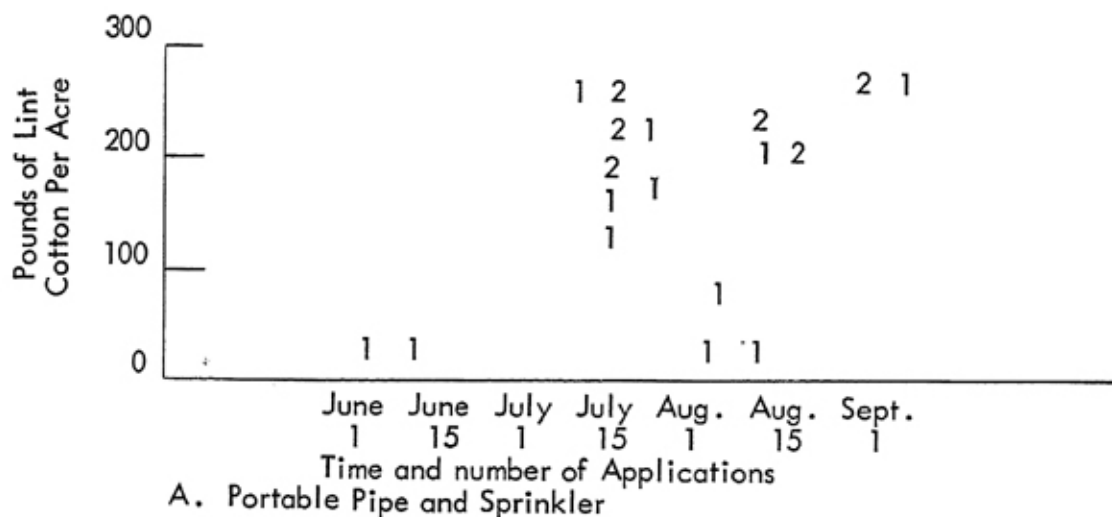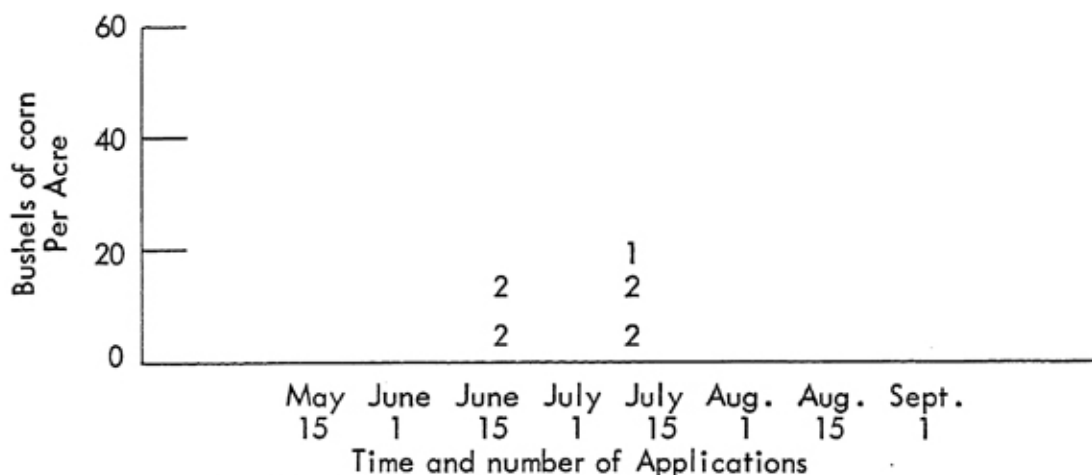

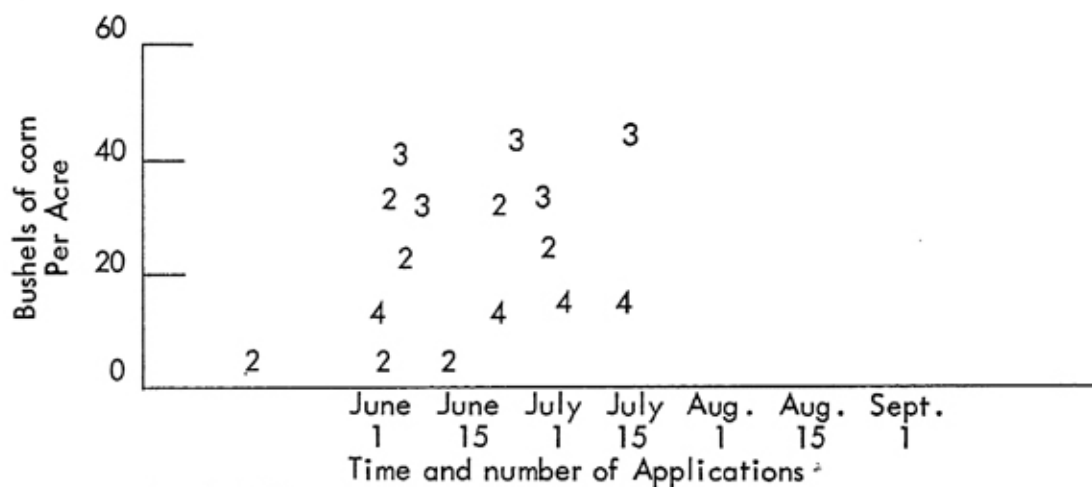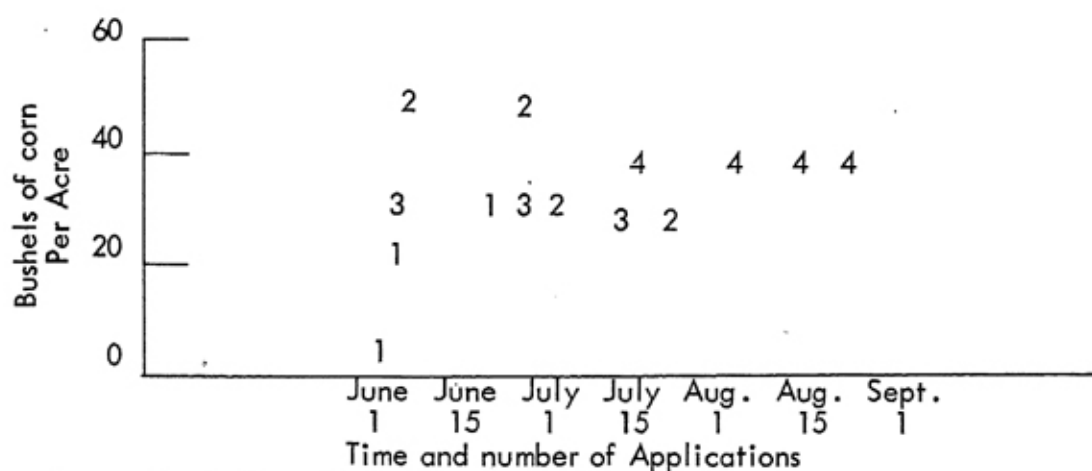C. Surface – Gated Pipe and Ditch and Furrow

FIGURE 4
YIELD INCREASE PER ACRE OF CORN IRRIGATED AND TIME
AND NUMBER OF APPLICATIONS, BY TYPE OF IRRIGATION
SYSTEM, 16 FARMERS, FOUR SOUTHEAST MISSOURI COUNTIES, 1960

A. Portable Pipe and Sprinkler

B. Sprinkler-Trailer Boom and Giant Sprinkler

C. Surface-Gated Pipe and Ditch and Furrow

FIGURE 5
YIELD INCREASE PER ACRE OF IRRIGATED SOYBEANS AND TIME
AND NUMBER OF APPLICATIONS: BY TYPE OF IRRIGATION
SYSTEM, 12 FARMERS, FOUR SOUTHEASTERN MISSOURI
COUNTIES 1960.

A. Portable Pipe and Sprinkler

B. Sprinkler-Trailer Boom and Giant Sprinkler

C. Surfact-Gated Pipe and Ditch and Furrow
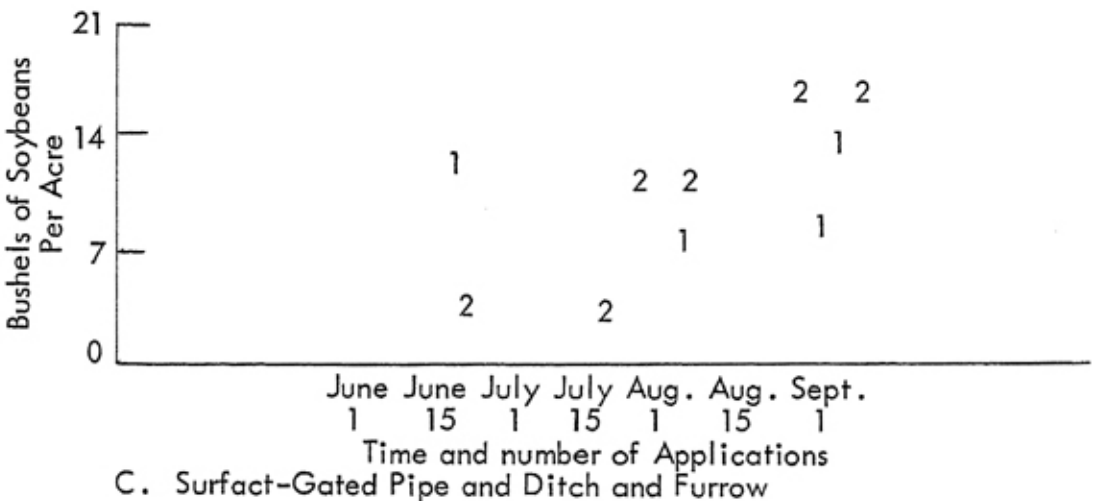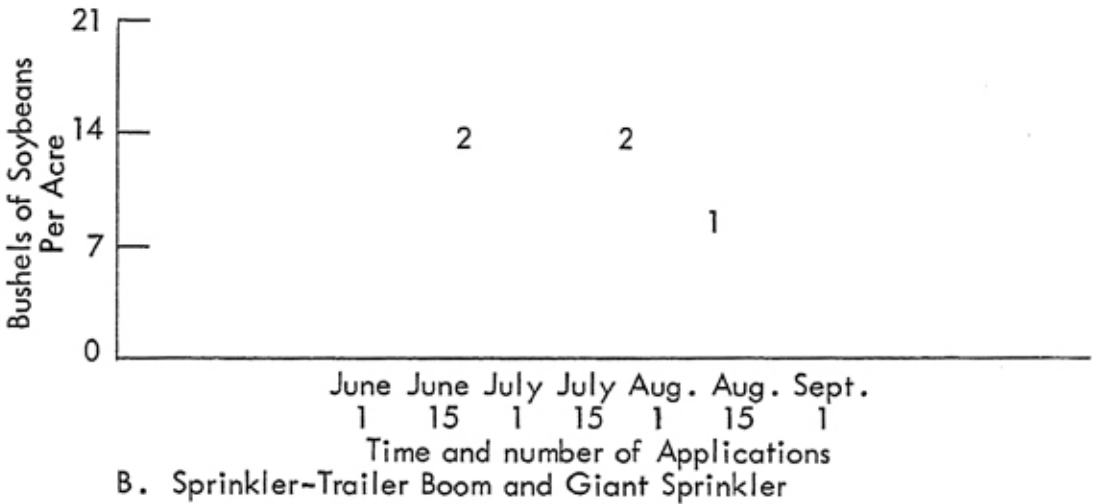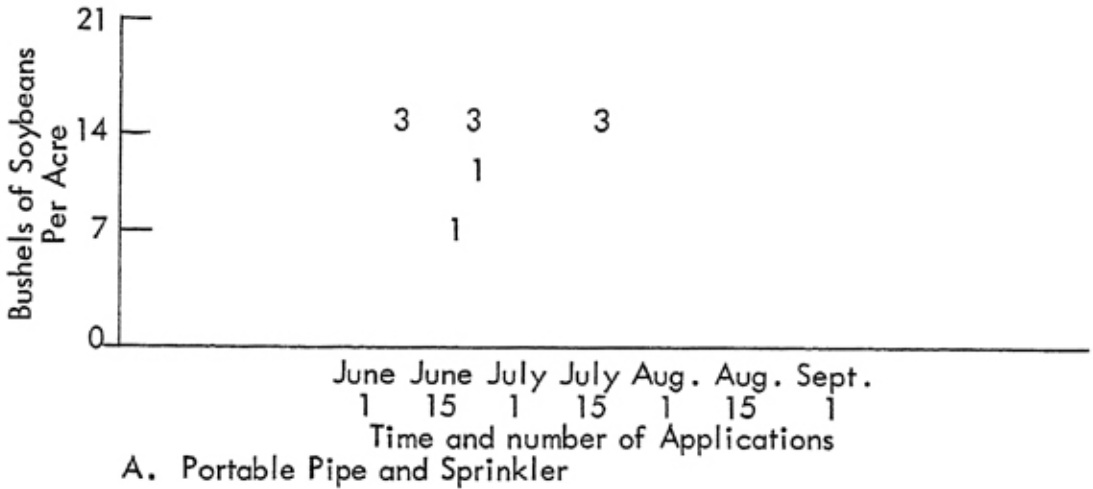
Procedures Used to Determine Net Return and Return Above Variable Cost

The average fixed, variable, and total cost computations, shown in tables 6, 7, and 8, did not include expenses of harvesting the increased yield attributable to irrigation. The objective was to estimate the cost of applying water by different types of systems. In this section, the purpose is to indicate the relationship between total costs and total returns attributable to irrigation. Harvesting costs are included.

The average estimated yield response, shown in the above tables, was multiplied by the average price received for the products from September to December 1960, to compute the gross returns from irrigation. The prices used were $0.955 per bushel for corn; $0.305 per pound of lint cotton, and $1.96 per bushel for soybeans. The corn and cotton prices were $0.045 and $0.017 per unit lower, respectively, than in 1959, and soybeans were $0.01 higher per unit.

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

The net return and return above variable cost per acre-inch, per irrigated acre, and per acre application were computed for the three different systems. Only net return and return above variable cost per irrigated acre will be discussed in the text.

Net returns from irrigation were equal to total revenue minus total costs or adjusted gross returns minus average costs. The returns above average variable costs were equal to the adjusted gross returns minus average variable costs.

IRRIGATION RETURNS FROM SPECIFIC CROPS

Cotton

Per irrigated acre—The net return per irrigated acre of cotton averaged $12.74, $30.44, and $20.71 for farmers using categories I, II, and III systems, respectively (Table 11). The net return per acre on individual farms ranged from –$79.20 to +$58.14 (Appendix Table 2).

Seventy-three percent of the cotton irrigators obtained a net return per acre, but 27 did not receive enough to cover total irrigation costs (Table 12). Eighteen percent had a net return greater than $40.00 per acre, while nine percent failed to pay their irrigation costs by more than $30.00 per acre.

Returns above variable costs averaged $26.03, $40.73, and $29.57 for farmers using categories I, II, and III systems, respectively (Table 11). On individual farms, the range was from –$4.76 to +$64.82 per irrigated acre (Appendix Table 2).

Seventy-nine percent of the cotton irrigators obtained yield increases large enough to pay average variable costs (Table 13). Thirty-nine percent obtained returns above variable costs, which were larger than $40.00 per acre. An additional 36 percent had returns ranging from $20.00 to $39.99 per irrigated acre.

Twenty-one percent of the cotton irrigators did not obtain yield increases

TABLE 11-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, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Item	Category I (Portable Pipe and Sprinkler)[1]	Category II (Trailer Boom and Giant Sprinkler)[2]	Category III (Surface System)[3]
	Dollars	Dollars	Dollars
Per Acre-Inch of Water:			
Adjusted Gross Return	11.06	9.74	7.17
Average Cost	6.46	3.44	2.65
Net Return	+4.60	+6.30	+4.52
Average Variable Cost	1.68	1.31	.71
Return Above Average Variable Cost	+9.38	+8.43	+6.46
Per Acre Irrigated:			
Adjusted Gross Return	30.69	47.07	32.81
Average Cost	17.95	16.63	12.10
Net Return	+12.74	+30.44	+20.71
Average Variable cost	4.66	6.34	3.24
Return Above Average Variable Cost	+26.03	+40.73	+29.57
Per Acre Application:			
Adjusted Gross Return	23.44	23.72	20.43
Average Cost	13.71	8.38	7.53
Net Return	+9.73	+15.34	+12.90
Average Variable Cost	3.56	3.20	2.02
Return Above Average Variable Cost	+19.88	+20.52	+18.41

[1] Fifteen irrigation systems.
[2] Eight irrigations systems.
[3] Ten irrigation systems.

large enough to pay average variable costs (Table 13). All of these operators failed to pay their variable costs per acre by amounts ranging from -$0.01 to -$9.99.

Yield increase required to pay irrigation costs—The yield increases needed to pay total irrigation costs ranged from 52 to 187 pounds of lint cotton per acre (Appendix Table 2). They ranged from 72 to 187, 59 to 122, and 52 to 102 pounds of lint cotton for farmers using categories I, II, and III systems, respectively.

Average variable costs could have been paid by a yield increase of 22 to 76 pounds of lint cotton per acre (Appendix Table 2). Farmers using categories I, II, and III systems needed from 30 to 58, 22 to 76, and 32 to 48 pounds of lint cotton per acre, respectively, to pay average variable costs.

TABLE 12–COTTON: NET GAIN OR LOSS ABOVE TOTAL IRRIGATION COSTS PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Return Above Total Irrigation Costs	Type of Irrigation System			
	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom and Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Acre	Percent	Percent	Percent	Percent
+40.00 or more	13[1]	37[2]	10[3]	18
+30.00 to +39.99	13	13	20	15
+20.00 to +29.99	20	13	30	22
+10.00 to +19.99	7	..	30	12
+ 0.01 to + 9.99	7	13	..	6
− 0.01 to − 9.99	13	..	..	6
−10.00 to −19.99	13	..	10	9
−20.00 to −29.99	7	..	..	3
−30.00 or more	7[4]	24[5]	..	9
Total	100	100	100	100

[1] +$40.70 and +$44.94.

[2] +$41.82, +$49.20, and +$58.14.

[3] +$48.53.

[4] −$79.20.

[5] −$32.26 and −$46.46.

TABLE 13–COTTON: ADDITIONAL RETURN OR LOSS ABOVE VARIABLE COST OF IRRIGATION PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Return Above Variable Cost	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom and Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Acre	Percent	Percent	Percent	
+50.00 or more	20[1]	25[2]	10[3]	18
+40.00 to +49.99	20	25	20	21
+30.00 to +39.99	20	..	40	21
+20.00 to +29.99	7	25	20	15
+10.00 to +19.99	7	..	..	4
+ 0.01 to + 9.99	..	..	..	..
− 0.01 to − 9.99	26	25	10	21
Total	100	100	100	100

[1] +$50.17, +$50.94 and +$51.01.

[2] +$64.82.

[3] +$53.76.

Summary of Cotton Irrigation—Cotton was the most profitable crop to irrigate in 1960. The average net return per acre was $12.74, $30.44, and $20.71 for farmers using categories I, II, and III systems, respectively.

Seventy-three and 79 percent of the irrigators obtained yield increases large enough to pay average total and variable irrigation costs, respectively.

Cotton irrigators obtained higher per acre returns in 1960 than in 1959. Also, in 1959, only 35 percent of the cotton irrigators obtained a yield increase large enough to pay total irrigation costs, while 73 percent obtained a net return in 1960. The average yield increase per acre was 133 pounds of lint in 1960, which was twice as great as the average increase in 1959.

Corn

Returns per irrigated acre—Farmers using categories II and III systems obtained net returns equal to $0.36 and $4.55 per acre, but category I farmers had net losses equal to $8.21 per acre from irrigating corn. (Table 14). The net return per acre on individual farms ranged from -$44.37 to +$27.60 (Appendix Table 3).

Forty-four percent of the corn irrigators obtained net gains from applying water to corn, but 56 percent did not obtain a return large enough to pay the total cost of irrigation (Table 15). Six percent had a net return greater than $20.00 per acre, but another six percent failed to pay their total costs by more than $20.00 per acre.

Returns above variable irrigation costs averaged +$3.01, +$10.39, and +$12.35 for farmers using categories I, II, and III systems, respectively (Table 14). On individual farms, the range was from -$16.84 to +$33.40 per acre (Appendix Table 3). The range on individual farms was from -$5.50 to +$5.05, -$16.84 to +$26.47, and -$1.43 to +$33.40 for farmers using categories I, II, and III systems, respectively.

Seventy-five percent of the corn irrigators obtained yield increases large enough to pay average variable costs (Table 16). Twenty-five percent paid their variable costs and had a remaining balance of more than $20.00 per acre.

Twenty-five percent did not pay their variable irrigation costs from increased yields. Six percent failed to pay their variable costs, which ranged from -$10.00 to -$19.99 per acre.

Yield increase required to pay irrigation costs—The yield increases needed to pay total irrigation costs ranged from 13 to 59 bushels per acre (Appendix Table 3). They ranged from 17 to 24, 13 to 59, and 13 to 46 bushels for farmers employing categories I, II, and III systems, respectively.

Average variable costs could have been paid by a yield increase of 5 to 15 bushels per acre (Appendix Table 3). Farmers using categories I, II, and III systems needed from 6 to 8, 8 to 15, and 5 to 16 bushels of corn, respectively, to pay average variable costs.

Summary of corn irrigation—Corn did not give as great a net return from irrigation in 1960 as cotton. The average per acre for corn was -$8.21, +$0.36, and +$4.55 for farmers employing categories I, II, and III systems, respectively.

TABLE 14-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, 1960

Irrigation Costs and Returns	Type of Irrigation System		
	Category I (Portable Pipe and Sprinkler)[1]	Category II (Trailer Boom and Giant Sprinkler)[2]	Category III (Surface System)[3]
Per Acre-Inch Water:			
Adjusted Gross Return	2.66	2.98	2.50
Average Cost	5.35	2.92	1.81
Net Return	- 2.69	+ .06	+ .69
Average Variable Cost	1.68	1.25	.66
Return Above Average Variable Cost	+ .98	+ 1.73	+ 1.84
Per Acre Irrigated:			
Adjusted Gross Return	8.13	17.87	16.82
Average Cost	16.34	17.51	12.27
Net Return	- 8.21	+ .36	+ 4.55
Average Variable Cost	5.12	7.48	4.47
Return Above Average Variable Cost	+ 3.01	+10.39	+12.35
Per Acre Application:			
Adjusted Gross Return	4.83	6.31	9.18
Average Cost	9.70	+ 6.18	6.69
Net Return	- 4.87	+ .13	+ 2.49
Average Variable Cost	3.04	2.64	2.44
Return Above Average Variable Cost	+ 1.79	+ 3.67	+ 6.74

[1]Three Farmers.

[2]Six Farmers.

[3]Seven Farmers.

Forty-four and 75 percent of the irrigators obtained yield increases large enough to pay average total and variable irrigation costs, respectively.

Corn irrigators obtained lower per acre returns in 1960 than in 1959. In 1959, the net return per acre averaged $10.34, $14.00, and $13.72 for farmers using categories I, II, and III systems, respectively. Also, in 1959, 56 percent of the irrigators obtained returns greater than total costs as compared with 44 percent in 1960. The average yield increase was 20 bushels per acre in 1960, which was 10 bushels less than in 1959.

Soybeans

Return per irrigated acre—The net return per irrigated acre of soybeans averaged +$9.27, +$11.80, and -$0.38 for farmers using categories I, II, and III

TABLE 15–CORN: NET GAIN OR LOSS ABOVE TOTAL IRRIGATION COST PER
IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Return Above Total Irrigation Cost	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom and Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per acre	Percent	Percent	Percent	Percent
+20.00 or more	..	..	13[1]	6
+10.00 to +19.99	..	16	29	19
+ 0.01 to + 9.99	..	16	29	19
− 0.01 to − 9.99	33	36	29	31
−10.00 to −19.99	67	16	..	19
−20.00 or more	..	16[2]	..	6
Total	100	100	100	100

[1] +$27.60.

[2] −$44.37.

TABLE 16–CORN: ADDITIONAL RETURN OR LOSS ABOVE VARIABLE COST OF
IRRIGATION PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM,
16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

| Return Above Variable Cost | Type of Irrigation System | | | |
	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom and Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Acre	Percent	Percent	Percent	Percent
+30.00 to +39.99	..	..	14	6
+20.00 to +29.99	..	17	29	19
+10.00 to +19.99	..	50	43	38
+ 0.01 to + 9.99	67	..	..	12
− 0.01 to − 9.99	33	17	14	19
−10.00 to −19.99	..	16	..	6
Total	100	100	100	100

systems, respectively (Table 17). The net on individual farms ranged from
−$13.88 to +$25.32 (Appendix Table 4).

Seventy-five percent of the soybean irrigators obtained a positive net return
per acre, but 25 percent did not (Table 18). All of the farmers using categories
I and II systems obtained a positive net return, but 43 percent of the farmers
using category III systems had net losses ranging from −$0.01 to −$19.99. An
additional 50 percent of the returns ranged from +$0.01 to +$9.99.

Returns above variable irrigation costs averaged $16.62, $18.04, and $13.08
for farmers using categories I, II, and III systems, respectively (Table 17). On
individual farms, the range was from +$1.83 to +$29.30 per acre (Appendix

TABLE 17–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, 12 FARMERS,
FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Irrigation Costs And Returns	Type of Irrigation System		
	Category I (Portable Pipe and Sprinkler)[1]	Category II (Trailer Boom And Giant Sprinkler)[2]	Category III (Surface System)[3]
	Dollars	Dollars	Dollars
Per Acre-Inch of Water:			
Adjusted Gross Return	9.96	5.64	4.15
Average Cost	5.46	2.72	4.23
Net Return	+ 4.50	+ 2.92	− .08
Average Variable Cost	1.86	1.19	.87
Return Above Average			
Variable Cost	+ 8.10	+ 4.45	+ 3.28
Per Acre Irrigated:			
Adjusted Gross Return	20.42	22.91	16.60
Average Cost	11.15	11.11	16.98
Net Return	+ 9.27	+11.80	− .38
Average Variable Cost	3.80	4.87	3.52
Return Above Average			
Variable Cost	+16.62	+18.04	+13.08
Per Acre Application:			
Adjusted Gross Return	13.45	12.95	12.95
Average Cost	7.33	6.28	13.18
Net Return	+ 6.12	+ 6.67	− .23
Average Variable Cost	2.50	2.75	2.73
Return Above Average			
Variable Cost	+10.95	+10.20	+10.22

[1]Three farmers.

[2]Two farmers.

[3]Seven farmers.

Table 4). All soybean irrigators obtained a yield increase that more than paid the average variable cost of applying water and harvesting the increased yield.

Seventeen, 67, and 16 percent of the soybean irrigators had returns above variable costs which ranged from $20.00 or more, $10.00 to $19.99, and $0.01 to $9.99, respectively (Table 19).

Yield increase required to pay irrigation costs—The yield increases needed to pay total irrigation costs ranged from 7 to 9, 6 to 9, and 7 to 20 bushels for farmers using categories I, II, and III systems, respectively (Appendix Table 4).

Average variable costs could have been paid by a yield increase of 3 to 6 bushels per acre (Appendix Table 4). Farmers using categories I, II, and III systems needed from 3 to 4, 3 to 5, and 2 to 5 bushels, respectively, to pay average variable costs.

TABLE 18–SOYBEANS: NET GAIN OR LOSS ABOVE TOTAL IRRIGATION COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 12 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Return Above Total Irrigation Cost	Type of Irrigation System			
	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom And Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Acre	Percent	Percent	Percent	Percent
+20.00 to +29.99	..	..	14	8
+10.00 to +19.99	33	50	..	17
+ 0.01 to + 9.99	67	50	43	50
- 0.01 to - 9.99	..	..	29	17
-10.00 to -19.99	..	..	14	8
Total	100	100	100	100

TABLE 19–SOYBEANS: ADDITIONAL RETURN OR LOSS ABOVE VARIABLE COST OF IRRIGATION PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 12 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Return Above Variable Cost	Type of Irrigation System			
	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom And Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Acre	Percent	Percent	Percent	Percent
+20.00 or more	..	..	29[1]	17
+15.00 to +19.99	67	50	14	33
+10.00 to +14.99	33	50	29	34
+ 5.00 to + 9.99	..	..	14	8
+ 0.01 to + 4.99	..	..	14	8
Total	100	100	100	100

[1]+$21.75 and +$29.30.

Summary of soybean irrigation—Soybean irrigation was more profitable than corn for farmers using categories I and II systems, but less profitable for category III farms. In 1959, farmers using category III systems obtained greater net returns than farmers using the other systems.

Seventy-five and 100 percent of the irrigators obtained yield increases large enough to pay average total and variable irrigation costs, respectively. In 1959, 46 and 31 percent of the irrigators did not obtain yield increases large enough to pay average total and variable costs. The average yield increase per irrigated acre was 12 bushels in 1960 and 8.5 bushels in 1959.

EFFECT OF IRRIGATION ON FARM INCOME—1960

Net Returns to Cotton, Corn, and Soybean Irrigators

An individual farmer is concerned with the influence of irrigation on net farm income, which encompasses all of his farm enterprises. For this reason, net returns from cotton, corn, and soybean irrigation were added together to determine the effect on returns to the farm business.

The net per farm averaged $512, $2,234, and $598 for farmers using categories I, II, and III systems, respectively (Table 20).

TABLE 20-TOTAL RETURNS FROM COTTON, CORN AND SOYBEAN IRRIGATION PER FARM MINUS TOTAL IRRIGATION COST AND MINUS VARIABLE IRRIGATION COSTS, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Total Return from Irrigation					
Less		Less		Less	
Total Cost	Variable Cost	Total Cost	Variable Cost	Total Cost	Variable Cost
Category I (Portable Pipe and Sprinkler)[1]		Category II (Giant Sprinkler and Trailer Boom)[2]		Category III (Surface System)[3]	
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
+6,336[4]	+7,074	+8,540	+10,044	+1,941[4]	+2,150
+1,851	+2,406	+3,267	+ 4,475	+1,850	+2,105
+1,096	+1,917	+3,070	+ 4,232	+1,142	+1,923
+1,045	+1,650	+2,728	+ 3,843	+1,138	+1,663
+ 729	+1,073	+1,573	+ 2,382	+1,010	+1,449
+ 673[5]	+1,020	+ 747	+ 2,204	+ 836	+1,357
+ 548	+ 993	- 819	+ 782	+ 547	+1,357
+ 233[6]	+ 757	-1,234	- 244	+ 254[5]	+ 766
+ 119	+ 661			+ 227[6]	+ 660
+ 18	+ 639			+ 215	+ 645
- 14	+ 504			+ 185	+ 625
- 475	+ 479			+ 19	+ 516
- 800	- 15			- 248	+ 473
- 810	- 170			- 746	- 134
- 986	- 265				
-1,368	- 363				
Mean	Mean	Mean	Mean	Mean	Mean
+ 512	+1,148	+2,234	+ 3,465	+ 598	+1,111

[1] Sixteen systems.

[2] Eight systems.

[3] Fourteen systems.

[4] One farmer using two different systems.

[5] One farmer using two different systems.

[6] One farmer using two different systems.

Seventy-one percent, or 25, of the 35 farmers obtained net gains from irrigation, and 29 precent had net losses (Table 21). Forty-nine percent of the farmers using category II systems had net gains of $2,000 or more per farm. Fifty-seven, 26, and 82 percent of the farmers using categories I, II, and III systems had net gains, which ranged from $1 to $1,999, respectively.

Net returns from irrigation in 1960 compared with 1959—The average net gain per farm in 1959 was $761 and $316 for farmers using categories II and III systems, respectively. Farmers using category I systems had an average net loss of $65. Forty-three percent of the cotton, corn, and soybean growers who used supplemental water obtained net gains from irrigation in 1959.

In 1960, the average net gain per farm was considerably greater for farmers using all three types of systems. Also, 71 percent of the irrigators obtained net gains from irrigation, compared with 43 percent in 1959.

Returns Above Variable Cost to Cotton, Corn, and Soybean Irrigators

The average gains per farm above variable irrigation costs were $1,148, $3,465, and $1,111 for farmers using categories I, II, and III systems, respectively (Table 20).

Eighty-three percent, or 29, of the 35 irrigators obtained returns larger than variable irrigation costs (Table 22). For 17 percent, yield increases were not large enough to pay variable irrigation costs. Thirteen percent obtained returns above variable costs per farm, which amounted to more than $3,000. An additional 39 percent received returns ranging from $1,000 to $2,999 above variable costs and 31 percent obtained returns from $1 to $999.

Returns above variable costs, 1960 compared with 1959—The number of farmers obtaining returns above variable irrigation costs and the average gains per farm were greater in 1960 than in 1959. In 1959, 48 percent of the irrigators obtained returns larger than variable irrigation costs. The average return above variable costs was $629, $1,820, and $880 for farmers using categories I, II, and III systems, respectively.

The average return above variable costs per farm was 83, 90, and 26 percent greater in 1960 than in 1959.

Annual Fixed Cost of Nonirrigators

Twenty-seven of the 65 farmers from whom data were obtained did not irrigate in 1960. The average annual fixed cost attributable to the investment in irrigation equipment was $552. The amount ranged from $228 to $1,174 per farm. The annual fixed costs should be considered a net loss from irrigation. This loss reduced net farm income an average of $552 on the 27 farms.

In 1959, 19 of the 65 farmers did not apply water to crops, and the average fixed cost per farm was $490. Five of the 19 farmers who had not applied water in 1959 irrigated in 1960, but 14 did not irrigate in either year.

A larger proportion of the 65 farmers failed to irrigate in 1960 than in 1959. One reason may have been the relatively limited yield response from irrigation in 1959.

TABLE 22-RETURN ABOVE VARIABLE IRRIGATION COST PER FARM FROM COTTON, CORN, AND SOYBEAN IRRIGATION, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

| | Type of Irrigation System | | | |
Irrigation Cost	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom And Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Farm	Percent	Percent	Percent	Percent
+4,000 or more	6[1]/	37[2]/	...	10
+3,000 to +3,999	...	13	...	3
+2,000 to +2,999	6	25	14	13
+1,000 to +1,999	25	...	43	26
+ 01 to + 999	38	13	36	31
- 01 to - 999	25	12	7	17
Total	100	100	100	100

[1]/ +$7,074.

[2]/ +$4,232, +4,475 and $10,044.

TABLE 21-NET RETURN PER FARM FROM COTTON, CORN AND SOYBEAN IRRIGATION, BY TYPE OF IRRIGATION SYSTEM, 35 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

| | Type of Irrigation System | | | |
Net Return From Irrigation	Category I (Portable Pipe and Sprinkler)	Category II (Trailer Boom And Giant Sprinkler)	Category III (Surface System)	Total
Dollars Per Farm	Percent	Percent	Percent	Percent
+3,000 or more	6[1]/	37[2]/	...	10
+2,000 to +2,999	...	12	...	3
+1,000 to +1,999	19	13	36	24
+ 01 to + 999	38	13	46	34
- 01 to - 999	31	13	18	23
-1,000 to -1,999	6	12	...	6
Total	100	100	100	100

[1]/ +$6,336.

[2]/ +$3,070, +$3,267 and +$8,540.

APPENDIX TABLES

APPENDIX TABLE 1–FIXED INVESTMENT IN IRRIGATION EQUIPMENT BY TYPE OF IRRIGATION SYSTEM, 65 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1959

| Type of Equipment | Sprinkler | | | Surface | | |
	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	23	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	13	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	46	56	42	11	52
Total Investment	$13,200	$8,844	$6,810	$5,518	$4,100	$7,122

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

APPENDIX TABLE 2-COTTON: ADDITIONAL RETURN OR LOSS, BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE COST, AND AVERAGE VARIABLE COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 29 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Number of Irrigation Systems	Additional Return or Loss Per Acre Above		Breakeven Point			
	Total Cost	Variable Costs	Average Cost, Including Harvest Cost	Average Cost, Excluding Harvest Cost	Average Variable Cost, Including Harvest Cost	Average Variable Cost, Excluding Harvest Cost
	Dollars		(Pounds of Lint)			
			Portable Pipe and Sprinkler			
15	+44.94	+50.17	74.9	35.6	57.8	18.5
	+40.70	+47.31	72.2	35.8	50.5	14.1
	+37.29	+46.19	83.3	47.0	54.1	17.8
	+34.86	+50.94	108.0	68.7	55.3	16.0
	+28.99	+38.88	71.7	42.2	39.2	9.7
	+28.03	+38.21	91.5	59.1	58.1	25.7
	+27.41	+51.01	132.5	93.1	55.1	15.7
	+11.66	+23.95	72.9	53.2	32.6	12.9
	+ 5.95	+37.85	147.2	117.7	42.6	13.1
	- 0.92	+42.61	186.8	153.8	43.7	11.1
	- 9.86	- 3.63	...1/	32.3	...	11.9
	-17.78	- 3.78	...	58.3	...	12.4
	-17.99	+11.21	125.7	113.9	29.9	18.1
	-22.81	- 4.42	...	74.8	...	14.5
	-79.20	- 2.53	...	259.7	...	8.3
			Trailer Boom and Giant Sprinkler			
8	+58.14	+64.82	87.3	38.2	65.4	16.3
	+49.20	+54.63	83.2	40.0	22.2	65.4
	+41.82	+49.10	68.4	32.1	44.6	8.3
	+30.69	+44.74	121.7	82.3	75.6	36.2
	+22.76	+27.51	58.8	35.1	43.2	19.5
	+ 9.38	+23.95	80.4	60.7	32.6	12.9
	-32.26	- 4.76	...	105.7	...	15.6
	-46.46	- 2.00	...	152.3	...	6.6
			Surface Systems			
10	+48.53	+53.76	63.2	23.8	46.1	6.7
	+34.19	+38.17	54.6	25.1	41.6	12.1
	+30.62	+36.96	55.2	27.6	34.4	6.8
	+29.17	+44.33	90.3	57.8	40.6	8.1
	+26.72	+30.96	51.3	26.7	37.4	12.8
	+25.62	+41.94	101.6	68.8	48.1	15.3
	+17.37	+23.22	54.2	34.5	35.0	15.3
	+16.67	+31.14	78.9	55.2	31.5	7.8
	+11.36	+23.65	73.9	54.2	33.6	13.9
	-12.42	- 2.23	...1/	40.7	...	7.3

1/ Farmer did not obtain a yield increase, therfore, there was no harvest cost attributable to irrigation.

APPENDIX TABLE 3-CORN: ADDITIONAL RETURN OR LOSS, BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE COST, AND AVERAGE VARIABLE COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 16 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

Number Irrigation Systems	Additional Return or Loss Per Acre Above		Breakeven Point			
	Total Cost	Variable Costs	Average Cost, Including Harvest Cost	Average Cost, Excluding Harvest Cost	Average Variable Cost, Including Harvest Cost	Average Variable Cost, Excluding Harvest Cost
	Dollars		Bushels			
			Portable Pipe and Sprinkler			
3	- 6.20	+ 2.70	16.5	14.9	7.2	5.6
	-11.03	+ 5.05	23.5 [1]	21.6	6.7	4.8
	-15.39	- 5.50	... [1]	16.1	...	5.7
			Trailer Boom and Giant Sprinkler			
6	+12.19	+19.46	17.2	12.5	9.6	4.9
	+ 7.12	+11.87	12.6	9.4	7.6	4.4
	- 0.17	+14.40	30.1	25.4	14.9	10.2
	- 5.67	- 0.26	18.9	17.0	13.2	11.3
	-17.99	+26.47	58.7 [1]	52.5	12.2	6.0
	-44.37	-16.84	... [1]	46.4	...	17.6
			Surface Systems			
7	+27.60	+33.40	21.1	13.2	15.0	7.1
	+16.38	+20.36	12.8	8.2	8.6	4.0
	+10.45	+16.96	19.0	14.3	12.2	7.5
	+ 7.05	+14.32	12.6	9.5	5.0	1.9
	+ 4.99	+17.42	23.7 [1]	19.2	10.7	6.2
	- 5.66	- 1.43	... [1]	5.9	...	1.5
	- 6.16	+23.63	46.4	40.2	15.2	9.0

[1] Farmer did not obtain a yield increase, therefore there was no harvest cost attributable to irrigation.

APPENDIX TABLE 4–SOYBEANS: ADDITIONAL RETURN OR LOSS, BREAKEVEN POINT IN PHYSICAL UNITS REQUIRED TO PAY AVERAGE COST, AND AVERAGE VARIABLE COST PER IRRIGATED ACRE, BY TYPE OF IRRIGATION SYSTEM, 12 FARMERS, FOUR SOUTHEASTERN MISSOURI COUNTIES, 1960

| | Additional Return or Loss Per Acre Above | | Breakeven Point | | | |
| | | | Average Cost, Including | Average Cost, Excluding | Average Variable Cost, Including | Average Variable Cost, Excluding |
Number of Irrigation Systems	Total Cost	Variable Cost	Harvest Cost	Harvest Cost	Harvest Cost	Harvest Cost
	Dollars			Bushels		
			Portable Pipe and Sprinkler			
3	+12.24	+19.51	7.8	5.6	4.1	1.9
	+ 8.63	+18.52	8.6	6.6	3.6	1.6
	+ 5.86	+12.47	7.0	5.5	3.6	2.1
			Trailer Boom and Giant Sprinkler			
2	+12.76	+13.73	8.5	6.2	5.1	2.8
	+ 8.98	+19.44	5.4	3.9	3.0	1.5
			Surface Systems			
7	+25.32	+29.30	7.1	4.0	5.1	2.0
	+ 6.46	+12.80	6.7	5.1	3.5	1.9
	+ 3.78	+18.25	11.1	9.1	3.7	1.7
	+ 1.55	+ 7.40	6.2	5.1	3.2	2.1
	− 2.72	+13.60	11.4	9.8	3.1	1.5
	− 8.04	+21.75	19.1	16.8	3.9	1.6
	−13.88	+ 1.83	9.8	9.3	2.1	1.6