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Irrigating Corn on Well-Drained, Limestone-Derived Soils

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*CROPS *SOILS

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IRRIGATING CORN ON WELL-DRAINED, LIMESTONE-DERIVED SOILS

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Yield Increases From Irrigation

In trying to determine if it would pay Kentucky farmers to irrigate corn, one of the most important steps is to ascertain the long-time average yield increases to be expected from supplemental irrigation. The yield data reported below are the results of an experiment applicable for a fairly large group of soils occurring in Kentucky.

The experiment ran from 1962 through 1965 on a Maury silt loam soil (a deep limestone-derived soil characteristic of much of Central Kentucky). The corn was planted at a population of 15, 500 plants per acre and at three planting dates (April, May and June) each year of the 4-year study. Fertilizer and many other yield-influencing factors were held constant. Half the plots received supplemental irrigation sufficient to keep the soil moisture at or above 75 percent of the soil's water-holding capacity. This high moisture level was used in order to be certain that the crop had all the water it could use. It would not be economical for a farmer to add enough water to keep the soil moisture this high; however, his yields would not be seriously reduced by a much lower irrigation frequency and amount of water. The results were as follows:

TABLE 1. GRAIN YIELDS FROM IRRIGATED AND UNIRRIGATED PLOTS

Planting Date	Yield of Grain/Acre (15.5% Moisture)		Increases Due To Irrigation
	Unirrigated	Irrigated	
	Bu/A		
1962			
April	135	207	72
May	109	168	59
June	75	118	43
1963			
April	152	165	13
May	145	161	16
June	126	136	10
1964			
April	103	156	53
May	16	156	140
June	55	112	57
1965			
April	97	144	47
May	78	172	94
June	26	126	100

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The yield increases due to irrigation, averaged across the 4 years, were 46, 77, and 52 bushels per acre for the April, May and June plantings, respectively.

Drought Days During Four-Year Study

The preceding yield data are not very useful in trying to decide whether you can afford to irrigate or not, unless you also know how dry these 4 years were relative to the long-term average. For this reason, the number of drought days were calculated and related to the yield increase due to irrigation. (A drought day is a day when the upper 18 inches of soil has less than 50 percent of the available water supply present and there is less than 0.5 inch of available water in the upper 6 inches of soil.) [1]

The plant available water supply in this soil was concluded to be 4.5 inches (0.15 inches available water per inch of soil times 30 inches of soil, being the effective depth to which the corn crops removed water from the soil). Since corn yields seem to be reduced more by a drought occurring at or near silking time, the drought days during the 3-week period surrounding silking were determined. The yield increases resulting from irrigation during the 4-year study are plotted against the number of drought days that occurred (Fig. 1). The correlation of yield increase due to irrigation and the number of drought days was highly significant (r=0.86).

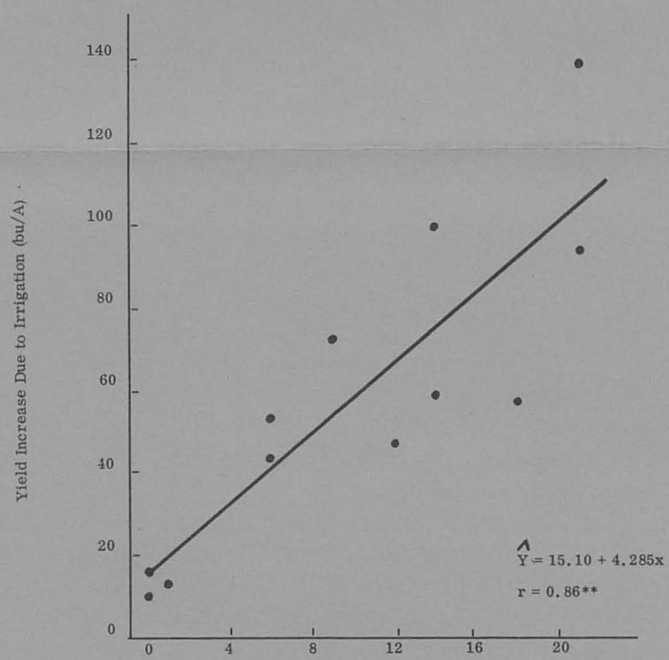

Figure 1. Number drought deficient days in 3-week period surrounding the silking date.

Long-Term Yield Increases to Expect from Irrigation

In order to predict the expected long-time average yield increase, the average number of drought days that occurred during the past 35 years was calculated from weather records. It was found that the number of drought days that would have occurred during the 3 weeks surrounding silking was 8.9 for the April planting, 10.5 for the May planting and 12.1 days for the June planting. The average planting dates during the 4-year study were April 16, May 18 and June 19.

By entering the number of drought days into Figure 1 and reading the average annual yield increase to be expected from irrigation, it was estimated that there would have been average increases of 53, 60, and 67 bushels per acre for the April, May and June plantings, respectively, for each of the 35 years. In arriving at these estimated average increases in yield, it was assumed that the same varieties, fertilizer rates, insect and weed control practices would have been used during each of the 35

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[1] J. T. Ligon, A. B. Elam and D. G. Dickson, "Occurrence of Soil Moisture Deficiency in Kentucky," Kentucky Agricultural Experiment Station Bulletin 706, April 1967.

years that were employed for calculations for the 1962-65 study. If the average rainfall in the next 35-year period equals that of the past 35 years, similar average yield increases would be expected. It can be expected, however, that water will become more critical and, therefore, greater increases in yield due to supplemental irrigation will result as improved varieties are developed and the other factors of production are more completely provided.

Substituting Early Planting for Irrigation

It should be noted in the case of the unirrigated plantings that much better yields were obtained from early planting (Table 1). On the average, early planting is an effective way of reducing the chances of drought. This does not insure that early plantings on soils of the type used in this study will always yield better, but on the average they will.

Cost of Irrigating Corn

No attempt was made to determine the economic level of moisture for corn production, as this is largely a decision which an individual farmer must make, considering many factors which may be unique to his situation. The question whether a farmer can profitably irrigate corn produced on soils such as was used in this experiment will depend on the value of corn (increased yield times corn prices) attributed to irrigation and the cost of irrigation. Farmers should not overlook the available alternatives open to him for the use of his investment in irrigation and also for the possible alternatives of coping with farm problems caused by reduced corn yields due to a lack of moisture.

The cost of irrigation depends on the cost of a dependable water supply, size and design of the system, acreage and crop to be irrigated, and operational costs. About 40 to 50 percent of the investment can be eliminated if water can be obtained from a stream. For example, a middle-sized irrigation system capable of covering one acre per setting and applying 4 acre-inches of water per season on 60 acres of corn will cost a total of $25.04 per acre (Table 2). For those years when irrigation is not needed, the cost will be about $10.36 per acre because of depreciation, taxes, and other overhead costs. A study of long-time weather records indicate that there would be enough rainfall in 30 to 40 percent of the years.

One major problem which may be encountered in irrigating corn during the silking stage is the difficulty in moving the system unless adequate planning is done ahead of time. To the extent that this is not done, the cost will be increased substantially.

TABLE 2. ESTIMATED COST OF IRRIGATION, 1968

Item	Size of System		
	Small	Medium	Large
Cost of reservoir (assumed)	$1500.00	$2600.00	$5200.00
Cost of equipment	1875.00	3940.00	7840.00
Total investment	$3375.00	$6540.00	$13,040.00
Acres irrigated	30	60	120
Acre-inches applied	120	240	480
Acres covered per setting	.5	1.0	3.5
Investment per irrigated acre	$ 112.50	$ 109.00	$ 108.67
Fixed costs:			
Depreciation	$ 202.50	$ 392.40	$ 782.40
Interest and taxes	118.12	228.90	456.40
Total fexed costs	$ 320.62	$ 621.30	$1238.80
Average fixed cost per irrigated acre	$ 10.69	$ 10.36	$ 10.32
Average fixed cost per acre-inch	$ 2.67	$ 2.59	$ 2.58
Variable costs:			
Labor ($1.50 per hour)	$ 324.00	$ 480.00	$ 560.00
Fuel, oil, etc.	204.05	369.38	828.54
Repairs	16.25	31.46	60.81
Total variable costs	$ 544.30	$ 880.84	$1449.35
Average variable cost per irrigated acre	$ 18.14	$ 14.68	$ 12.08
Average variable cost per acre-inch	$ 4.54	$ 3.67	$ 3.02
Total costs:	$ 864.92	$1502.14	$2688.15
Average total cost per irrigated acre	$ 28.83	$ 25.04	$ 22.40
Average total cost per acre inch	$ 7.21	$ 6.26	$ 5.60

Summary:

The following conclusions were drawn from the results of the 4-year irrigation study conducted on well-drained, limestone-derived soils:

(1) The average yield increases to expect from irrigating corn planted in mid-April, mid-May and mid-June are 53, 60, and 67 bushels per acre per year. This conclusion should not be extended to sandstone- and shale-derived soils, as only the limestone-derived soil was tested.

(2) The cost of irrigation varies with many factors (as explained), but would range around $25 per acre per year to add 4 inches of water. In years when no irrigation was needed, depreciation and interest costs would be approximately $10 per acre.

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