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EC57-805 Will it Pay to Irrigate Corn?

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will it pay to IRRIGATE CORN ?

EXTENSION SERVICE
UNIVERSITY OF NEBRASKA
COLLEGE OF AGRICULTURE
AND U.S. DEPARTMENT OF AGRICULTURE
COOPERATING
W. V. LAMBERT, DIRECTOR

Gated pipe irrigation system.

FOREWORD

THERE are several questions the prospective irrigator should ask himself in trying to decide whether to invest in an irrigation system.

One of the first considerations is water supply. The Conservation and Survey Division of the University of Nebraska has general information concerning underground water resources indicating the probability of finding sufficient water for irrigation. If the possibilities are good, the next step (before making the final determination of what the actual water situation is) might be to consider the financial requirements and possible net returns connected with irrigation. The final check on the water supply can then be made by drilling a test hole at the exact location where you want the well. The cost of such a test has been usually about $0.50 a foot.

Assuming that water is available, how much will it cost to put down a well? What kind of power unit will be most economical? What kind of distribution system will be most feasible? Is it possible to increase production enough in years of normal rainfall to justify the extra investment and higher costs of operation? If we should have another dry year, how much will it be worth to have irrigation?

Let's take a look at information that may help answer these questions.

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Will It Pay To Irrigate Corn?

BY

PHILIP A. HENDERSON[1]

Well, Pump, Power Costs

Currently, the cost of putting down a well, together with casing, developing, and packing will run $8 to $12 per foot. Obviously, the deeper the well the greater the total cost.

The costs of pump and power unit will depend on the distance water must be lifted. The greater the lift and amount of water to be pumped, the larger the power unit and pump must be; the bigger the outfit, the higher the initial cost.

High initial cost means high annual fixed costs. The higher the fixed costs, the more important it is to make full use of the equipment represented. Total fixed costs (depreciation, interest, taxes, insurance, etc.) tend to remain about the same regardless of amount of use during the year; extensive use results in lower fixed costs and lower total costs *per hour of operation.*

Table 1 illustrates this principle. The figures shown are for a diesel engine. However, the principle illustrated would apply to any type power unit.

TABLE 1. Costs of pumping water with a given size power unit as related to the amount of use.

	Total costs	Costs per hour of operation			
		200 hrs.	500 hrs.	800 hrs.	1,000 hrs.
Fixed costs (depreciation, interest, taxes, insurance)	$358.28	1.79	.72	.45	.36
Variable costs (fuel, oil, grease, labor, repairs)		.22	.22	.22	.22
Total costs		2.01	.94	.67	.58

The type power unit selected will depend in part on the availability of fuel. Electricity and natural gas are not always readily available. Where electricity is available landlords may prefer to use electric motors since they require little care and maintenance as compared to combustion engines.

It is important to keep power units and pumping equipment in good working order. The cost of making needed adjustments may be

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small in comparison to the cost of the extra fuel which would be burned by a poorly adjusted unit.

The advice of a competent engineer or reliable dealer in selecting irrigation equipment—the right size and kind—is important. "Cheap" first cost *may* mean higher operating costs in the long run.

Forms for calculating costs of pumping are available from the Department of Agricultural Engineering.

Illustrations of possible total investments required under several different "lift situations" are shown in Table 2. Where a relatively shallow well is involved and a minimum of leveling is required to permit gravity irrigation, the total investment required to establish irrigation on 80 acres of land may be as little as $5,000. On the other hand, if the well is deep and the land is rough enough to require an expensive leveling job or the use of gated pipe or a sprinkler system, the investment may run as high as $10,000-$12,000, or more.

TABLE 2. Estimated investment requirements (assuming 80 acres to be irrigated with a minimum of leveling) under three different lift situations.

				Your farm
Depth of well (feet)	100	150	240	.....
Lift (feet)	60	80	150	.....
Capacity of well (gpm)	750	700	800	.....
Probable investment in well, motor, and pump	$3300–3800	$4000–4500	$6100–6600	.....
Leveling 80 acres	1600	1600	1600	.....
Equipment for distributing	900	900	900	.....
TOTAL INVESTMENT	$5800–6300	$6500–7000	$8600–9100	.....

Methods of Distribution

In choosing the method of distributing water, several things must be considered. Very little land is sufficiently level to permit satisfactory irrigation by gravity flow. The cost of grading will vary depending on the slope of the land and how far the dirt has to be hauled to get the desired slope. A topographic map and the advice of an engineer is desirable in planning the irrigation system. How far one can go in grading will depend on cost of grading compared to cost of buying pipe or sprinkler system; cost of operating a sprinkler system; whether or not the land to be irrigated is subject to flooding which might destroy the effects of grading; how much fertilizer will be needed to compensate for removal of topsoil; how much danger there is of wind erosion; and on the effect of the grading on the value of the farm itself. Each farm is an individual problem.

Here again, relatively fixed costs are involved. With a gravity system, fixed charges are at a minimum since the investment in distribut-

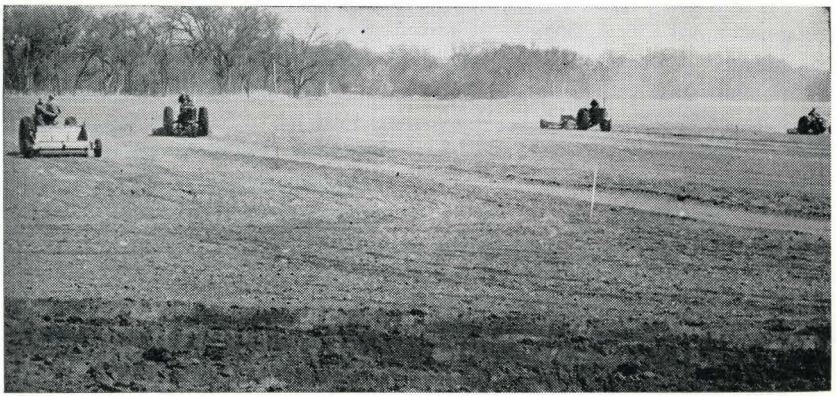
ing equipment is comparatively low. An illustration of the investment required and the costs which would be involved on a particular farm are shown in Table 3.

TABLE 3. Comparison of investment and annual costs for siphon tube, gated pipe, and sprinkler systems on a given farm.*

	Siphon tube	Gated pipe	Sprinkler
Number of acres irrigated	141	141	141
Investment in equipment	$836.00	$7,089.05	$7,779.04
Investment in permanent structures	853.70		
Land grading costs	6,038.50	5,953.43	
Total investment	$7,728.20	$13,042.48	$7,779.04
Interest on investment	193.21	326.06	194.48
Depreciation	55.75	347.68	388.97
Taxes	21.12	88.61	97.24
Repairs	6.42	23.94	56.16
Labor	447.36	388.07	997.42
Tractor	39.84	89.00	111.00
Power (for pumping & distribution)	112.00	112.00	1,632.00**
Total annual cost	$875.70	$1,375.36	$3,477.27
Cost per acre irrigated	$6.21	$9.75	$24.66
Cost per acre, each 4-inch irrigation	$1.29	$2.03	$5.14
Cost per acre, each 1-inch irrigation	.32	.51	1.28
Cost per acre irrigated			
Fixed	$1.92	$5.40	$8.64
Percent of total	31	55	35
Variable	$4.29	$4.35	$16.02
Percent of total	69	45	65

* Source: Thorfinnson, T. S., Hunt, Meryl, and Epp, A. W., *Cost of Distribution of Irrigation Water by Different Methods,* University of Nebraska Experiment Station Bulletin 432, August 1955. The costs shown were calculated for one particular farm by Warren DeKrey.

** The extra power to produce pressure for a sprinkler system is computed at $0.85 an hour.



Leveling farm land for irrigation.

Cost of Labor

Labor is the principal variable cost in water distribution except in the case of the sprinkler system where costs of power to produce pressure in the sprinkler line are high. (See Table 3.)

TABLE 4. Labor requirements per acre (once over) on corn and alfalfa, central Nebraska.*

Crop	Method of distribution		
	Siphon tube	Gated pipe	Sprinkler
	(hours)	(hours)	(hours)
Corn	.9	.7	1.4
Alfalfa	.6	.5	.9

* Based on Tables 1, 2, and 3, in Thorfinnson, T. S., Hunt, Meryl, and Epp, A. W., *Cost of Distribution of Irrigation Water by Different Methods,* Nebraska Experiment Station Bulletin 432, August 1955.

Not only does the sprinkler system require more hours of labor, but it is hard work, especially in tall growing crops.

Off-season irrigation is especially advantageous in the case of sprinkler systems. Where soils with good water-holding capacity are involved, off-season irrigation permits the sprinkler irrigator to store enough moisture to support high yields of row crops, even in dry years, with a minimum of effort as compared to in-season irrigation.

Gravity distribution is limited to land which has a satisfactory slope or which has been artificially leveled. The use of conveyor and gated pipe eliminates ditch losses and makes it possible to carry water across low spots to irrigable land beyond. Sprinkler systems lend themselves to use on ungraded land and are more flexible as a distribution system than either of the others—within the limits of the pipe and power available.

Production Costs

Leveling or grading on a farm definitely adds to farm value and is subject to very little "depreciation," although some floating may be necessary to keep the land in good irrigable condition. Both gated and sprinkler pipe are subject to depreciation and won't represent as much value at the end of 25 to 30 years as a similar amount invested in leveling.

The important question, of course, is whether or not an investment such as shown in Table 2 or Table 3 will pay. In an effort to answer this question, costs of producing corn under the various situations shown in Table 2 have been estimated and are shown in Tables 5, 6, and 7, along with the estimated costs of producing dryland corn.

If a sprinkler system was used, the costs shown in Table 5 would increase to approximately $56, $60, and $65 respectively.

Siphon tube irrigation system.

TABLE 5. Estimated per acre costs of producing corn under dryland and specific siphon-tube irrigated conditions with normal weather.*

Item or operation**	Dryland	Irrigated			
		60′ lift	80′ lift	150′ lift	Your farm
Assumed yields	30 bu.	80 bu.	80 bu.	80 bu.	.....
Costs of production					
Disk	1.65‡				.....
Corn root-worm control***	1.00	1.00	1.00	1.00	.....
Corn stalk cutter (2 row)		1.06	1.06	1.06	.....
Plow (2-16″ 2 way)		3.81	3.81	3.81	.....
Application of fertilizer	§	1.40	1.40	1.40	.....
Fertilizer	2.20 (20 lb.)	9.35 (85 lb.)	9.35 (85 lb.)	9.35 (85 lb.)	.....
Disk (10′ tandem)		1.18†	1.18†	1.18†	.....
List (2 row mounted)	1.83				.....
Plant (2 row)		1.36	1.36	1.36	.....
Seed ($12/bu.)	1.33	2.14	2.14	2.14	.....
Rotary hoe (or harrow) 2 row		1.10†	1.10†	1.10†	.....
Go-dig (4 row)	1.87				.....
Cultivator	1.82§	2.79‡	2.79‡	2.79‡	.....
Irrigation****		10.95	14.85	19.90	.....
Harvest	3.56	3.85	3.85	3.85	.....
Hauling and elevation	1.52	3.29	3.29	3.29	.....
TOTAL*	$16.78	$43.28	$47.18	$52.23	.....

* Does not include any charge for land. Assumed that power unit and pump were purchased new; water was distributed by gravity (siphon tube); a minimum amount of leveling was required; 21 inches of water pumped (14″ assumed to be effectively used by plant); only 80 acres irrigated.

** Machine costs based on Bulletin 413 were increased 10 percent to adjust for changes in cost since 1952. Costs shown are intended to reflect average costs to the owner-operator.

*** With attachment on planter or lister.

**** For more information on the costs of pumping and distributing irrigation water, see Epp, A. W., *The Cost of Pumping for Irrigation in Nebraska,* Nebraska Experiment Station Bulletin 426; and Thorfinnson, T. S., Hunt, Meryl, and Epp, A. W., *Cost of Distribution of Irrigation Water by Different Methods,* Nebraska Experiment Station Bulletin 432, 1955.

† Designates one time over.

‡ Designates two times over.

§ Includes application of fertilizer as side dressing.

If a land charge is included, the total cost will increase in relation to the value of the land. For example, in normal rainfall years, total per-acre costs of producing 80-bushel corn (average irrigated yield in Nebraska is about 70 bushels) under the conditions shown, run from $55 to $70 an acre if a charge for the use of land is included as shown in Table 6 and 7. With sprinkler irrigation, costs would range from $68 to $83 per acre.

TABLE 6. Average total costs per acre (including land charge) for corn under various conditions.* (Dryland valued at $150 per acre.)

Item	Per-acre costs			
	Dryland (30-bu. corn)	80-bushel irrigated corn		
		60′ lift	80′ lift	150′ lift
Costs, not including land (Table 5)	$16.78	$43.28	$47.18	$52.23
Interest @ 5% on land**	7.50	8.50	8.50	8.50
Taxes (est.) on land	2.50	3.00	3.00	3.00
Total costs**	$26.78	$54.78	$58.68	$63.73

* Assuming normal weather conditions.

** An extra $1.50 was charged on the irrigated land because of the $20 additional value per acre resulting from the grading done; otherwise the same land charge was made in each case, since interest, taxes, and depreciation on the extra investment are included in the "irrigation" charges.

TABLE 7. Average total costs per acre (including land charge) for corn under various conditions.* (Dryland valued at $250 per acre.)

Item	Per-acre costs			
	Dryland (30-bu. corn)	80-bushel irrigated corn		
		60′ lift	80′ lift	150′ lift
Costs, not including land (Table 5)	$16.78	$43.28	$47.18	$52.23
Interest @ 5% on land**	12.50	13.50	13.50	13.50
Taxes (est.) on land	4.00	4.50	4.50	4.50
Total costs**	$33.28	$61.28	$65.18	$70.23

* Assuming normal weather conditions.

** An extra $1.50 was charged on the irrigated land because of the $20 additional value per acre resulting from the grading done; otherwise the same land charge was made in each case, since interest, taxes, and depreciation on the extra investment are included in the "irrigation" charges.

On a per-bushel basis, average total costs might range from about $0.65 or $0.70 to as high as $0.85 or $0.90 under the conditions shown in Tables 5, 6, and 7. This can be compared to $0.89 to $1.11 under dryland conditions in a normal year *if* yields of 30 bushels per acre were obtained.

Another way of comparing costs is to express extra costs due to irrigation (total per-acre irrigated cost less total per-acre dryland cost) in terms of the extra bushels produced (irrigated yield minus dryland yield), and compare this to the average cost per bushel of producing

TABLE 8. Average costs per bushel under dryland and siphon-tube irrigated conditions.

	Dryland 30-bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
	$150 land (dryland basis)			
Total costs	$26.78	$54.78	$58.68	$63.73
Assumed yields	30	80	80	80
Average cost per bushel	.89	.68	.73	.80
	$250 land (dryland basis)			
Total costs	$33.28	$61.28	$65.18	$70.23
Assumed yield	30	80	80	80
Average cost per bushel	1.11	.77	.81	.88

TABLE 9. Extra costs due to siphon-tube irrigation expressed in terms of extra bushels produced.

	60′ lift	80′ lift	150′ lift
Extra costs due to irrigation	$28.00	$31.90	$36.95
Extra costs per bushel based on a margin of 50 bushels above dry-land yield	.56	.64	.74

dryland corn. The per-bushel costs of producing the extra corn by means of irrigation are shown in Table 9.

Comparison of costs

A comparison of these costs with the costs of producing 30-bushel dryland corn shows that the extra bushels produced as a result of irrigation can be produced for less money (per bushel) than the bushels produced on dryland. The advantage in this respect lessens as the wells get deeper, especially if a sprinkler system is used.

It would appear that irrigators who operate under conditions similar to those shown in this article should be able to compete successfully at lower prices than can the dryland operator. However, careful thought needs to be given to the matter of launching into an irrigation system involving deep wells of only moderate capacity where sprinkler distribution is necessary.

In terms of 80 acres of corn, costs and returns might add up to something like those shown in Table 10 and Table 11 under normal rainfall conditions. With corn worth $1 or $1.30 per bushel, irrigators who can produce 80 bushels an acre stand to make more money than 30-bushel dryland farmers.

With subnormal rainfall conditions such as occurred in 1955 and 1956, the financial outcome would be considerably different. Tables 12 and 13 illustrate how net incomes from 80 acres of siphon-tube irrigated corn might compare to those from dryland corn under

TABLE 10. Total net returns on 80 acres of corn under dryland and irrigated (siphon tube) conditions ($150 land—normal rainfall).

	Dryland 30 bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
Total bushels	2,400	6,400	6,400	6,400
Total value @ $1	$2,400.00	$6,400.00	$6,400.00	$6,400.00
Less total costs	2,142.00	4,382.00	4,694.00	5,098.00
Net profit	$ 258.00	$2,018.00	$1,706.00	$1,302.00
Total value @ $1.30	$3,120.00	$8,320.00	$8,320.00	$8,320.00
Less costs	2,142.00	4,382.00	4,694.00	5,098.00
Net profit	$ 978.00	$3,938.00	$3,626.00	$3,222.00

TABLE 11. Total net returns on 80 acres of corn under dryland and siphon-tube irrigated conditions. ($250 land—normal rainfall).

	Dryland 30 bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
Total bushels	2,400	6,400	6,400	6,400
Total value @ $1	$2,400.00	$6,400.00	$6,400.00	$6,400.00
Less total costs	2,662.00	4,902.00	5,214.00	5,618.00
Net profit	$ -262.00	$1,498.00	$1,186.00	$ 782.00
Total value @ $1.30	$3,120.00	$8,320.00	$8,320.00	$8,320.00
Less total costs	2,662.00	4,902.00	5,214.00	5,618.00
Net profit	$ 458.00	$3,418.00	$3,106.00	$2,702.00

drought conditions. Irrigation costs probably will run higher in dry years, according to a survey made in the fall of 1955.[1] Extra fuel and labor amounted to $6.41 per acre on the farms surveyed. Dryland costs, on the other hand, might be reduced by approximately $2.50 per acre.

TABLE 12. Total net returns on 80 acres of corn on dryland and siphon-tube irrigated land with below normal rainfall ($150 land).

	Dryland	Irrigated		
		60′ lift	80′ lift	150′ lift
Yield	5 bu.	80 bu.	80 bu.	80 bu.
Total bushels	400	6,400	6,400	6,400
Value @ $1/bushel	$ 400	$6,400	$6,400	$6,400
Costs	1,942	4,895	5,207	5,611
Net profit	$-1,542	$1,505	$1,193	$ 789
Value @ $1.30/bushel	$ 520	$8,320	$8,320	$8,320
Costs	1,942	4,895	5,207	5,611
Net profit	$-1,422	$3,425	$3,113	$2,709

[1] Study by Thorfinnson, T. S. in central Nebraska covering crop year 1955.

TABLE 13. Total net returns on 80 acres of corn on dryland and siphon-tube irrigated land with below normal rainfall ($250 land).

	Dryland	Irrigated		
		60′ lift	80′ lift	150′ lift
Yield	5 bu.	80 bu.	80 bu.	80 bu.
Total bushels	400	6,400	6,400	6,400
Value @ $1/bushel	$ 400	$6,400	$6,400	$6,400
Costs	2,462	5,415	5,727	6,131
Net profit	$–2,062	$ 985	$ 673	$ 269
Value @ $1.30/bushel	$ 520	$8,320	$8,320	$8,320
Costs	2,462	5,415	5,727	6,131
Net profit	$–1,942	$2,905	$2,593	$2,189

Management Factor

One of the most important factors determining the success of an irrigation enterprise is the human element or management factor. The kind of management required for irrigation differs from that needed for dryland farming. Timing and attention to details become much more important. Careful attention must be given to adequate fertilization, planting and cultivation methods, amount and variety of seed and good distribution of water.

One of the principal advantages of irrigation is that it permits a capable operator to exercise managerial ability through the use of fertilizer, timing of water application, amount of seed used, etc. The dryland farmer, on the other hand, may find that any efforts on his part to exercise managerial ability may be completely over-shadowed by the limitations imposed by the lack of moisture.

It has been repeatedly demonstrated in the last few years that 100-bushel yields are well within the realm of possibility. In order to produce such yields, inputs of fertilizer, seed, water, labor, and management will have to be increased.

Table 14 shows the approximate amount by which costs would be increased if the irrigated yield were to be raised from 80 bushels to 100 bushels per acre, and the dryland yield from 30 to 40 bushels per acre. No attempt has been made to evaluate the extra management which must enter the picture.

A comparison of the figures in Tables 15 and 16 with those in Tables 10 and 11 indicates the amount of additional profit from 80 acres of corn which can be expected as a result of raising the yield from 80 to 100 bushels per acre. The difference in favor of the higher yields is substantial.

One of the problems associated with management as it relates to irrigated corn production is the amount of corn left in the field.

TABLE 14. Estimated additional costs per acre required to produce 40 and 100-bushel corn.

	Dryland 40 bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
Fertilizer	$2.20*	$ 8.20**	$ 8.20**	$ 8.20**
Seed		.53	.53	.53
Rotary hoe		1.10	1.10	1.10
Spray for corn borer		1.75	1.75	1.75
Extra water		1.56	2.12	2.84
Harvesting		.30	.30	.30
Total	$2.20	$13.44	$14.00	$14.72

* Additional 20 pounds of N.
** Includes 60 additional pounds of N and 20 pounds of P_2O_5.

TABLE 15. Total net returns on 80 acres of corn under dryland and irrigated (siphon-tube) conditions under superior management ($150 land—normal rainfall).

	Dryland 40 bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
Total bushels	3,200	8,000	8,000	8,000
Total value @ $1/bushels	$3,200	$8,000	$8,000	$8,000
Less costs	2,318	5,458	5,814	6,276
Net profit	$ 882	$2,542	$2,186	$1,724
otal value @ $1.30/bushel	$4,160	$10,400	$10,400	$10,400
Less costs	2,318	5,458	5,814	6,276
Net profit	$1,842	$4,942	$4,586	$4,124

TABLE 16. Total net returns on 80 acres of corn under dryland and irrigated (siphon-tube) conditions under superior management ($250 land—normal rainfall).

	Dryland 40 bu. yield	Irrigated		
		60′ lift	80′ lift	150′ lift
Total bushels	3,200	8,000	8,000	8,000
Total value @ $1/bushel	$3,200	$8,000	$8,000	$8,000
Less costs	2,838	5,978	6,334	6,796
Net profit	$ 362	$2,022	$1,666	$1,204
Total value @ $1.30/bushel	$4,160	$10,400	$10,400	$10,400
Less costs	2,838	5,978	6,334	6,796
Net profit	$1,322	$4,422	$4,066	$3,604

There are many reports of as much as 10 to 30 bushels of corn being left in the field. This could represent a large share of the potential profit. Irrigators might well afford to give serious thought to possibilities of early picking (25-33 percent moisture) and artificial drying. A

The results of irrigation are shown in this picture.

study in Indiana[2] indicates that the cost (total cost including labor and overhead) of drying corn either in the ear or as shelled corn can be held to 5 cents per bushel or even less where as much as 3,000 bushels or more are dried. Depending on the volume of drying done, whether heated air or natural air is used, and the initial moisture content of the grain, costs of drying may run as low as three or four cents a bushel, or as high as 30 to 35 cents. If unheated air is used and as much as 3,000 bushels of corn are dried, the total cost of drying corn containing 30% moisture can be held to 5 cents a bushel (or less if the equipment is used for a greater volume of corn and/or other crops). At a cost of 5 cents, and with a yield of 80 bushels per acre, the cost of drying would amount to $4 per acre. As little as 5 bushels of corn left in the field @ $1.20 per bushel would more than pay for the cost of drying unless some other means of salvaging the corn were worked out.

One of the big advantages of irrigation is the stabilizing influence it lends to the livestock program on the farm. This is especially true on farms where breeding herds are involved. In addition to the assurance of feed supplies in dry years, irrigation also offers the good livestock man the opportunity to increase his profits through the handling and feeding of more livestock.

[2] Snodgrass, Milton M. and Hardin, Lowell S., "An Economic Analysis of Drying Wheat and Corn on Indiana Farms."

Sprinkler irrigation system.