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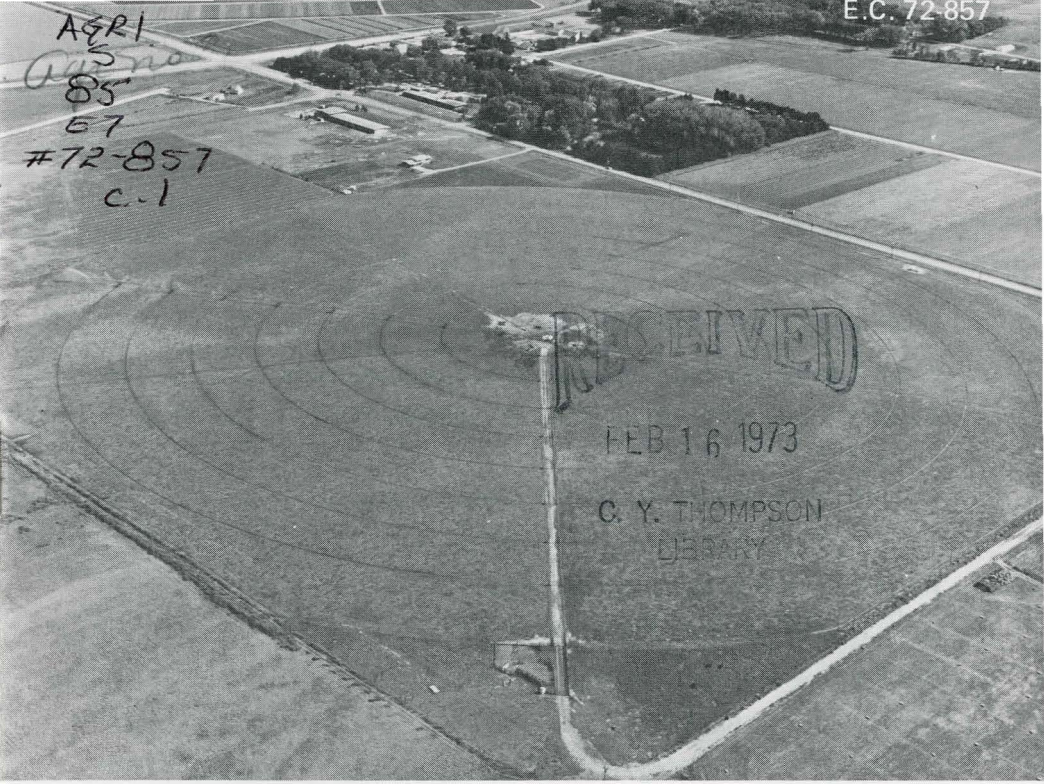

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Costs and Returns for Center-pivot Irrigated Corn in SOUTHWEST NEBRASKA 1970

Extension Service, University of Nebraska-Lincoln College of Agriculture Cooperating with the
U. S. Department of Agriculture and the College of Home Economics
E. F. Frolik, Dean J. L. Adams, Director

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Issued December 1972, 3,000

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The authors acknowledge with grateful appreciation the cooperation of the 19 farmer-cooperators who participated in the study of costs and returns from center-pivot irrigated corn in Southwest Nebraska in 1970. They were most helpful in maintaining the record forms provided, and in giving their time while this study was in progress.

SUMMARY

Center-pivot irrigation, first developed in 1952, has increased rapidly in Nebraska. It is popular because of relatively low labor requirements compared to other irrigation methods, and its adaption to sandy soils and soils of uneven topography.

A 1969 fall survey in southwest Nebraska indicated that corn was grown on 57.8% of the acreage under center-pivot systems in that year. Cost and return information on irrigated corn production was collected from 19 cooperators with 54 center-pivot systems in 1970. Data from 17 of these cooperators, with 39 systems used to grow 5,099 acres of corn for grain production, were used to compile average costs and returns for grain production. Harvesting costs for silage are the averages of five cooperators with nine center-pivot systems.

Average total costs of producing corn for grain were $113.39/A with an average yield of 118.8 bu/A. Yields ranged from 88.2 to 160 bu/A corrected to 15.5% moisture. Costs per bushel averaged $0.954. The fixed costs of depreciation, interest and taxes on the irrigation equipment and interest and taxes on the land averaged $31.72/A. Variable costs including all machinery costs, labor at $2/hour and purchased inputs, averaged $81.67/A.

Returns from 118.8 bushels of grain at the average price received of $1.26/bushel were $149.61/A. Stalks were valued by the operators at an average of $7.12/A, making an average gross income of $156.73/A. Net income, including returns for management, averaged $43.34/A.

Five operators with nine center-pivot systems used wholly or partially for silage had harvesting, hauling and packing costs that averaged $42.95/A. Their average silage harvesting costs, added to the preplant, planting and growing costs of the grain-producing operators, resulted in a total cost for silage production of $136.98/A.

Silage yields averaged 20.5 tons of green material as estimated by the operators. The silage was valued at $10/ton as a feed. A 15% shrink factor applied to the estimated yields resulted in a 17.42-ton per acre yield of cured silage. Estimated value at $10/ton was $174.20/A. Estimated net return was $37.22/A.

The most common leasing arrangement and the one that shared the costs and returns the most equitably was the 50-50 arrangement. Costs of seed, fertilizer and irrigation fuel or power were usually shared on a 50-50 basis.

Yield, exclusive of stalk values, required to cover all costs or break even at the 1970 corn price of $1.26/bushel was 90 bu/A on the average. At the $1.10 per bushel price (1966–1970 average), the average break-even yield was 103.1 bu/A.

Budgeted costs for producing corn with a new 133-acre system using electric power and custom field operations were $33.48 fixed costs, $92.61 variable costs, or a total cost of $126.09/A.

Costs and Returns for Center-Pivot Irrigated Corn in Southwest Nebraska, 1970

Robert E. Perry[1]
Leslie F. Sheffield[2]

INTRODUCTION

During the five-year period 1965–1969, the use of center-pivot irrigation systems increased from 14 to 349 systems in nine southwestern Nebraska counties.[3] (Chase, Dundy, Frontier, Hayes, Hitchcock, Keith, Lincoln, Perkins and Red Willow). Corn accounted for 57.8% of the acreage irrigated by center-pivot systems in 1969.

In 1970, nineteen farmers in southwest Nebraska who irrigated corn with center-pivot irrigation systems kept records of their costs and returns. Data from 17 of these cooperators with 39 systems and 5,099 acres of corn are summarized in this circular as averages and ranges for their investments and costs and returns in producing irrigated corn for grain.

Records of five cooperators with nine systems and 641 acres of corn were the basis for determining the costs of harvesting silage. To avoid duplication, investments and costs of silage production other than harvesting were considered as being the same as those of the irrigated grain producers. Returns to silage production were estimated by the five silage producers.

Records of costs and returns of seven cooperators with 12 systems and 1,529 acres of corn under leasing arrangements provided the basis for a discussion of leases involving center-pivot irrigated corn.

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[3] Sheffield, L. F., "Economic Analysis of the Costs and Returns for the Production of Corn Using Center-Pivot Irrigation Systems, Southwest Nebraska, 1970." Unpublished Ph.D. dissertation, University of Nebraska 1971.

Tables in this circular are developed on a similar format. Since all cooperators did not use all practices for which costs were incurred, the numbers in parentheses, ( ), are the number of center-pivot systems under which each particular item did incur a cost. Averages are the average for the number of systems indicated.

The range columns indicate the minimum and maximum investment, cost, or return for those operators who incurred that particular cost or received that particular income. The totals in the range columns are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.

A budgeted column is also included in the tables for a new 133-acre system powered by electricity. This column permits consideration of changes from the averages for those items which, in the authors' opinions, may benefit the reader to consider. Explanation is given in the text for changes between the average and budgeted figures. Custom rates for field operations were used in the budgeted column for comparison with the costs shown in the average column which are the estimated costs of owning and operating owned equipment.

INVESTMENTS PER ACRE IN LAND AND IRRIGATION EQUIPMENT

Investments in land and irrigation equipment (Table 1) indicate the amount of capital required and serve as the basis for figuring the annual fixed costs of depreciation, interest, personal taxes and insurance on the irrigation equipment as well as taxes and interest on the land.

Land Values

Land values were estimates of the operators on the 1970 value of the land before irrigation development. Values ranged from a low of $50/A for land on a very sandy site to $225/A for one site that was suitable for gravity irrigation development. The average estimate was $121.92/A with an average investment in earth moving or shaping for irrigation of $3.37/A for the ten center-pivot installations receiving shaping.

Land values per acre when land use is changed from nonirrigated to irrigated have traditionally increased more than the cost of the investments made during the irrigation development. Land that is irrigable and in the vicinity of developed land also tends to increase in value once irrigation potential has been demonstrated. A value of $135.00/A is used in the budgeted column along with the $3.37/A average land shaping cost.

Table 1. Investments per acre land and center-pivot irrigation equipment, Southwest Nebraska—1970.

	Investments per acre[a]		
	Average	Range[b]	Budgeted[c]
Land (39)	$121.92	$ 50.00 –$225.00	$135.00
Land shaping (10)	3.37	0.39 – 5.80	3.37
Total land investment (39)	$125.29	$ 55.07 –$229.62	$138.37
Well (39)	$ 26.82	$ 12.26[d]– 38.36	$ 29.77
Pump (39)	20.46	11.11[d]– 28.52	20.46
Center pivot[e] (39)	130.46	100.37 – 173.54	130.46
Power unit[f] (39)	16.87	5.80 – 32.54	17.60
Other components[g] (28)	6.08	0.51 – 27.16	7.65
Total equipment investment	$200.69	$153.59 –$233.02	$205.94
Total land and equipment investment	$325.98	$230.70 –$452.17	$344.31

[a] Data from 39 center-pivot systems. Average and range values from the number of systems in parentheses.

[b] Totals in the range colums are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.

[c] Estimated for a new 133-acre system powered by electricity.

[d] Wells and pumps used on two center-pivot systems.

[e] Average acreage 133 acres. $100.37/A investment on a 196-acre system. $173.54/A investment on a 65-acre system.

[f] Electric motors averaged $14.98/A and ranged from $5.80/A (for a used motor) to $24.19/A. Natural gas engines averaged $18.63/A and ranged from $8.98 to $26.16/A. Diesel engines averaged $29.22/A.

[g] Electric powered systems averaged $7.65/A and ranged from $1.00 to $27.16/A. Natural gas powered systems averaged $3.57/A and ranged from $0.77 to $5.35/A. Diesel powered systems averaged $0.65/A.

Well Investments

The amount invested in the irrigation well is directly related to depth. Average depth of the wells for the 39 center-pivot systems was 329 feet. Average cost per well for drilling and casing was $3,568 or $10.84 per foot of depth. Investments in wells averaged $26.82/A including three wells which were used on two systems each. Excluding these three, the average investment was $27.56/A.

Sixteen of the 39 irrigation wells were drilled in either 1969 or 1970 at an average cost of $11.86 per foot. The $29.97/A figure in the budgeted column for well investment represents a 330-foot well costing $12 per foot and used on 133 acres.

Pump Investments

The rate of pumping averaged 978 gpm with 900 gpm being the most common rate of water application. The most common pressure at the pivot was 70 psi. Depth to water at the draw-down level varied between installations from 26 to 240 feet with an average lift of 87.7 feet. The average investment per pump was $2,721.20 or $20.46/A.

Power Unit Investments

The average investment of $16.87/A (Table 1) for power units includes electric motors, natural gas engines and diesel engines. Average investments varied between power sources.

Electric motor investments for 24 motors averaged $14.98/A. The range was from $5.80/A for a used motor to $24.19/A for a 150 HP motor used with a 175-acre system. In the budgeted column (Table 1), $17.60/A is the average of eight electric motors bought in 1969 or 1970.

Natural gas engine investments averaged $18.36/A. This average was influenced by the purchase of 14 engines by one operator in one purchase. Excluding the engines in that particular purchase, the average investment was $19.68/A. The lowest investment per acre was on the large purchase at $8.96/A. The highest investment per acre was $26.16 for a 112 HP engine used on a 128-acre system.

Only two diesel engines were used on the 39 systems. The average investment was $29.22/A. One was used with a 126-acre distribution system and cost $32.54/A. The other was used with a 196-acre distribution system and cost $19.26/A.

Center-Pivot Investments

The average investment for the 39 center-pivot systems, which averaged 133 acres in size, was $130.46/A. The investment in the distribution system of center-pivots is directly related to the length of the system. The smallest system covered 65 acres and cost $173.54/A. The largest system covered 196 acres and cost $100.37/A.

Investments in Other Components

Other irrigation system components include such items as the installation of electrical panels, underground electric lines, underground irrigation supply lines, natural gas lines, fuel tanks for diesel engines, and generators for electricity driven systems where no electricity is available. These costs varied from $0 to $5,134 per system. The higher figure includes the installation of an underground irrigation supply line from a well located outside the center-pivot circle to the pivot, and a weather-tight electrical control panel. For the 28 systems listing other components as separate items, the average investment was $6.08/A.

Other components were listed for 13 electric systems. The average investment for these was $7.65/A. They ranged from $1/A to $27.16/. The average of $7.65/A was used in the budgeted column (Table 1).

Owners of 13 natural gas engines listed other components separately as an investment item at an average of $5.35/A.

The two diesel engines required fuel tanks at an average cost of $0.65/A.

Investment Totals

The average investment per acre in land and land shaping was $125.29/A. One operator reported a land investment of $55.07/A and one reported a total land investment of $229.62/A including land shaping.

Total investments in irrigation equipment averaged $200.69/A. Investments per acre in irrigation equipment are directly influenced by the number of acres irrigated with the system. The operator with the lowest investment per acre in irrigation equipment ($153.59/A) had a 196-acre center-pivot system. The operator with the irrigation equipment investment of $233.02/A was using his system on 115 acres.

ANNUAL FIXED COSTS OF LAND AND IRRIGATION EQUIPMENT

Annual fixed costs are defined as costs that are not affected by the amount of annual use. That is, they are incurred on property whether that property is used or idle. Annual fixed costs associated with the investment in land are real estate taxes and interest on the investment. Depreciation, interest, personal property tax and insurance are the annual fixed or ownership costs of the well, pump, power unit and center-pivot. These are summarized in Table 2.

Annual fixed costs for field machinery were not included in Table 2. The ownership costs for machinery were not included as fixed costs because fixed costs per acre for machinery are more closely related to total cropland farmed than to the corn enterprise only. The ownership costs of machinery and equipment were based on EC 69-836, "Costs of Owning and Operating Farm Machinery," and are included as part of the variable costs for field operations in Table 3.[4]

Real Estate Taxes

Assessed value and mill levy determine the real estate tax per acre. Since the irrigation systems were located in several counties, differences were found in the procedures used to determine the number of acres irrigated by center-pivot systems and in the time lag of changing the land from nonirrigated to irrigated classifications. In most cases, the well and pump were assessed as part of the land, while

[4] Duey, D. D., Rawson, R. D., "Farm Custom Rates Paid in Nebraska 1970." Nebraska Extension Circular 71–806, 1971.

Table 2. Annual fixed costs per acre land and center-pivot irrigation equipment, Southwest Nebraska—1970.

		Annual fixed costs per acre[a]		
		Average	Range[b]	Budgeted[c]
Real estate tax	(39)	$ 2.17	$ 0.38–$ 3.70	$ 2.75
Interest on land	(39)	7.52	3.30– 13.78	8.10
Total land cost	(39)	$ 9.69	$ 3.71–$16.33	$10.85
Depreciation				
Well	(39)	$ 1.07	$ 0.49–$ 1.53	$ 1.15
Pump	(39)	1.31	0.74– 1.90	1.31
Motor[d]	(39)	1.12	0.23– 2.71	0.70
Center-pivot	(39)	8.76	6.69– 11.57	8.76
Other equipment[e]	(28)	0.27	0.03– 1.81	0.51
Total depreciation	(39)	$12.53	$ 9.99–$15.72	$12.43
Interest on equipment	(39)	$ 7.84	$ 6.14–$ 9.32	$ 8.20
Personal tax	(35)	0.99	0.66– 1.39	1.00
Insurance on system	(35)	0.67	0.08– 1.83	1.00
Total fixed costs on irrigation equipment		$22.03	$18.09–$26.96	$22.63
Total land and Equipment fixed costs		$31.72	$23.14–$41.86	$33.48

[a] Data from 39 center-pivot systems. Average and range of the numbers in parentheses.

[b] Totals in the range columns are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.

[c] Estimated for a new 133-acre system powered by electricity.

[d] Twenty-three electric motors averaged $0.59/A and ranged from $0.23 to $0.97/A. Fourteen natural gas engines averaged $1.86/A and ranged from $0.90 to $2.62/A. Two diesel engines averaged $2.16/A and were $1.61 and $2.71/A individually. Motor and engine lives were 25 years for electric, 12 for diesel and 10 for natural gas.

[e] Includes 13 electric averaging $0.51/A and ranging from $0.23 to $0.97/A, 14 natural gas averaging $1.86/A and ranging from $0.90 to $2.62/A, and two diesels averaging $0.03/A.

the power unit and the distribution system were assessed as personal property. Real estate taxes varied from $0.38/A to $3.70/A. The average tax was $2.17/A. An arbitrary figure of $2.75/A is used in the budgeted column.

Interest on Land

Interest on the land was computed at 6% of the nonirrigated value plus land shaping costs. Average interest charge for land was $7.52/A. The range was from $3.30 to $13.78/A.

The $8.10/A in the budgeted column was computed for land at $135.00/A and interest at 6%. In cases where the owner has a small equity in the land investment, the rate of interest may need to be increased to reflect rates charged by the lender.

Depreciation on Irrigation Equipment

A straight line method was used in computing depreciation, with

Table 3. Variable costs per acre[a] center-pivot irrigated corn, Southwest Nebraska—1970.

	Average	Range[b]	Budgeted[c]
Preplant stage			
Equipment cost (28)	$2.05	$ 0.94–$ 7.20	
Labor (28)	1.00	0.39– 3.12	$ 3.00
Preplant subtotal	$ 3.05	$ 1.33–$10.32	$ 3.00
Planting stage			
Planting equipment (39)	$ 1.39	$ 0.73– 2.25	
Planting labor (39)	0.56	0.23– 1.05	$ 3.00
Seed (39)	5.50	3.89– 8.99	5.50
Fertilizer equipment (39)	0.89	0.21– 1.94	
Fertilizer labor (39)	0.37	0.02– 0.86	1.50
Fertilizer (39)	23.70	9.45– 37.86	22.50
Herbicide equipment (24)	0.21	0.00– 1.00	
Herbicide labor (24)	0.05	0.00– 0.30	1.00
Herbicide (24)	3.41	0.28– 8.00	3.41
Insecticide (18)	2.11	1.23– 3.56	2.11
Planting subtotal	$38.19	$23.25–$48.59	$39.02
Growing stage			
Cultivation equipment (38)	$ 1.41	$ 0.76–$ 2.32	
Cultivation labor (38)	0.67	0.28– 1.20	$ 3.00
Irrigation labor (39)	0.60	0.11– 2.13	1.00
Power or fuel (39)[d]	10.22	5.14– 15.94	12.53
Maintenance & repair (39)	0.86	0.06– 6.74	1.00
Transportation (39)	0.24	0.00– 4.61	0.24
Hail insurance (7)	7.10	2.46– 8.80	8.34
Growing subtotal	$21.10	$ 8.96–$26.92	$26.11
Harvesting stage—grain			
Harvesting equipment (18)	$ 8.00	$ 4.40–$ 9.60	$12.00[e]
Hauling (18)	5.74	2.74– 8.67	6.00[e]
Drying (20)	2.80	0.44– 4.44	6.00[e]
Labor (18)	2.31	1.08– 3.54	
Harvesting grain subtotal	$18.85	$10.48–$23.54	$24.00
Grain tax	$ 0.48	$ 0.35–$ 0.64	$ 0.48
Total variable costs for grain production	$81.67	$51.89–102.67	$92.61
Silage costs			
Harvesting, hauling and packing silage (9)	$42.95		$ 45.00
Total variable costs for silage production	$105.29		$113.13

[a] Data from 39 center-pivot systems. Average and range values from the number of systems in parentheses.

[b] Totals in the range columns are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.

[c] Estimated for a new 133-acre system powered by electricity.

[d] Twenty-three electric systems averaged $12.53/A for power and ranged from $8.91-$15.94/A. Fourteen natural gas systems averaged $6.89/A for fuel and ranged from $5.14-$8.79/A. Two diesel systems averaged $6.94/A for fuel and ranged from $5.76-$8.13/A.

[e] Based on custom rates of $0.10/bu. for harvesting, $0.05/bu. for hauling and drying.

no salvage value allowed. Wells were depreciated on the basis of a 25-year life or at a rate of 4% of the original cost per year. Well depreciation averaged $1.07/A. This amount is raised slightly in the budgeted column to reflect new well cost. Pumps were estimated to have a 15-year life and were depreciated at a rate of 6.66% per year. The average depreciation was $1.31/A per year.

Electric motors were depreciated over 25 years, natural gas engines over 10 years and diesel engines over 12 years. The annual depreciation averaged $0.59/A, $1.86/A and $2.16/A respectively. $0.70/A was used in the budgeted column for an electric motor at current prices.

The center-pivot distribution systems and other irrigation components were depreciated over a 15-year life. Depreciation for the center-pivot systems averaged $8.76/A and ranged from $6.69 to $11.57/A.

Total depreciation on the irrigation equipment averaged $12.53/A and ranged from $9.99 to $15.72/A.

Interest on Irrigation Equipment

An 8% interest rate was charged against half of the original investment in irrigation equipment or against the average undepreciated balance. The procedure establishes an average cost per year over the expected life of the equipment. No salvage value was assumed. Interest averaged $7.84/A and ranged from $6.14 to $9.32/A. $8.20/A is charged in the budgeted column.

Personal Property Taxes on Irrigation Equipment

Thirty-five of the 39 center-pivot systems were taxed in 1970. The mill levies varied between school districts. The range in taxes paid on the irrigation equipment was from $0.66 to $1.39/A. The $0.99/A average in Table 2 is the average for the 35 systems taxed.

Insurance on Irrigation Equipment

Insurance against damage caused by wind, tornado, lightning and similar hazards was carried on 35 of the 39 installations. The cost of insurance ranged from $10 per installation for one cooperator, who was covered by a rider on an existing insurance policy, to $203 for a 196-acre system. Per acre costs ranged from $0.08 to $1.83/A, with no analysis made of coverage obtained. The average insurance cost for the 35 systems covered by insurance was $0.67/A. An arbitrary figure of $1.00/A was used in the budgeted column.

Annual Fixed Cost Totals

The average annual land cost was $9.69/A with the range of $3.71

to $16.33/A reflecting land values of $50 and $225/A, respectively. The estimated annual cost for $135/A land with some improvements was $10.85/A.

Annual fixed costs on irrigation equipment averaged $22.03/A and ranged from $18.09 to $26.96/A. An estimate of $22.63/ in the budgeted column is largely the result of increased equipment costs.

The range in total land and equipment annual fixed costs ($23.14–$41.86/A) again represents the $50 and $225/A land investments. The average total annual fixed cost for land and equipment was $31.72/A and the budgeted total was $33.48/A.

VARIABLE COSTS OF IRRIGATED CORN PRODUCTION UNDER CENTER-PIVOT SYSTEMS

Field operations performed in the production of corn are essentially the same for either grain or silage until harvest. The costs for seed, fertilizer, herbicide and irrigation fuel are nearly the same regardless of final use of the crop. Therefore, the production costs until harvest time are averages and ranges of corn grown for both grain and silage.

All labor inputs in this study were calculated on the basis of $2 per hour including the owner and/or tenant's labor and any hired labor regardless of the variation in actual wage rates paid for hired labor by the 19 cooperators. In addition, an allowance was made for time spent in preparing equipment for field work, such as servicing, repairing, fueling and adjusting equipment over and above the time actually spent in the field. An arbitrary allowance of 3 hours for each 10 hours of field operation was added at a cost of $2/hour for the preparation and servicing of farm equipment for field work.

The data are subdivided by stages of production in Table 3 to facilitate the discussion of the differences found in getting specific jobs done. Stages, as used here, are:

Preplant: All field operations in preparing the seed bed.

Planting: The planting operation including the cost of seed, insecticide, herbicide and fertilizer (in actual practice, fertilizer is added at the preplant, planting and growing stages).

Growing: Includes all cultivations, irrigation and hail insurance.

Harvesting: The costs of harvesting as silage are shown separately from those for harvesting as grain.

Field equipment costs were not divided between fixed and variable costs. The average and range of costs shown for field operations in Table 3 include depreciation, interest, taxes, housing, insurance and maintenance on equipment as well as fuel and oil. The budgeted column is an estimate of having the same jobs done by custom opera-

tors[5] as the jobs included in the average column. Discussion of the variations in jobs done is in the text. By adding the equipment and labor costs in the average column, comparisons can be made with the budgeted column for custom costs of field operations.

Preplant Operations

The number of preplant operations varied from none to four. The most common combination of practices used were stalk shredding followed by two tandem diskings. Other practices used among the cooperators were chiseling, plowing, harrowing and cultipacking. Equipment and labor costs for preplant operations ranged from $0/A for two cooperators who used minimum tillage equipment, such as flex-planters on corn ground and in sod, to $10.32/A for one operator who chiseled twice, plowed and used a cultipacker. The minimum cost for two cooperators who used two tandem diskings as preplant operations was $1.33/A.

The 1970 custom rate for tandem disking in Southwest Nebraska was $1.50/A.[6] Two tandem diskings were the most common preplant operations. Therefore, the rate used in the budgeted column was $3/A.

PLANTING, SEED, HERBICIDE, FERTILIZER AND INSECTICIDE

Planting

Equipment costs for planting were the costs of owning and operating the tractor and planter. Application of fertilizer, herbicide and insecticide was accomplished in many cases in combination with other essential preplant, planting or cultivation operations. It was not possible to separate the equipment and labor costs for application of fertilizer, herbicide, or insecticide in those cases. The costs shown in Table 3 for fertilizer and herbicide equipment and labor are from those cases that had separate operations for these purposes. No costs are shown for insecticide equipment or labor since insecticides were applied either at planting time or were custom applied in all cases.

Tractor and planter costs averaged $1.39/A and ranged from $0.73/A for a 12-row planter and power unit to $2.25/A for a 4-row planter and power unit. Labor costs for planting averaged $0.56/A and ranged from $0.23/A to $1.05/A. The 1970 custom rate for planting with fertilizer attachment and band applicator was about $3.00/A.[7] This rate was used in the budgeted column.

[5] See footnote 4.

[6] See footnote 4.

[7] See footnote 4.

Seed costs varied from $3.89/A to $8.99/A. Factors contributing to the wide variation in seed costs per acre appeared to be: (1) the amount of single-cross hybrid seed used vs. multiple-cross seed and (2) operators who were also seed-corn dealers reporting dealer's price. Seed costs averaged $5.50/A.

Fertilizing

Fertilizer equipment costs averaged $0.89/A. The lowest cost of $0.21/A was reported by an operator who borrowed a fertilizer spreader at no charge and used his own tractor to spread the fertilizer. The highest cost of $1.94/A was incurred by an operator who rented a spreader for $0.25/A, a chisel for $0.60/A and used his own tractor for these two operations at $0.86/A. In addition, he used fertilizer equipment to inject fertilizer solutions through the irrigation system at a cost of $0.23/A.

Labor for fertilizing averaged $0.37/A. The minimum cost of $0.02/A was for an operator who estimated two hours spent injecting fertilizer through a 196-acre center-pivot system. The maximum labor cost of $0.86/A was for spreading dry fertilizer, at $0.41/A, followed by chiseling in anhydrous ammonia at $0.45/A. In the budgeted column $1.50/A was the 1970 custom rate in Southwest Nebraska for anhydrous ammonia application.[8]

Fertilizer was the largest single variable cost item associated with irrigated corn production. The kinds, amounts, number of applications and methods of application varied. Fertilizer costs also varied according to the kind of fertilizer used and the price paid by each cooperator. The range in costs for fertilizer was $9.45 to $37.86/A and the average was $23.70/A. Starter fertilizer was applied on all but one of the 39 fields. The remaining portion of the fertilizer was applied as gas, liquid or solid material either in separate field operations or with the irrigation water through the center-pivot irrigation system.

The number of applications ranged from two (two anhydrous applications) to nine (a starter and eight applications with irrigation water).

The amount of nitrogen applied by all methods ranged from 110 to 354 pounds per acre. The average application of nitrogen was 236 lb/A of actual nitrogen.

Nitrogen was applied with the irrigation water through 28 of the 39 systems at an average rate of 48.2 lb/A of actual nitrogen.

Phosphorus was applied on 35 of the 39 fields at an average rate of 65 lb/A (P_2O_5) with the largest application being 105 lb/A and the smallest being 36 lb/A.

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[8] See footnote 4.

Potassium was applied on 21 fields at an average rate of 24 lb/A of K_2O. Applications of potassium ranged from 8.4 to 45.0 lb/A.

Zinc was applied on 35 fields at an average rate of 3.5 lb/A and a maximum application of 10 lb/A and a minimum of 0.7 lb/A.

Sulfur was used on 21 fields. The average application was 24.9 lb/A, and the range was from 3.0 to 52.0 lb/A.

Magnesium was applied on 11 fields averaging 18.2 lb/A. One operator applied 5.0 lb/A and another applied 25.7 lb/A.

Except for nitrogen, the level of fertilization for irrigated corn production by some of the cooperators in this survey appeared to be higher than the annual application required to maintain adequate fertility levels. In the budgeted column in Table 3, the $22.50/A fertilizer cost estimate includes 230 lb of nitrogen with 120 lb applied as anhydrous ammonia at $0.05/lb, 10 lb of nitrogen as starter at $0.08/lb, and 100 lb of nitrogen as liquid through the system at $0.105/lb. Forty pounds of phosphorus (P_2O_5) at $0.08/lb and two pounds of zinc at $1.00/lb are also included.

Herbicides

Atrazine was the most popular herbicide treatment, accounting for 57% of the acres treated for weed control. Other herbicides used were Banvel D; Ramrod-Atrazine; Ramrod; Banvel D and 2, 4-D; Sutan and 2, 4-D; and 2, 4-D. Average herbicide cost by herbicide users was $3.41 per treated acre. The range in costs was from $0.28 to $8/A.

Methods of herbicide application were by tractor and sprayer, by custom aerial application, with liquid starter at planting time, and through the center-pivot irrigation system.

Herbicides were applied on six fields by operators who used their own equipment at an average estimated cost for the equipment of $0.40/A. Two operators had herbicides custom applied at $0.75/A and $1/A. Average equipment and labor costs for all operators who applied herbicide were $0.21/A and $0.05/A, respectively.

Insecticides

Insecticides were applied on 18 fields at an average cost of $2.11 per treated acre. The range in insecticide costs was from $1.23 to $3.56/A. A total of 382 acres were treated for adult corn rootworm beetles and 260 acres were treated for western bean cutworms.

Aldrin was used on 33% of the acres treated for corn rootworm control. Other insecticides used as rootworm treatments were Bux Ten, Thimet and Di-Syston. Endrin and Endrin-Parathion were applied aerially to corn under two systems for control of western bean cutworms. Differences in per acre insecticide costs were mainly attributable to the choice of insecticide.

GROWING STAGE OF IRRIGATED CORN PRODUCTION

Cultivation

The number of cultivations varied from none to three, with two cultivations being the most common. One operator substituted Atrazine for all cultivations. Some cultivation was used on the other 38 systems. The average cultivation cost was $2.08/A for equipment and labor. One operator with an 8-row cultivator used only one cultivation at a cost of $1.04/A for equipment and labor. One operator used a 6-row cultivator and two cultivations. He incurred a $2.32/A cost for equipment and a $1.20/A cost for labor.

Two custom cultivations were used in the budgeted column at $1.50/A each.

Irrigation

The average amount of water applied in 1970 with the center-pivot irrigation systems was 18.9 inches. Water application during the 1970 growing season ranged from 9.5 inches to 24.9 inches.

Average irrigation power cost, Table 3, is the average for the three kinds of power. Power cost in the budgeted column of $12.53/A, Table 3, is the average of the 23 electric units.

Average water pumped/A, fuel used/A, fuel cost/A and fuel cost/acre-inch are shown in Table 4 by power source.

Electric power costs ranged from $8.91/A with 444.9 KWH/A used and 9.5 inches of water applied to $15.94/A with 917.5 KWH/A used and 21.6 inches of water pumped.

Natural gas costs ranged from $5.14/A for 73.3 CCF/A used and 15.9 inches of water pumped to $8.47 for 122.5 CCF/A used and 22.5 inches of water pumped.

Fuel cost for the two diesels averaged $5.76/A for 35.5 gallons of fuel/A and 14.0 inches of water pumped, and $8.13/A for 43.5 gallons of fuel/A and 22.7 inches of water pumped.

Table 4. Average water applied, fuel or power used, cost per acre, costs per acre-inch, center-pivot irrigation systems, Southwest Nebraska—1970.[a]

	Water applied inches/A	Fuel used/ acre	Fuel cost/ acre	Fuel cost/ acre inch
Electric (23)[b]	18.9	683.2 KWH	$12.53	$0.662
Natural gas (14)[b]	19.0	101.9 CCF[c]	6.89	0.362
Diesel (2)[b]	18.3	39.5 Gal.	6.94	0.379

[a] Prices charged for both electricity and natural gas for irrigation have been increased since 1970 by most energy suppliers in Nebraska.

[b] Number of power units.

[c] CCF = 100 cubic feet of natural gas.

Costs of irrigation labor, maintenance of irrigation equipment, and a charge for transportation during the irrigation season for operating the systems are shown in Table 3. Maintenance and repair costs may have been influenced by how many years the systems had been used. Nearly 50% of the systems were in either their first or second year of operation in 1970. Some were still under warranty so that repairs were still the responsibility of the dealer or manufacturer. Estimates by two operators with several combined years of center-pivot irrigation experience were that repairs will not exceed $1/A on an annual basis plus the labor to make the repairs. $1/A was used in the budgeted column for maintenance and repairs.

Wide variations were found between operators and even between systems operated by the same operator in the amount of labor required for irrigation, maintenance and repairs. The range of costs for irrigation labor was from $0.11 to $2.13/A with labor at $2/hour. The average labor cost for irrigation alone was $0.60/A. The budgeted column, Table 3, includes labor for irrigation at $1/A and $1/A for maintenance of the irrigation equipment.

Hail Insurance

Hail insurance is an optional cost. Since corn was insured on only 7 of the 39 systems, you may wonder why the average cost for the 7 is shown in Table 3 rather than the average cost for insured and uninsured corn. Risk of hail is not optional. Risk must either be assumed by the operator or transferred via a cost (premium) to an insurance company. No records of irrigation systems that had 20% or greater hail loss were included in the 39 systems from which the corn was harvested for grain. Thus, the hail risk is understated by virtue of higher average yields per acre than would be the case if those fields with more than 20% hail loss had been included in the data. Therefore, the cost of insuring against hail loss is more correctly reflected by the average of those who incurred this cost.

For 270 townships in the nine-county area, the average standard policy rate per $100 coverage for corn in 1969 was $13.90.[9] At this rate per acre, the average of $7.10/A paid by those who carried hail insurance was adequate for an average of $51.08 coverage per acre on standard policies.

In 1970, the average irrigated corn yield for the Southwest Cropping District was 109.5 bushels per acre.[10] This was 9.3 bushels less than the 118.8 bushels/A average yield achieved from corn produced with 39 center-pivot systems in the survey. Although the difference

[9] Delvo, H. W., Greer, J. D., "Hail Insurance: an Analysis of Policy Forms in Nebraska 1969." Dept. of Ag. Economics Rep. No. 51, Univ. of Nebraska 1969.

[10] Beller, N. D., "Nebraska Agricultural Statistics Annual Report 1970." State Federal Division of Agricultural Statistics 1972.

cannot be attributed to hail damage alone, the point is illustrated that when calculating costs and returns over a period of years, average yields either need to be adjusted to reflect hail risk; or a realistic insurance cost, even if the risk is carried by the operator, needs to be included. A hail insurance cost of $8.34/A is included in the budgeted column in Table 3, which would provide $60/A on a standard policy for coverage of cash costs incurred in corn production.

HARVESTING, HAULING AND DRYING COSTS

Corn Harvested as Grain

In this section of Table 3, the average and range of costs for corn grain harvested from 18 center-pivot systems was included where the corn was harvested with the operators' own equipment and labor. Corn harvested from the other 21 systems was either custom harvested or custom hauled. It was not possible to separate equipment and labor costs in the custom operations. For those cooperators who used their own equipment, the average cost for harvest equipment was $8/A and the range was from $4.40 to $9.60/A. Labor for harvesting averaged $2.31/A and ranged from $1.08 to $3.54/A. A $12/A cost is estimated in the budgeted column for custom harvesting (120 bushels @ $0.10/bushel).

Custom harvesting rates paid by cooperators in the survey ranged from $0.07/bushel without hauling to $0.15/bushel with hauling.

Hauling

Hauling costs averaged $5.74/A and ranged from $2.74 to $8.67/A. This wide variation reflected the differences in the distance the corn was hauled. Hauling costs in the budgeted column, Table 3, were computed at the rate of $0.05/bushel on a custom basis.

Drying

Drying costs in 1970 were probably lower than average due to the relatively long growing season which permitted corn to mature and dry normally. Most of the corn harvested for dry storage was below 20% moisture. The average cost of 20 cooperators who dried corn was $2.80/A with a range of $0.44 to $4.44/A. In the budgeted column, on Table 3, drying costs of $6/A were estimated (120 bushels x $0.05).

Grain Tax

Corn is subject to an excise tax on the grain produced on farms. The rate in all counties in Nebraska is four mills per bushel. The grain tax on 118.8 bushels, which was the average yield for the cooperators in this study, was $0.48/A.

Table 5. Average gross returns per acre 39 irrigation systems center-pivot irrigated corn, Southwest Nebraska—1970.

	Grain		
	Average	Range[a]	Budgeted[b]
Yield (bu/A)	118.8	88.2 – 160.0	120.0
Price per bushel	$ 1.26	$ 1.20–$ 1.35	$ 1.26
Value corn grain/A	149.61	110.19– 204.15	151.20
Value stalks/A	7.12	3.97– 16.00	7.50
Total	$156.73	$119.36–$213.38	$158.70
	Silage		
Yield—chopped tons/A	20.5	18.0 – 24.0	20.0
Yield—tons silage/A[c]	17.42	15.3 – 20.4	17.0
Value/ton silage	$ 10.00		$ 10.00
Silage value/A	$174.20	$153.00–$204.00	$170.00

[a] Totals in the range columns are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.
[b] Estimated averages.
[c] Yield of green chop adjusted for estimated 15% shrink in trench silos.

Harvesting Costs for Silage

Five cooperators reported costs for cutting, hauling and packing silage. Three used their own equipment for the entire operation. Two had the silage custom cut and hauled. The total costs for equipment and labor were about the same, averaging $41.27/A for those who did their own harvesting, hauling and packing and $43.67/A for those having the operations performed by custom operators. The average cost for the five cooperators was $42.95/A.

Custom rates paid were $1/ton for cutting, $0.75/ton for hauling and $0.50/ton for packing with all labor included. A cost of $45/A was estimated in the budgeted column in Table 3 by using these custom rates and an estimated 20-ton/A yield.

GROSS RETURNS TO GRAIN AND SILAGE

Average gross returns per acre are shown in Table 5.

Corn grain harvested under the 39 systems averaged 118.8 bu/A at 15.5% moisture; 88.2 bu/A was the lowest yield and 160 bu/A was the highest. A 120 bu/A yield was assumed in the budgeted column in Table 5.

The blended price for corn grain for all corn sold, fed or stored by the cooperators averaged $1.26/bu for 1970 and ranged from $1.20 to $1.35/bu. The average corn price received by Nebraska farmers in November and December of 1970 was also $1.26/bu.[11] This price was used in the budgeted column in Table 5.

[11] See footnote 10.

Stalk values estimated by the cooperators averaged $7.12/A, including one cooperator with one system who did not use his stalks for pasture. A value for cornstalks of $7.50/A was the most common estimate. Therefore, $7.50/A was used in the budgeted column of Table 5.

Total returns for corn and stalks averaged $156.73/A. Total returns among the cooperators ranged from $119.36 to $213.38/A.

Government payments for participation in the 1970 feed grain program were not included in the returns in this analysis for 1970. They were considered to be for program compliance rather than a return to the corn enterprise.

Field-chopped silage yields averaged 20.5 tons/A and ranged from 18 to 24 tons/A. These yields were reduced by 15% to estimate the silage available as feed after shrink. Operators estimated the value of silage on the basis of feed in the silo at $10/ton.

Returns from silage averaged $174.20/A and ranged from $153 to $204/A.

NET RETURNS OR RETURNS TO MANAGEMENT

By definition, net returns, or returns to management, are the difference between gross returns and all costs, fixed and variable, including labor. Table 6 summarizes costs and returns for irrigated corn for grain.

Figures in the range column represent the minimums and maximums found for individual items among all cooperators and the total minimum and maximum figures for individual operators. The totals in this column are not the sum of the individual items above.

The average total cost was $113.39/A with an average gross return of $156.73/A for an average net return, or return to management, of $43.34/A.

The net return in the budgeted column was $32.61/A, or $10.73/A less than the average return for the 39 center-pivot systems surveyed. This budget included custom work for all field operations and assumed a 120-bushel yield vs. the 118.8 bushel yield for the average. Labor was included at $2/hour in the average cost column. The total labor cost for producing an acre of corn under center-pivot was $5.56/A. It may well be that an operator's time is worth more than $2/hour during part or all of the corn growing season. If so, custom hiring of some or all jobs for corn production could be economically justified, assuming equal competence for the hired labor or custom work.

The net returns to silage averaged $37.22/A with an average yield of 20.5 tons of silage, a total production cost of $137.01/A packed into the silo, and estimated value of $10/ton for silage.

Table 6. Estimated costs and returns per acre center-pivot irrigated corn for grain Southwest Nebraska—1970.

	Average	Range[a]	Budgeted[b]
Gross return:	$156.73	$119.36–$213.38	$158.70
Fixed costs:			
Real estate tax	$ 2.17	$ 0.38– 3.70	$ 2.75
Interest on land	7.52	3.30– 13.78	8.10
Depreciation	12.53	9.99– 15.72	12.43
Int. irrig. equip.	7.84	6.14– 9.32	8.20
Personal tax	0.99	0.66– 1.39	1.00
Insurance	0.67	0.08– 1.83	1.00
Total fixed costs:	$ 31.72	$ 23.14–$ 41.86	$ 33.48
Variable costs:			
Preplant[c]	$ 3.05	$ 1.33–$ 10.32	$ 3.00
Planting[d]	38.19	23.25– 48.59	39.02
Growing[e]	21.10	8.96– 26.92	26.11
Harvest & haul[e]	18.85	10.48– 23.54	24.00
Grain tax	0.48	0.35– 0.64	0.48
Total variable costs:	$ 81.67	$ 51.89–$102.67	$ 92.61
Total fixed and variable costs:	$113.39	$ 81.14–$130.44	$126.09
Return to management:	$ 43.34	$ 8.37–$123.95	$ 32.61

[a] Totals in the range columns are not totals of the figures which appear above them but are the minimum and maximum totals reported by individual operators.

[b] Estimated for a new 133-acre system powered by electricity.

[c] Machines and labor.

[d] Machines, labor, seed, herbicide, insecticide, fertilizer.

[e] Machines, labor, irrigation, hail insurance.

YIELDS REQUIRED TO COVER ALL COSTS

Yields required to cover all costs are commonly called break-even yields. Break-even yields are calculated from the cost of production and the price of corn.

Total annual costs averaged $113.39/A and ranged from $81.14/A to $130.14/A among the 39 center-pivot systems in the survey. The budgeted total cost was $126.09/A.

A corn price of $1.26/bushel was used in all the 1970 budgets. However, the average Nebraska corn price for November and December, 1966–1970 average, was $1.10/bushel. Table 7 illustrates the effects of production cost and corn price on the grain yields required to cover all costs without considering stalk value.

LANDLORD-TENANT SHARING OF COSTS AND RETURNS

Fifty-fifty share leases were the most popular, and apparently the most equitable, for the sharing of costs and returns of corn produced

Table 7. Yields of corn grain required to cover total production costs at 1970 corn price and average 1966–1970 corn price.[a]

Total production costs/acre	1970 price $1.26/bu.	1966-1970 corn price $1.10/bu.
	Break-even yields—bushels/acre	
$130.44 (high)	103.5	118.6
$126.09 (budgeted)	100.1	114.6
$113.39 (average)	90.0	103.1
$ 81.14 (low)	64.4	73.8

[a] Stalk values not included.

under center-pivot irrigation. Eight of twelve center-pivot systems were leased with a 50-50 arrangement. Three systems were leased under a 60-40 arrangement and one was leased for two-thirds and one-third, with the tenant owning the center-pivot system. The three landlords under the 60-40 arrangements all received negative net returns. The landlord with the two-thirds/one-third lease where the tenant owned the center-pivot system incurred 25.8% of the costs and received 46.5% of the net return.

The average total cost per acre for the eight 50-50 leases was $102.49/A. Cases varied, but the most usual arrangement in the 50-50 leases was for seed, fertilizer, irrigation and other chemical costs to be shared equally. The tenants' costs averaged 48.6%.

Returns for grain and stalks averaged $142.08/A with the tenants averaging 48.8% of the returns.

In five of the eight cases, the corn grain income and the stalk values were both shared on an equal basis. In one case, the tenant received the stalks and in the other two cases the landlord received the stalks as well as half the corn.

Table 8 is an example for a 50-50 cost sharing arrangement, using the average costs for the 39 systems previously discussed. In this example, the costs of seed, fertilizer and irrigation fuel or power are shared equally. Drying costs and hail insurance costs are not included since these decisions can be made individually by either landlord or tenant on their share of the crop without affecting the other.

In this example, the costs are $52.68 for the landlord, which are 50.6% of the total cost of $104.05. The tenant's costs are $51.37, or 49.4% of the total costs. Sharing grain and stalks on a 50-50 basis would be equitable in this example. However, at the time leases are drawn or signed, costs, yields and prices are only estimates.

Since leases that share the returns in the same proportion as the costs are shared are said to be equitable, an adjustment provision may need to be provided in the lease to allow for final settlement on an

Table 8. Example of a 50–50 cost sharing lease for center-pivot irrigated corn based upon study in Southwest Nebraska—1970.

Cost items:	Average cost 39 systems		Your situation	
	Landlord cost	Tenant cost	Landlord cost	Tenant cost
Real estate tax	$ 2.17	.....	_____	_____
Interest on land	7.52	.....	_____	_____
Depreciation on irrig. equip.	12.53	.....	_____	_____
Interest on irrig. equip.	7.84	.....	_____	_____
Personal property tax	0.99	.....	_____	_____
Insurance on system	0.67	.....	_____	_____
Preplant expense	.....	$ 3.05	_____	_____
Planting	.....	1.95	_____	_____
Seed	3.00	3.00	_____	_____
Fertilizer application	.....	1.26	_____	_____
Fertilizer	11.85	11.85	_____	_____
Herbicide application	.....	0.26	_____	_____
Herbicide	.....	3.41	_____	_____
Insecticide	.....	2.11	_____	_____
Cultivation	.....	2.08	_____	_____
Irrigation labor	.....	1.00	_____	_____
Irrigation fuel or power	5.11	5.11	_____	_____
Repairs for irrig. equip.	1.00	.....	_____	_____
Transportation	.....	0.24	_____	_____
Harvesting	.....	16.05	_____	_____
Total	$52.68	$51.37	_____	_____
Percent	50.67	49.4	_____	_____

adjusted basis if actual costs or yields deviate appreciably from those estimated.

Each leasing situation is somewhat different and the costs for both landlord and tenant need to be estimated in each case. Blank lines are provided in Table 8 for your estimates. In cases where either the tenant or landlord desire exclusive use of the stalks, adjustments in the sharing of fuel or power costs or seed costs from those in the example might be considered. For example, tenants in the survey who paid the full seed cost usually were entitled to the use of the stalks.