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An Economic Analysis of Selected Irrigation Systems Applicable to the Eastern Missouri Slope Area of South Dakota

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AN ECONOMIC ANALYSIS OF SELECTED IRRIGATION SYSTEMS APPLICABLE TO THE EASTERN MISSOURI SLOPE AREA OF SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Arts, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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CHAPTER I

INTRODUCTION

Statement of the Problem

For many years the prospect of irrigation development has captured the minds of farmers, agribusinessmen, and residents of the Eastern Missouri Slope area of South Dakota. The area has shared in the over-all technological advance in agriculture, but agricultural production and incomes have remained highly variable. This variability is generated by inconsistent yields caused by extreme annual fluctuations in the quantity and seasonal distribution of rainfall. Irrigation is the logical solution for stabilizing production and income.

In the last decade there has been a major transition from gravity to sprinkler irrigation systems. Economic and physical factors have caused the trend toward sprinkler irrigation. Rising labor costs and more efficient power sources have led farmers to substitute mechanical power and capital investment for farm labor and thus convert to sprinkler irrigation. The current technology in sprinkler irrigation permits the farmer to irrigate shallow topsoil without disturbing it by land leveling. He can sprinkler-irrigate sloping and sandy lands without problems of excessive runoff and soil erosion. Also, the farmer can apply a rather exact, uniform quantity of water where and when needed. As a result of these advantages, land which would have otherwise been considered non-irrigable under gravity irrigation can often be adapted to sprinkler systems.

Each type of irrigation system has its advantages and disadvantages. Some systems can be designed for use on almost all land, whereas others have limited applications. Each system also has different capital and labor requirements. The individual farm firm considering irrigation as a new enterprise must choose a particular system from the continuously changing array. In making such a choice, the firm must consider its particular economic objectives within its specific set of limiting resources.

The realization of the full benefits from an irrigation system involves an examination of capital requirements, labor supply, crop responses, soil conditions, and in general a new approach to management practices on the farm. The benefits from irrigation are not always easy to measure in terms of dollars. The net dollar return is an important factor in the decision-making process, but there are others. Irrigation may have some of the following benefits in addition to increasing yields. The presence of an irrigation system may act as a type of insurance against the probability of drought. Irrigation may hasten the maturity date of a crop thus enabling the farmer to harvest and sell his crop at higher prices and with fewer risks.

The increasing interest in irrigation, rapid improvement in technology, and the expanding range of available choices of irrigation sprinkler systems have increased the demand for adequate information for economic planning. Current economic data on irrigation sprinkler systems cannot meet the present demand. This study is expected to help supply information that will serve as guidelines for farm firms in the Eastern Missouri Slope area of South Dakota.

Objectives

The objectives of the study were:

1. To determine the optimum enterprise combinations and farm organization necessary to maximize returns from the adoption of irrigation in Eastern Missouri Slope area of South Dakota.
2. To determine how the optimum combination of enterprises vary between different systems.

Description of the Area

The South Dakota counties of Campbell, Walworth, Potter, Sully, and Hughes lie in a block bounded on the west by the Missouri River and on the north by the North Dakota border.[1] This area is known as the Eastern Missouri Slopes. The Eastern Missouri Slope area of South Dakota, because of its inland position, has a climate characterized by extremes of summer heat, winter cold, and rapid fluctuations of temperature. The climate in this area is considered in the high risk zone for production of dryland crops. This is because of unfavorable distribution of growing-season rainfall and also because of variability over a period of years. The annual precipitation averages 15 to 17 inches. Fifty percent of this moisture falls in the March 1st to July 4th period.[2] The area's average frost free period

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[1] See Figure 1, page 4.

[2] Fred C. Westin, et. al., Soil Atlas and Crop Production Guide for North Central South Dakota, Extension Circular 660, Cooperative Extension Service (South Dakota State University, Brookings, 1968).

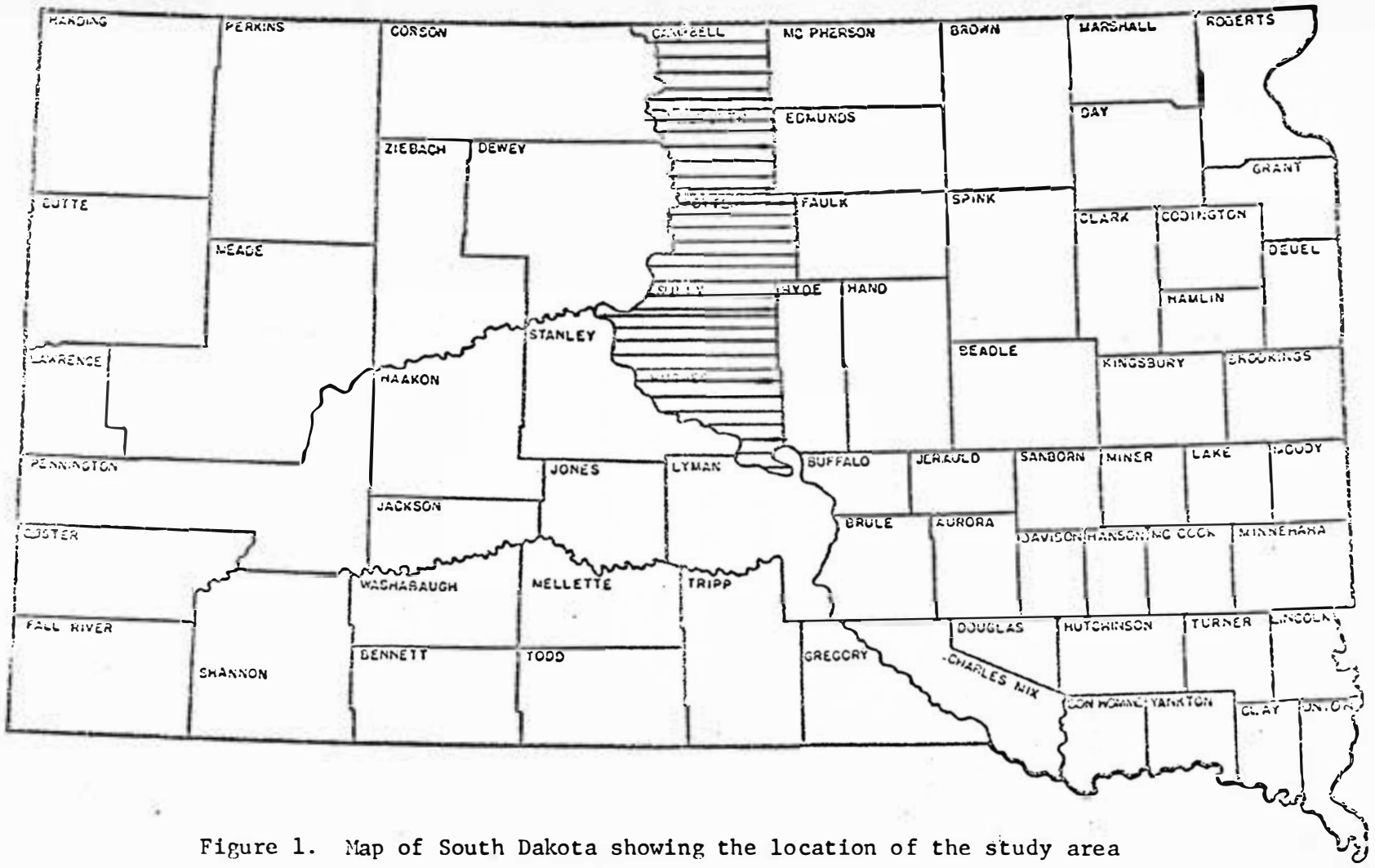

Figure 1. Map of South Dakota showing the location of the study area

varies from about 114 days in Campbell county to about 140 days in Hughes county.[3]

Summer days during the growing season average 11.5 hours of sunshine which is more than 70 percent of the possible sunshine. The long, sunny days during the growing season are conducive to rapid crop growth, thus partly compensating for the rather short frost-free period. The temperature ranges from an extreme of 115 degrees above zero in the summer to 40 degrees below zero in the winter.[4]

The study area is located within the Chestnut soil zone.[5] The area is made up of undulating or sloping, well drained, grayish brown silt loams and loams.[6] These soils are of the Agar-William, William-Zahl, and Raber-Eakin series. Some of the problems inherent in this kind of soil are maintenance of organic matter, nitrogen, and moisture conservation.

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[3]Ibid.

[4]Report on Oahe Unit, U. S. Department of the Interior, Bureau of Reclamation, Region 6, Appendix D-Project Lands, Missouri-Oahe Project Office: Huron, South Dakota, June, 1960, p. 7.

[5]Fred C. Westin, op.cit., p. 3.

[6]Erwin O. Ullrich, Jr., et. al., "Machinery Costs on Typical Wheat Farms in North Central South Dakota," Experiment Station Circular No. 187, Agricultural Experiment Station (South Dakota State University, Brookings, 1968), pp. 4-5.

The major crops grown in the study area are wheat, oats, barley, corn, and alfalfa.[7] Farm types vary from predominately livestock to cash-grain depending on the percentage of cropland in the farm unit and the preference of the farm operator.

Related Studies

A study conducted by Dr. Rex Helfinstine was designed to compare the returns from dryland and irrigation farming for the Oahe Irrigation area of North Central South Dakota. The study emphasized that perhaps the most important factor favoring irrigation comes from stabilizing or leveling out high and low income and production periods.[8] The results also indicate that labor and management returns were more than two times greater on irrigated farms. The capital and labor requirements were also about twice as large on irrigated farms. In addition, the results show that irrigation reduces income variability over dryland farming by about one-third.[9]

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[7]South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1968.

[8]Rex D. Helfinstine, "Economic Comparison of Irrigated and Dryland Farming in Central South Dakota," Bulletin 518, Agricultural Experiment Station (South Dakota State University, Brookings, 1964), p. 14.

[9]Ibid.

The Bureau of Reclamation has completed several studies concerning the development of irrigation in South Dakota. The proposed development of the Oahe Unit would serve multiple purposes in addition to irrigation, including municipal and industrial water supplies, fish and wildlife conservation, recreation, flood control, and pollution abatement.[10] The number of acres that would be irrigated in North Central South Dakota under this project is 482,000. The Report on Oahe Unit represents a complete report on costs, benefits, and repayment schedules along with facts and findings in detail to determine the engineering and economic feasibility of the Oahe Unit as a multipurpose project. The plan of development has economic justification based on comparison of benefits to costs.

A publication by North Dakota State University deals with the advances in irrigation technology.[11] McMartin and Bergan observed that operators of well financed farms readily invested in irrigation equipment when high returns seemed evident. Their study also showed that labor supply was one of the most important factors considered in the selection of an irrigation system.[12] Therefore, mechanical sprinkler systems were very suitable to the firm's resource base.

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[10] Report on Oahe Unit, U. S. Department of the Interior, Bureau of Reclamation, Region 6, Missouri-Oahe Project Office: Huron, South Dakota, 1964, p. 1.

[11] Wallace McMartin and Ronald Bergan, "Irrigation Practices and Costs in North Dakota," Bulletin 474, Agricultural Experiment Station (North Dakota State University, Fargo, March, 1968).

[12] Ibid.

Fischer completed a linear programming analysis of Brookings County in August of 1969.[13] The purpose of this study was to analyze the irrigation potential on terrace soils in Brookings County. Crop activities in the model included corn, wheat, oats, flax, and alfalfa. Beef cow herds were allowed in all model formulations, including feeder calf systems, and stock enterprises. Dairy and hog enterprises were also included. The results of the study indicated that the adoption of sprinkler irrigation on high terrace soils would be profitable. It showed that all representative farms could experience gains in returns to family labor and management. The capital and labor requirements were increased in every instance with the adoption of irrigation.

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[13]Norman M. Fischer, "An Economic Analysis of Irrigation Potential on Terrace Soils of Brookings County" (unpublished Master's thesis, South Dakota State University, Brookings, August, 1969).

CHAPTER II

ASSUMPTIONS OF THE MODEL

Linear programming was used in this analysis to determine the optimum allocation and use of scarce resources to maximize profits.[14] The linear programming model of a hypothetical farm was intended to be representative of farms in the study area. The representative farm concept traces back at least as far as Alfred Marshall.[15] Taussig paraphrases Marshall's notion of the "representative" as "one not far in the lead, but well-equipped, well led to maintain itself permanently with substantive profits."[16] Carter explains that the representative firm was initially an abstract idea used to explain economic phenomena of supply and business profits.[17] Today the idea of the representative firm (called planning model in this study) is intended to be an empirical tool to guide management decisions.[18]

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[14]It is not the author's intent to present a detailed explanation of linear programming. For additional information the reader may consult any of several well known texts on the subject.

[15]Alfred Marshall, Principles of Economics (New York: Macmillan and Company, 1930), pp. 317-318.

[16]F. W. Taussig, Principles of Economics (New York: Macmillan and Company, 1926), p. 176.

[17]Harold Carter, "Representative Farms-Guides for Decision Making?" Journal of Farm Economics, Vol. 45, No. 5, December, 1963, p. 1449.

[18]Ibid., p. 1454.

Several simplifying assumptions were made concerning the characteristics of the representative farm situation. The assumptions of the model in this study are specified and explained in the following sections.

Resource Restrictions

Land

The representative farm in the Eastern Missouri Slope area of South Dakota was assumed to consist of 1,600 acres. Information based on recent trends from the South Dakota Crop and Livestock Reporting Service shows the representative farm size in the study area is approaching 1,600 acres. In order to have a representative farm situation, each acre must necessarily approach a representative acre of the study area. The relative amounts of native pasture, cropland, and land classes must be estimated to approach the real situation in order to achieve results useful in comparing present dryland operations against the potentials under both dryland and irrigation farming. The assumed composition of the total acreage and the percentage composition of an acre of agricultural land among pastureland, cropland, and other uses is given in Table I.

Cropland was divided into two classes. The division was based upon potential yield capabilities, management practices, and different problems that arise when land is used for cropping purposes. Continuous grain crop sequences and an oat-alfalfa-alfalfa-alfalfa rotation activity were allowed on both land classes.

Table I. Assumed Composition of Total Acreage and the Percentage Composition of an Acre of Farmland in the Eastern Missouri Slope Area, South Dakota.

Item	Percent	Acres
Class I Cropland	44.87	718
Class II Cropland	23.87	382
Total Cropland	68.75	1,100
Pasture	28.75	460
Other: Farmstead, Roads, Trees, Fences, and Wasteland	2.5	40
Total Land	100.0	1,600

Grazing was limited to the 460 acres of native pasture. However, the model included a pasture improvement option. A maximum of 320 acres could be improved if profitable. In the irrigation planning models the improved pasture could also be irrigated.

Pasture grazing production was expressed in tons of hay equivalent. The production from an acre of native pasture was assumed to equal 0.75 tons of hay equivalent. The dryland improved and irrigation improved pasture production were 1.55 tons and 3.8 tons respectively. The planning models assumed three grazing periods. The seasonal pattern of pasture production results in the highest production in the first grazing period and then diminishes in the latter two periods. Tons of hay equivalent of aftermath grazing were obtained from small grain stubble in period two and from corn in period three.

The following is the designation of the three grazing periods:

Period one, May 10 to June 30;

Period two, July 1 to August 15; and

Period three, August 16 to September 30.

Labor

The representative farm assumed in this study was a family farm with operator and family labor available for farm use. The operator labor available for use in the planning models was 3,224 hours per year. Total hours of labor including that available from the family was 4,376 hours per year. There were 3,476 hours available for livestock and crop enterprises after 900 hours of overhead labor were deducted. The farm operator was assumed to have a high level of managerial ability with the capacity of inaugurating any farm plan specified by the linear programming model. Operator and family labor available for use by crop and livestock enterprises for each of the ten periods used in this study are shown in Table II. These ten periods are intended to be representative of the different seasonal rush periods of farm and ranch work in the Eastern Missouri Slope area of South Dakota. Hours of total labor available per month are shown in Table VII of Appendix A. The average dates for cropping operations in the study area are given in Table I of Appendix A. Table V of Appendix A gives the labor requirements for crop and livestock activities by period.

No restrictions were placed on the amount of labor that could be used. Additional labor could be hired in each of the ten periods at a cost of 2.00 dollars per hour as long as it remained profitable. The 2.00 dollar rate is considered to a competitive wage in the area at the present time.

Table II. Hours of Labor Available Per Period

Period	Dates	Operator Hours	Family Hours	Total Hours	Minus Overhead Hours	Hours for Enterprises
1	November 16-January 31	480	132	612	162	450
2	February 1-March 31	480	120	600	117	483
3	April 1-April 30	338	78	416	63	353
4	May 1-May 31	338	78	416	72	344
5	June 1-June 15	163	100	263	45	218
6	June 16-June 30	162	100	262	45	217
7	July 1-July 15	162	100	262	45	217
8	July 16-July 31	163	100	263	45	218
9	August 1-August 31	325	200	525	90	435
10	September 1-November 15	613	144	757	216	541
Total		3,224	1,152	4,376	900	3,476

Capital

The amount of capital available to the firm was unlimited if the return on its use was greater than the market rate of interest. Thus, capital could be borrowed as long as returns to the firm exceeded or were equal to the interest charge.

The capital requirements for the dryland planning models were broken down into five major types which are as follows: annual operating, period 2 operating, livestock facility, livestock animal, and crop machinery. The irrigation models added two more types of capital to the five already mentioned above. They were irrigation system and irrigation operating capital. Annual operating capital was assumed to be used for the entire year, and was charged an eight percent rate of interest. The second type of capital was period two or short term capital. This was borrowed for a time period of less than a year. The annual interest rate on this capital was 8 percent, but since repayment was made within the year, the effective rate was assumed to be 4 percent. A 6.5 percent interest rate was charged on the average investment in livestock facilities. An 8 percent interest rate was charged on the average investment in livestock animal, crop machinery, irrigation system, and irrigation operating capital. This is the approximate current market rate of interest charged in the study area.

A large portion of the total capital is tied up in the value of the land. The assumed price of the farm land was 70 dollars per acre for pasture, 150 dollars per acre for dryland cropland, and 185

dollars per acre for irrigable land. An interest rate of 7 percent was charged against this investment.

Buildings, Machinery, and Equipment

The average building investment required for livestock enterprises was allocated directly to each enterprise. Facilities for grain storage were assumed to be included in the value of the land. Average investment and operating costs for crop machinery were assumed to be current costs when machinery is fully utilized at a high level on farms in the area.

The assumed investment and operating cost requirements for crop machinery were developed from Determining Least-Cost Machinery Combinations.[19] The fixed costs included depreciation, interest, taxes, and insurance. The variable costs or operating costs included fuel, repairs, and lubrication. The depreciation[20] was calculated on the estimated useful life of the machines. Machinery and equipment costs which could not be allocated to a particular activity or on a per acre basis were included as overhead costs. Costs for pickups, trucks, and wagon would be examples.

This area is currently utilizing six and seven plow equipment. The use of six-plow equipment was assumed in this study. The assumed

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[19]Douglas H. Eidsvig and Carl E. Olson, Determining Least-Cost Machinery Combinations, Bulletin 479, Agricultural Experiment Station (North Dakota State University, Fargo, 1969).

[20]See Table VI in Appendix A.

fixed costs for six-plow machinery on a 1,600 acre farm in the study area are shown in Table III. The variable costs are given in Table IV.

It would be unlikely that all crop machinery on a farm would be new. Therefore, it was assumed that average crop machinery investment would be calculated at 55 percent of the new cost of machinery in use.

Livestock equipment costs were allocated on a use basis to the individual livestock enterprise. Investment and costs of special feeding equipment were charged directly to the enterprise requiring the equipment.

Overhead Costs

It was not possible to allocate certain costs to specific enterprises. These included such things as the farm pickup truck, fuel storage tank, wagon, tools, telephone expenses, farm records, and tax services. These non-allocated overhead costs which were assumed in this study are shown in Table II of Appendix A. There were also costs such as depreciation and maintenance of fences, taxes and insurance fo. land, and interest on land that could not be allocated to any specific enterprise. These charges on a per acre basis are given in Table III of Appendix A. These costs were deducted after the optimum program had been obtained.

Resource Restrictions

In summary, a listing of resource restrictions at their initial level is presented in Table V. Rows 72, 73, 74, and 75 each have three numbers. These three numbers for rows 72, 73, and 74 represent the

Table III. Fixed Costs for Six-Plow Machinery on a 1600 Acre Farm in Eastern Missouri Slope Area of South Dakota

	Cost[1]	Salvage Value[2]	Average Investment[3]	Annual Depreciation[4]	Interest[5]	Insurance[6]	Taxes[7]	Expected Life[8] (Years)	Total Fixed Costs
Tractor	$ 7,740.00	$ 774.00	$4,257.00	$ 696.60	$340.56	$17.80	$134.68	10	$1,189.64
Plow 6-16"	1,485.00	148.50	816.75	83.53	65.34	3.42	25.84	16	178.13
Cultivator 18 1/2'	1,305.00	130.50	717.75	65.25	57.42	3.00	22.71	18	148.38
Harrow 35'	625.00	62.50	343.75	28.13	27.50	1.44	10.88	20	67.95
Disk 16'	1,710.00	171.00	940.50	96.19	75.24	3.93	29.75	16	205.08
Chisel Plow 16'	1,080.00	108.00	594.00	69.43	47.52	2.48	18.79	14	138.22
Drill 16'	1,890.00	189.00	1,039.50	94.50	83.16	4.35	32.89	18	214.90
Swather 16'	3,000.00	300.00	1,650.00	270.00	132.00	6.90	52.20	10	461.10
Corn Planter 12-Row	4,212.00	421.20	2,316.60	252.72	185.32	9.69	73.29	15	521.02
Corn Cultivator 12-Row	2,034.00	203.40	1,118.70	114.41	89.50	4.68	35.39	16	243.98
Combine	12,500.00	1,250.00	6,875.00	1,125.00	550.00	28.75	217.50	10	1,921.25
Corn Head 2-Row	2,000.00	200.00	1,100.00	180.00	88.00	4.60	34.80	10	307.40
Truck	6,000.00	600.00	3,300.00	540.00	264.00	13.80	104.40	10	922.20
Pickup	3,200.00	320.00	1,760.00	576.00	140.80	7.36	55.68	5	779.84
Mower	600.00	60.00	330.00	36.00	26.40	1.38	10.44	15	74.22
Rake	630.00	63.00	346.50	37.80	27.72	11.45	10.96	15	77.93
Baler	1,890.00	189.00	1,039.50	170.10	83.16	4.35	32.89	10	290.50
Sprayer	3,000.00	300.00	1,650.00	337.50	132.00	6.90	52.20	8	528.64
Corn Head 4-Row	4,000.00	400.00	2,200.00	360.00	176.00	9.20	69.60	10	614.80
Corn Chopper 2-Row	3,500.00	350.00	1,925.00	315.00	154.00	8.05	60.90	10	537.95
Corn Chopper 3-Row	4,400.00	440.00	2,420.00	396.00	193.60	10.12	76.56	10	676.28
Forage Wagon	2,200.00	220.00	1,210.00	198.00	96.80	5.06	38.28	10	338.14
Hayliner	3,000.00	300.00	1,650.00	180.00	132.00	6.90	52.20	15	371.10
Stacker	1,000.00	100.00	550.00	60.00	44.00	2.30	17.40	15	123.70
Tractor 4-Plow	6,480.00	648.00	3,564.00	583.20	285.12	14.90	112.75	15	995.97

[1]Douglas H. Eidsvig and Carl E. Olson, Determining Least-Cost Machinery Combinations, Bulletin 479, Agricultural Experiment Station (North Dakota State University, Fargo, 1969).

[2]Ten percent of original cost.

[3]$\frac{\text{Original cost plus salvage value}}{2}$

[4]$\frac{\text{Original cost minus salvage value}}{\text{useful life}}$

[5]Interest is figured at 8% of the average investment.

[6]Insurance: 0.23% of the original cost of equipment.

[7]Taxes: 1.74% of the original cost of the equipment.

Source: Merlyn M. Dahl, and Wallace G. Aanderud, Machinery Costs--Own, Lease or Custom Hire, Extension Circular 644, Cooperative Extension Service (South Dakota State University, Brookings, 1968).

[8]G. H. Larson, C. E. Fairbanks, and F. C. Fenton, What It Costs to Use Farm Machinery, Bulletin 417, Agricultural Experiment Station (Kansas State University, Manhattan, 1960).

Table IV. Variable Costs Per Acre for Six-Plow Machinery on a 1,600 Acre Farm in the Eastern Missouri Slope Area, South Dakota

Item	Cost Per Acre	
	Dryland Farm	Irrigated Farm
Tractor	$ .18	$ .18
Plow 6 - 16"	.64	.64
Disk 16'	.31	.31
Field Cultivator 18½'	.33	.33
Harrow 35'	.30	.30
Corn Planter	.33	.33
Corn Cultivator	.33	.33
Corn Picker	2.55	2.55
Corn Chopper	1.90	2.90
Chisel Plow 16'	.35	.35
Drill 16'	.57	.57
Sprayer	.10	.10
Swather--small grain	.29	.29
Combine	1.09	1.36
Baler	1.08	1.62
Swather--alfalfa	1.08	1.62
Hayliner	.88	2.52
Stacker	1.70	4.86

Source: Douglas H. Eidsvig and Carl E. Olson, Determining Least-Cost Machinery Combination, Bulletin 479, Agricultural Experiment Station (North Dakota State University, Fargo, 1969).

Table V. Resource Restrictions Used in the Initial Tableau for Farm and Ranch Situations, Eastern Missouri Slope Area, South Dakota

Row	Item	Unit	Initial Level
01	Period One Labor	Man Hour	450
02	Period Two Labor	Man Hour	483
03	Period Three Labor	Man Hour	353
04	Period Four Labor	Man Hour	344
05	Period Five Labor	Man Hour	218
06	Period Six Labor	Man Hour	217
07	Period Seven Labor	Man Hour	217
08	Period Eight Labor	Man Hour	218
09	Period Nine Labor	Man Hour	435
10	Period Ten Labor	Man Hour	541
11	Total Operators Labor Available	Man Hour	3,476
12	Total Labor Hired	Man Hour	0
13	Total Labor Hired Available	Man Hour	Varies
15	Annual Operating Capital	Hundred Dollars	0
16	Period two Operating Capital	Hundred Dollars	0
17	Livestock Facilities Capital	Hundred Dollars	0
18	Livestock Animal Capital	Hundred Dollars	0
19	Crop Machinery Capital	Hundred Dollars	0
20	Irrigation Operating Capital	Hundred Dollars	0
21	Irrigation System Capital	Hundred Dollars	0
22	Dryland Corn to Harvest	Bushels	0
23	Irrigation Corn to Harvest	Bushels	0
24	Corn Equivalent	Bushels	0
25	Corn Silage	Cwt	0
26	Dryland Hay to Harvest	Cwt	0
27	Hay Equivalent	Cwt	0
28	Irrigation Hay to Harvest	Cwt	0
29	Class I--Cropland	Acre	718
30	Class II--Cropland	Acre	382
31	Flax Limit	Acre	275
32	Corn Sell Limit	Bushel	0
33	Grazing Period One	Ton Hay Equivalent	0
34	Grazing Period Two	Ton Hay Equivalent	0
35	Grazing Period Three	Ton Hay Equivalent	0
36	Native Limit	Acre	460
37	Improved Pasture Limit	Acre	320
38	Irrigation Improved Pasture Limit	Acre	320
39	Corn Feed Restriction	Bushel	0

Table V. (Continued)

Row	Item	Unit	Initial Level
40	Wheat Grow Limit	Acre	350
41	Sell Wheat Limit	Bushel	0
42	Barley Grow Limit	Acre	250
43	Sell Barley Limit	Bushel	0
44	Oats Grow Limit	Acre	275
45	Sell Oats Limit	Bushel	0
46	Calf Transfer	Head	0
47	Period One Yearling Transfer	Head	0
48	Period Two Yearling Transfer	Head	0
49	Gross Income Livestock	Dollars	0
50	Purchase Stockers and Feeders	Dollars	0
51	Livestock Expense	Dollars	0
52	Livestock Insurance and Taxes	Dollars	0
53	Gross Income Dryland Crops	Dollars	0
54	Dryland Fertilizer	Dollars	0
55	Dryland Operating Expenses	Dollars	0
56	Machinery Insurance and Taxes	Dollars	0
57	Crop Insurance	Dollars	0
58	Irrigation Insurance and Taxes	Dollars	0
59	Crop Machinery Depreciation	Dollars	0
60	Livestock Facility Depreciation	Dollars	0
61	Annual Operating Capital Interest	Dollars	0
62	Period Two Operating Capital Interest	Dollars	0
63	Livestock Facility Capital Interest	Dollars	0
64	Livestock Animal Capital Interest	Dollars	0
65	Crop Machinery Capital Interest	Dollars	0
66	Gross Income Irrigated Crops	Dollars	0
67	Irrigation Fertilizer	Dollars	0
68	Irrigation Operating Expenses	Dollars	0
69	Irrigation System Depreciation	Dollars	0
70	Irrigation Operating Interest	Dollars	0
71	Irrigation System Interest	Dollars	0
72	Tow Line Irrigation Limit	Acre	304
		Acre	608
		Acre	912
73	Center Pivot Irrigation Limit	Acre	276
		Acre	552
		Acre	828

Table V. (Continued)

Row	Item	Unit	Initial Level
74	Wheel Move Irrigation Limit	Acre	308
		Acre	616
		Acre	924
75	Irrigation Acreage Limit	Acre	320
		Acre	640
		Acre	960

maximum acreage that can be irrigated with the respective systems at the three different irrigation levels which are given in row 75.

Enterprise Alternatives

Crop and livestock production possibilities included in the linear programming models for this study are shown in Table VI. The crop and livestock activities allowed in the planning models were consistent with those found on farms in the Eastern Missouri Slope area of South Dakota. In this study, the terms enterprise, activity, production possibility and process were used interchangeably as only one activity or process was considered for each enterprise or production possibility.[21]

Crop Activities

Two yield levels were used for each of the crop activities because of the two land classes. Dryland yields were estimated from a linear regression analysis of a 20 year production history from each county in the study area. A t test was used to determine the significance of the results. The projected yields for each county were found to be significant at the 90 percent level.[22] These projected yields

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[21]Chester O. McCorkle, Jr., "Linear Programming as a Tool in Farm Management Analysis," Journal of Farm Economics, Vol. 37, No. 5, December, 1955, pp. 1226-1227.

[22]Michael J. Brennan, Preface to Econometrics, (Cincinnati: South-Western Publishing Company, 1960), pp. 303-312.

Table VI. Activities Included in the Linear Programming Model for Farm Crops and Livestock Enterprises in the Eastern Missouri Slope Area, South Dakota

Activity	Description	Unit of Measure
	Hire Labor	
101	Period One Labor	Hour
102	Period Two Labor	Hour
103	Period Three Labor	Hour
104	Period Four Labor	Hour
105	Period Five Labor	Hour
106	Period Six Labor	Hour
107	Period Seven Labor	Hour
108	Period Eight Labor	Hour
109	Period Nine Labor	Hour
110	Period Ten Labor	Hour
	Borrow Capital	
201	Annual Operating Capital	Hundred Dollars
202	Period Two Operating Capital	Hundred Dollars
203	Livestock Facilities Capital	Hundred Dollars
204	Livestock Animal Capital	Hundred Dollars
205	Crop Machinery Capital	Hundred Dollars
210	Irrigation Operating Capital	Hundred Dollars
211	Irrigation System Capital	Hundred Dollars
	Harvest Dryland Crops	
301	Harvest Corn	Ten Bushels
302	Harvest Corn Silage	Ton
303	Harvest Alfalfa	Ton
	Purchase and Sale of Crops	
304	Sell Corn	Ten Bushels
305	Sell Alfalfa	Ton
306	Buy Corn	Ten Bushels
307	Buy Alfalfa	Ton
308	Sell Wheat	Ten Bushels
309	Sell Barley	Ten Bushels
310	Sell Oats	Ten Bushels

Table VI. (Continued)

	Activity Description	Unit of Measure
	Transfer Sell Grain to Corn Equivalent	
314	Corn	Ten Bushels
318	Wheat	Ten Bushels
319	Barley	Ten Bushels
320	Oats	Ten Bushels
324	Surplus Disposal of Corn Restriction Limit	Ten Bushels
	Class I Cropland	
401	Corn	Acre
404	Oats	Acre
405	Flax	Acre
406	Wheat	Acre
408	Barley	Acre
409	Alfalfa	Acre
410	Oats-Alfalfa-Alfalfa-Alfalfa	Acre
	Class II Cropland	
501	Corn	Acre
504	Oats	Acre
505	Flax	Acre
506	Wheat	Acre
508	Barley	Acre
509	Alfalfa	Acre
510	Oats-Alfalfa-Alfalfa-Alfalfa	Acre
	Pasture	
549	Transfer Grazing From Period 2 to Period 3	Acre
550	Transfer Grazing From Period 1 to Period 2	Acre
551	Native Pasture	Acre
552	Improved Pasture	Acre
555	Tow Line Irrigation Improved Pasture	Acre
560	Center Pivot Irrigation Improved Pasture	Acre
570	Wheel Move Irrigation Improved Pasture	Acre
	Purchase and Sales of Livestock	
601	Buy Calves	Head
602	Buy Yearlings Period 1	Head
603	Buy Yearlings Period 2	Head
604	Sell Calves	Head

Table VI. (Continued)

Activity Description		Unit of Measure
Beef Cow		
621	Beef Cow and Calf	Cow-Calf
Feeding Calves		
623	Drylot Calves, No Silage	Head
624	Drylot Calves, Silage	Head
625	Pasture Calves, No Silage	Head
626	Pasture Calves, Silage	Head
Feeder Yearlings		
622	Raise Feeders, Pasture, No Silage	Head
628	Yearling Feeder, Transfer	Head
629	Raise Yearling Feeder	Head
631	Drylot Yearlings, Period One, No Silage	Head
632	Drylot Yearlings, Period One, Silage	Head
641	Drylot Yearlings, Period Two, No Silage	Head
642	Drylot Yearlings, Period Two, Silage	Head
661	Drylot Yearlings, Period One and Period Two, No Silage	Head
662	Drylot Yearlings, Period One and Period Two, Silage	Head

also fell within the range that the Plant Science Department at South Dakota State University is currently using. It was assumed that high level management could achieve the projected yields through the use of current technology. The regression projections are shown in Appendix C, Tables IX through XIV.

Irrigated yields used in the programming were arrived at by taking 65 percent and 35 percent of the anticipated irrigated crop yields on Class I and II land respectively. Under irrigation the aggregate production must be considered since it is impossible to break a large tract of irrigated land into small fields by classification and productivity. The yields assumed in this study are shown in Table VII.

Crop activities in this study were all a continuous crop sequence except for one rotation. Dryland crop enterprises were corn, oats, flax, wheat, barley, alfalfa, and an oats-alfalfa-alfalfa-alfalfa rotation. All of these crop activities either could be sold or used as feed with the exception of flax. Under irrigation soybeans were added to all of the above alternative enterprises. Allotments for wheat and feed grain were based on past history figures from the South Dakota Crop and Livestock Reporting Service along with the results of a survey taken by the Economics Department of South Dakota State University. From this information a wheat base of 350 acres and a feed grain base of 250 acres was established.

Table VII. Crop Yields Per Planted Acre by Class of Land, Eastern Missouri Slope Area, South Dakota

Crop	Unit	Dryland		Irrigation	
		Class I Land	Class II Land	Class I Land	Class II Land
Corn, Grain	Bushels	40.0	33.0	125.0	110.0
Corn, Silage	Ton	8.0	6.6	20.8	18.3
Soybeans	Bushels			35.0	30.0
Barley	Bushels	40.0	34.0	85.0	75.0
Oats	Bushels	50.0	43.0	110.0	95.0
Wheat	Bushels	27.0	23.0	60.0	53.0
Flax	Bushels	11.0	9.0	23.0	18.0
Alfalfa	Ton	1.6	1.4	6.0	5.1
Alfalfa Aftermath	T.H.E.[a]	0.07		0.35	
Rotation Pasture	T.H.E.	0.75			
Improved Pasture	T.H.E.	1.55			
Irrigation Improved Pasture	T.H.E.			3.8	

Source: Based on regression analysis and estimates by South Dakota State University Agronomy Department personnel meeting with personnel from the Bureau of Reclamation, November 21, 1968.

[a]Tons of Hay Equivalent is defined as 1/3 ton of hay = 1 AUM in Guidebook for Planning a Farm or Ranch Business by Wallace G. Aanderud, Myron T. Barber, and Merlyn M. Dahl.

Prices

Projected prices that could be received for these crops were established in consultation with marketing personnel in the South Dakota State University Economics Department. Future agricultural policy and production possiblilites were considered in the projection of these prices. Table IV of Appendix A shows the assumed prices received for crops and livestock as well as prices paid for inputs.

Budgets for Crop Production Enterprises

Activity budgets or cost and returns schedules were determined for each of the various activities to obtain the net effect on total farm returns associated with the operation of each of the activities.

Budget examples are given in Appendix B, Tables VI through XIV. Fuel, oil, grease, repairs, fertilizer, weed and insect chemicals, seed, and crop insurance were considered as variable costs. As noted above, the variable and fixed costs related to the machinery were derived from the Eidsvig and Olson study at North Dakota State University.[23] Costs for seed and crop insurance were established in consultation with personnel of the South Dakota State Economics Department. Requirements for fertilizer, herbicides, and insect controls were from Derscheid and Westin's Soil Atlas and Crop Production Guide.[24] Tables IV through VIII in Appendix C show data on fertilizer requirements application, and costs.

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[23]Douglas H. Eidsvig and Carl E. Olson, op. cit., p. 3.

[24]Fred Westin, op. cit., p. 14.

Livestock Activities

Livestock activities were restricted to beef production enterprises. Different management strategies were presented in the planning models. One group of planning models permitted the firm to purchase calves and yearlings. In the planning models defined as cow-calf operations, the purchase of feeder cattle was not permitted. These models reflect practices common among operators in the Eastern Missouri Slope area of South Dakota.

A total of 14 livestock activities was considered as production alternatives. A cow-calf enterprise assumed a 92 percent calf crop. Therefore a cow herd of one hundred cows would produce ninety-two calves. A 16 percent replacement rate was assumed with 20 heifer calves held back for replacements. Sixteen of the ninety-two calves became herd replacements with four of the calves held back being sold as cull heifers. Seventy-two calves were then available to be sold or transferred to other activities. These seventy-two calves were composed of forty-six steer and twenty-six heifers.

Calves produced by the cow-herd for sale in October either could be sold, enter a fattening activity, or be wintered in period two from October 15 to April 15. The cow-calf activity considered four alternatives. One activity produced feeder calves for sale on October 15. Another activity produced calves to be wintered on rations of corn and supplement grain plus alfalfa hay. They were then sold as 650 pound yearlings on April 15. The fourth cow-calf alternative was related to the third alternative. The 650 pound calves sold on April 15 could be transferred instead, and fed in drylot. Under this plan,

they would be fed a silage or corn grain ration at a rate sufficient to allow sale of a good to choice 1,050 to 1,100 pound steer on October 15.

The four calf feeding activities allow 425 pound steer calves to be bought October 15, wintered and fed in drylot. A ration of silage or corn grain plus alfalfa hay provided a 1,050 pound animal salable ten months later. Pasturing calves for five months was also considered as an alternative to straight drylot feeding.

Six yearling feeding enterprises were considered. Yearling steers weighing 650 pounds could be purchased in both periods one and two, April 15 to October 15 and October 15 to April 15. Slaughter steers were marketed at 1,100 pound in a good to choice grade. Representative budgets for six of the fourteen livestock enterprises selected by the computer as the optimum combination of livestock enterprises are shown in Tables I through V in Appendix B.

The prices paid and received for cattle were established in consultation with marketing and farm management personnel in the Economics Department at South Dakota State University. The prices assumed in the study are shown in Table IV of Appendix A. These prices reflect an estimate of future average prices that are based on conditions predicted to be consistent relative to present day prices.

Irrigation Systems

Three irrigation systems were considered in this study. The systems selected were tow line, center pivot, and wheel move. These three systems were selected because they represent the present day

trend in agriculture of substituting capital for labor. The systems represent three different levels of investment and labor requirements in relation to modern mechanical irrigation technology. The study assumed that each quarter section of land irrigated required an individual system. The adoption of irrigation at three different acreage levels was analyzed. These were 320, 640, and 960 acres. Data on irrigation investment, repairs, and annual fixed costs per acre for each system are shown in Tables I through III of Appendix C.

Tow Line

Of the three systems selected, the tow line has the lowest investment cost per acre. The system also has a relatively low annual operating cost. The tow line lateral system has fixed or swiveled two-wheeled carriages which support the sprinkler pipe at intervals of 40 to 60 feet. To move the lateral from one setting to the next it is end-towed by truck or tractor. Each lateral has sprinkler heads at regular intervals throughout its length. The sprinklers are placed on long risers, and outriggers are used to provide stability when irrigating tall crops such as corn. The tow line system will irrigate 154 acres out of 160 acres.[25]

Center Pivot

A center pivot, self-propelled continuously moving system has a lateral pipeline which is anchored at the center of the irrigated area and swings like a huge clock hand around its full circle. This

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[25]Norman M. Fischer, op. cit., p. 43.

system does not irrigate the corners of fields since the shape of the area irrigated is circular. Thus, a 160 acre system only irrigated 138 acres.[26] Water is introduced into the lateral at the center from either a well, irrigation canal, or stream.[27]

Sprinklers varying in type, nozzle size, and discharge capacity are spaced at intervals along the lateral with the largest discharge at the furthest point from the pivot where the field area to be irrigated is larger.[28] The design is such that uniform water distribution occurs along the lateral.

Speed of this sprinkler rotation can be varied so that from 15 hours to 7 days are required to complete one revolution. The slower the lateral rotation, the greater the depth of water applied. The depth of water applied is determined by a combination of sprinkler nozzle size, nozzle pressure, spacing of sprinklers on the lateral, and speed of rotation.

The center pivot, self-propelled lateral systems move along on wheels, crawler tractor tracks, or skids. Wheel versions are powered by water-driven, hydraulic cylinders, rotating arm type sprinklers or electric motors. The skid type is pushed forward by a hydraulic-powered walking foot.

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[26]F. F. Kerr, "Selecting Your Irrigation Systems: Comparing Five Common Types," Fact Sheet 332, Cooperative Extension Service (South Dakota State University, Brookings, 1967), p. 2.

[27]Norman M. Fischer, op. cit., p. 43.

[28]Ibid.

The lateral pipeline in most center pivot, self-propelled systems is rigid pipe, but one system has flexible joints at each support point which permits satisfactory operation on uneven terrain. All systems have built-in safety devices that stop the lateral if a section gets out of alignment.[29]

Wheel Move

The wheel move irrigation system is sometimes called the side-move tow sprinkler system. The wheel move system requires a capital investment between that of the tow line and center pivot. Its labor requirements are greater than those of the center pivot and less than the tow line.

The wheel move system was developed to place the sprinkler above tall-growing crops such as corn.[30] The main lateral pipeline is supported at 50 to 60 foot intervals with a two-wheeled carriage arrangement. Each wheel is powered from a line shaft by a belt, chain drive, or gear. The line shaft power is a small 6 to 10 horsepower gasoline engine located at the middle of the lateral.[31] Another version uses electric motors to move sections of the line shaft.

Quick opening automatic valves are installed along the lateral to drain water from the system before moving.[32] Trailing pipelines

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[29]Guy O. Woodward, Sprinkler Irrigation, (Santa Monica: Sprinkler Irrigation Association, 1959), p. 14.

[30]Ibid.

[31]Ibid., p. 15.

[32]Ibid.

varying in diameter from 1 to 2 inches are used on some systems. The lateral and trailer lines are moved simultaneously by a power unit. From one to seven sprinklers are mounted on each trailer line making the seven-sprinkler trailer line system equivalent to eight hand-move laterals.[33]

Stabilizers are used on the trailer lines to keep sprinkler heads vertical and improve water distribution. Stabilizers may be attached to the sprinkler-head risers or on the trailer line itself.

When it comes time to transport the wheel move system from one field setting to another, adjustable carriage wheels or an extra set of wheels, allow it to be end-towed, using a truck or tractor. Tractor pipelines are loaded on an attached rack or carriage for the moving process.[34] This system irrigates 156 acres out of a quarter section.[35]

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[33] Ibid.

[34] Ibid., p. 16.

[35] F. F. Kerr, op. cit., p. 2.

CHAPTER III

ANALYSIS AND COMPARISON OF DRYLAND PLAN AND PARTIALLY IRRIGATED PLANS

The purpose of this chapter is to compare a dryland farming situation with three successively higher intensities of irrigation. A dryland farming situation is compared with farm organizations including 320, 640, and 960 irrigated acres. In each case, comparisons are also made between irrigation systems. In the first case, the dryland farm is compared with one in which 320 acres are irrigated using each of the three irrigation systems. Then, in the second and third cases, planning models permitting 640 and 960 irrigated acres are compared to 320 and 640 irrigated acres respectively.

A special analysis was made using the planning model permitting 960 irrigated acres. In this analysis, the firm was given the option of selecting a combination of three irrigation systems in a fourth irrigation planning model. Each type of system was given the option to irrigate 320 acres in this specific planning model.

The changes that occur in the mix of farm enterprises when the firm moves from dryland farming to successively higher levels of irrigated acres is the main purpose considered here. Also considered is the influence of the three different irrigation systems on the mix of farm enterprises. None of the planning models were permitted to purchase feed grain and forage. The purpose of this was to determine the extent to which each of the planning models could support livestock feeding.

The optimum solution of the dryland planning model was determined first. A linear programming solution was obtained maximizing net returns on the 1,600 acre representative farm. Solutions were then obtained for the same farm with 320 acres, 640 acres, and 960 acres of irrigation.

Comparison of Dryland Planning Model and Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

The linear programming solutions for the four planning models (dryland, tow line, wheel move, and center pivot) are given on the following pages. The analysis yielded information on the optimum land use, crop production, livestock organization, labor and capital requirements, expenses, and financial statements.

Land Use Plans

The activities selected for the optimum land use are presented in Table VIII. The total acres of crops along with the total crop production are given in Table IX. All crops raised in the four planning models were used to provide feed grain to satisfy the feeding requirements for the livestock enterprises. Optimum crop organizations were altered to some extent with the adoption of irrigation. The only major alteration among the organization of crops was a decrease in wheat production from 294.2 acres (dryland) to 34.7 acres (tow line), 31.1 acres (wheel move), and 60.0 acres (center pivot) at the 320 acre irrigation level. Barley production increased from 0 acres in the dryland planning model to 250 acres in the 320 and 640 acre irrigation

Table VIII. Optimum Land Use for Dryland Planning Model and the Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

Activities	Unit	Dryland Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Dryland Crops					
Class I Land					
Corn	Acre	448.8	235.7	236.7	228.6
Wheat	Acre	269.2	34.7	31.1	60.0
Barley	Acre	-----	250.0	250.0	250.0
Class II Land					
Alfalfa	Acre	357.0	275.6	274.2	285.4
Wheat	Acre	25.0	-----	-----	-----
Total Dryland Acres		1,100.0	796.0	792.0	824.0
Irrigated Crops					
Corn	Acre	-----	237.5	240.3	217.7
Alfalfa	Acre	-----	66.5	67.7	58.3
Total Irrigated Acres			304.0	308.0	276.0
Pasture					
Native	Acre	137.9	136.8	136.8	136.9
Improved	Acre	320.0	320.0	320.0	320.0
Feed Lot	Acre	2.1	3.2	3.2	3.1
Total	Acre	460.0	460.0	460.0	460.0

Table IX. Total Acres of Crops and Crop Production in Dryland Planning Model and Irrigation Planning Model with the Adoption of Irrigation at the 320 Acre Level

Item	Unit	Dryland Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Total Acres of Crops					
Corn	Acre	448.8	473.2	477.0	446.3
Wheat	Acre	294.2	34.7	31.1	60.0
Barley	Acre	-----	250.0	250.0	250.0
Alfalfa	Acre	357.0	342.1	341.9	343.7
Total	Acre	1,100.0	1,100.0	1,100.0	1,100.0
Grain and Forage Production					
Corn	Bushels	12,206	28,437	28,775	26,070
Wheat	Bushels	7,844	868	777	1,500
Barley	Bushels	-----	10,000	10,000	10,000
Corn Silage	Tons	1,149	1,885	1,893	1,829
Alfalfa Hay	Tons	500	764	767	730

planning models. The increase in barley production was needed to satisfy the balance of the feed requirements. As barley had a greater yield per acre than wheat, it met the grain supplement ration easier causing the shift from wheat to barley.

Under the intensive feeding operation with irrigation, total production of corn and alfalfa increased sufficiently to meet feed requirements. In the transition from dryland to irrigation the number of acres of alfalfa decreased although the production of alfalfa hay increased. A total of 500 tons of alfalfa was produced in the dryland planning model. The adoption of irrigation brought about an additional increase of 264 tons, 267 tons, and 230 tons in the tow line, wheel move, and center pivot planning models respectively. A total of 448.8 acres of corn was raised in the dryland model. With the adoption of irrigation, an increase in the total acres of corn raised occurred in the tow line and wheel move models while a slight decrease occurred in the center pivot planning model. A total of 473.2 acres (tow line) and 477.0 acres (wheel move) of corn was raised which was an increase of 24.4 acres and 28.2 acres respectively over the dryland planning model. The center pivot model raised 446.3 acres of corn which was 2.5 acres less than the dryland model. The number of acres of dryland corn in the irrigation model were 235.7 acres (tow line), 236.7 acres (wheel move), and 228.6 acres (center pivot) while 237.5 acres, 240.3 acres, and 217.7 acres were irrigated in the respective models. A total of 12,206 bushels of corn and 1,149 tons of corn silage was produced in the dryland model. Corn production in bushels increased to 28,437 in the tow line model, 28,775 in the wheel

move model, and 26,070 in the center pivot model. Corn silage increased by an additional 736 tons (tow line), 744 tons (wheel move), and 680 tons (center pivot) over the dryland model which amounted to a total of 1,885 tons, 1,893 tons, and 1,829 tons in the respective models.

Livestock Plans

The enterprises selected for the optimum livestock plan are shown in Table X. The feeding of livestock was the predominant enterprise in the planning models. A total of 914 head of livestock composed of 653 calves and 261 period 2 (October 15 to April 15) yearlings was purchased and fed in the dryland planning model. The most popular feeding enterprise was that of feeding calves. In the dryland planning model 336 head of calves were wintered on a high roughage ration, grazed through the summer and sold at 800 pounds. The remaining 317 head of calves were wintered on a light grain ration for six months before 261 head were transferred to drylot in period 1 (April 15 to October 15) to be fed out on a silage ration and sold for slaughter on October 15. The 261 head of purchased yearling feeders were also fed a silage ration in the same drylot activity during period 2 (October 15 to April 15) and sold for slaughter on April 15. The remaining 56 head of purchased calves were raised to yearling feeders and sold April 15 at 650 pounds.

In making the transition from the dryland planning model to a partially irrigated planning model, the feeding of calves continued to be the most popular enterprise. A total of 976 calves (tow line),

Table X. Optimum Livestock Enterprises for Dryland Planning Model and the Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

Livestock Activity	Unit	Dryland Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	336	306	306	310
Buy Calves, October, Winter on Light Grain Ration, Sell 650 Pound Feeders in April	Head	56	241	247	205
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	261	429	430	415
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	261	429	430	415
Total Calves Purchased	Head	653	976	983	931
Total Feeders Purchased	Head	261	429	430	415

983 (wheel move), and 931 calves (center pivot) was purchased. This was an increase of 323 head, 330 head, and 278 head of calves on feed above that of the dryland model. The total feeders purchased in period two (October 15 to April 15) were 429 head (tow line), 430 head (wheel move), and 415 head (center pivot). This amounted to an increase of 168 head, 169 head, and 154 head over that of feeders on feed during period two in the dryland model.

In the irrigation models a slight decrease in raising feeders on pasture was experienced. The decrease amounted to 30 head, 30 head, and 26 head for tow line, wheel move, and center pivot respectively. This slight decrease was attributed to the profitability of the grain ration feeding over the less efficient pasture. The raising of calves at this level in the respective models was done to fully utilize the pasture resource.

As an irrigation farmer, the ability to raise an adequate and stable feed supply brought about a relatively intensive feeding operation. A total of 670 calves (tow line), 677 calves (wheel move), and 620 calves (center pivot) was fed a light grain ration for six months before 429 head, 430 head, and 415 head respectively were transferred to drylot for period one and fed out to slaughter weight on a silage ration and sold on October 15. The same number of yearling feeders are fed in the respective models in this drylot activity during period 2. The remaining 241 head, 247 head, and 205 head of calves raised to yearling feeders in the respective models were sold at 650 pounds on April 15.

There appears to be a direct relationship between the number of acres irrigated and the number of cattle on feed in the respective models. The wheel move model irrigated the greatest number of acres and therefore has the greatest feed supply. Thus it has the greatest number of cattle on feed. The tow line and center pivot in that order have the next greatest feeding capacity.

Labor

Available operator and family labor was fully utilized in all four planning models. A summary of how operator and hired labor was used in each period is given in Table XI.

The dryland model hired labor in every period except six, eight, and nine. These periods are June 16 to June 30, July 16 to July 31, and August 1 to August 31 respectively. The total labor hired was 2,462 hours. Demand for hired labor varied seasonally. Period one, November 16 to January 31, in which feeding cattle is the predominant activity demanded nearly one full-time man. Period two and three demanded only part-time help equivalent to one-half and one-quarter men respectively. Planting of corn in period four, May 1 to May 31, required one full-time man. The hay season in period five and seven each demanded one and one-half men. Period ten, September 1 to November 15, was the period when the largest amount of labor was hired. This was attributed to the higher labor demands for harvesting corn and corn silage.

A total of 4,251 hours (center pivot), 4,572 hours (wheel move), and 4,667 hours (tow line) had to be hired with the adoption of

Table XI. Operator and Family Labor and Labor Hired by Period for Planning Models

Model Farms — Period:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
	Total Man Hours of Operator and Family Labor Available										
	450	483	353	344	218	217	217	218	435	541	3,476
Dryland											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	363	239	80	288	310	---	299	---	---	883	2,462
Total Labor	813	722	433	632	528	217	516	218	435	1,424	5,938
Irrigation: 320 Acres											
Tow Line											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	822	605	167	454	400	105	382	110	132	1,490	4,667
Total Labor	1,272	1,088	520	798	618	322	599	328	567	2,031	8,143
Wheel Move											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	829	611	167	412	401	65	398	53	133	1,503	4,572
Total Labor	1,279	1,094	520	756	619	282	615	271	568	2,044	8,048
Center Pivot											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	773	566	168	381	372	31	361	62	128	1,409	4,251
Total Labor	1,223	1,049	521	725	590	248	578	280	563	1,950	7,727

irrigation at the 320 acre level. This was an increase of 1,789 hours (center pivot), 2,110 hours (wheel move), and 2,205 hours (tow line) over that hired in the dryland planning model. This was a percentage increase of 72.6 percent, 85.7 percent, and 89.5 percent respectively.

In the irrigation planning models, labor was hired in all ten periods. Period two and four, February 1 to March 31 and May 1 to May 31, demanded slightly more than one full-time man. Periods one, five, and seven, November 16 to January 31, June 1 to June 15, and July 1 to July 15, required just slightly less than two full-time employees. In period one the additional demand for labor can be attributed to the more intensified feeding operation while the increased yields from alfalfa due to irrigation were the main reasons for the increased labor requirements in period five and seven. In the dryland model no hired labor was needed in periods six, eight, and nine. Period six and eight, June 16 to June 30 and July 16 to July 31, which is the prime time for irrigating required part-time help. A third crop of alfalfa made possible by the adoption of irrigation also required some part-time help in period nine. Period ten was again the period that required the most hired labor. Nearly three full-time men were required. The increase in labor requirements in period ten can be attributed to harvesting the increased total production of corn and corn silage resulting from irrigation.

Capital

Table XII gives the individual capital requirements, total annual capital, and total capital requirements. Since all the planning models are oriented towards a feeding operation, the biggest component of total annual capital is capital for the purchase of livestock. Livestock animal capital required $123,010 in the dryland planning model which was 56.6 percent of total annual capital. In the irrigation planning models, capital for the purchase of livestock amounted to $176,268 in the tow line model, $177,003 in the wheel move model, and $171,136 in the center pivot model. This was approximately one half (50.6 percent in tow line, 49.6 percent of wheel move, and 49.5 percent of center pivot) of the total annual capital in the respective models.

Total annual capital requirements for the dryland model were $217,078. The adoption of irrigation at the 320 acre level increased the annual capital required to $348,221 (tow line), $354,786 (wheel move), and $345,565 (center pivot). This was a percentage increase of 60.4 percent, 63.4 percent, and 59.1 percent for the respective irrigation models. It should be pointed out that capital requirements for the wheel move system are greater because a greater number of acres are being irrigated with this system, thus a greater feed supply is provided and more feeder cattle are purchased and fed.

The annual operating capital needed in the dryland model was $26,796. With the adoption of irrigation at the 320 acre level, annual operating capital requirements increased by an additional $12,096

Table XII. Total Annual Capital and Types of Capital Required for Dryland Planning Model and Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

Capital	Dryland	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Annual Operating	$ 26,796.00	$ 38,892.80	$ 38,794.10	$ 37,381.70
Period 2 Operating	6,103.00	9,611.30	9,678.80	9,139.60
Livestock Facility	46,975.00	76,566.90	77,074.20	73,023.10
Livestock Animal	123,010.00	176,268.80	177,003.50	171,136.50
Crop Machinery	14,194.00	15,820.20	16,506.90	15,651.10
Irrigation Operating		6,602.70	8,080.30	8,836.50
Irrigation System		24,458.30	27,648.20	30,396.60
Total Annual Capital	$217,078.00	$348,221.00	$354,786.00	$345,565.10
Land Capital:				
Dryland	168,000.00	120,000.00	120,000.00	120,000.00
Irrigable		59,200.00	59,200.00	59,200.00
Pasture	33,600.00	33,600.00	33,600.00	33,600.00
Total Land Capital	$201,600.00	$212,800.00	$212,800.00	$212,800.00
TOTAL CAPITAL REQUIRED	$418,678.00	$561,021.00	$567,586.00	$558,365.10

(tow line), $11,998 (wheel move), and $10,585 (center pivot) above those of the dryland model. Period two capital increased from $6,103 for dryland to $9,611 for towline, $9,678 for wheel move, and $9,139 for center pivot. Livestock facility capital increased from $46,975 (dryland) to $76,566 (tow line), $77,074 (wheel move), and $73,023 (center pivot). Capital requirements for crop machinery increased the least of all capital requirements. Capital needed for crop machinery was $14,194 in the dryland model. The greatest increase in crop machinery capital was in the case of the wheel move model. An increase of $2,315.90 was required. The center pivot and tow line planning models required only $1,457.10 and $1,626.20 increases respectively.

Irrigation operating capital was $6,602 (tow line), $8,080 (wheel move), and $8,836 (center pivot). Capital for irrigation systems amounted to $24,458 for tow line, $27,648 for wheel move, and $30,396 for center pivot. Center pivot had the greatest capital requirements because of its higher investment per acre and higher variable costs per acre in relation to the other systems.

Fixed investment in land amounted to $201,600 in the dryland model. The land investment in the irrigation models was $212,800 which was approximately 38 percent of the total capital required. The total capital required for the dryland model amounted to $418,678. The adoption of irrigation at the 320 acre level increased this requirement to $561,021 (tow line), $569,586 (wheel move), and $558,365 (center pivot).

Expenses

A breakdown of the different expense components in the dryland and irrigation planning models (320 acres) are presented in Table XIII. Total crop and livestock expenses for the dryland model were $211,009. With the initiation of irrigation at the 320 acre level, total expenses increased to $329,583 under tow line, $333,245 under wheel move, and $320,374 under center pivot. The purchase of livestock makes up the greatest percentage of total expenses. The total livestock expenses for the dryland planning model were $163,751. The adoption of irrigation brought about an additional total livestock expense of $78,484, $88,390, and $89,848 under center pivot, wheel move, and tow line, respectively.

The dryland crop expenses amounted to $19,454. The total crop expense involved in the transition from dryland to irrigation increased by $10,310 (tow line), $11,293 (center pivot), and $11,442 (wheel move) above those in the dryland model. The two major components making up the increase were variable operating and fertilizer expenses. Total variable operating expenses increased from $7,942 in the dryland model to $12,887 (tow line), $13,144 (wheel move), and $13,942 (center pivot) which were 62.1 percent, 65.4 percent, and 75.5 percent increases, respectively. The requirements for fertilizer increase greatly with the increased demand for plant food under irrigation. Irrigation at the 320 acre level requires an increase in fertilizer expenses within the range of $3,318 to $2,793 above that of the dryland planning model. Dryland fertilizer expense amounted to $8,369.

Table XIII. Summary of Expenses on the Dryland Planning Model and the Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

Expenses	Dryland	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Livestock				
Purchase Livestock	$140,747.00	$217,682.83	$218,943.78	$208,874.48
Operating Expense	19,761.00	29,259.74	29,386.99	28,370.78
Insurance and Taxes	3,243.00	5,199.15	5,228.99	4,990.67
Total Livestock Expenses	$163,751.00	$252,141.72	$253,559.76	$242,235.93
Crops				
Dryland Operating	$ 7,942.00	$ 5,953.83	$ 5,931.74	$ 6,096.85
Irrigation Operating		6,923.29	7,213.08	7,845.42
Total Variable Expenses	$ 7,942.00	$ 12,877.12	$ 13,144.82	$ 13,942.27
Dryland Fertilizer	$ 8,369.00	$ 6,287.02	$ 6,272.24	$ 6,390.23
Irrigation Fertilizer		5,816.16	5,890.40	5,297.55
Total Fertilizer Expense	$ 8,369.00	$ 12,103.18	$ 12,162.64	$ 11,687.78
Insurance and Taxes-Machinery	$ 701.00	$ 721.28	$ 721.73	$ 718.15
Insurance and Taxes-Irrigation		936.26	1,724.74	1,379.91
Crop Insurance	2,442.00	3,126.96	3,142.39	3,019.17
Total Insurance and Taxes	$ 3,143.00	$ 4,784.50	$ 5,588.86	$ 5,117.23
Total Crop Expenses	$ 19,454.00	$ 29,764.80	$ 30,896.32	$ 30,747.28
Total Hired Labor	$ 4,926.00	$ 9,336.00	$ 9,142.00	$ 8,502.00

Table XIII. (Continued)

Expenses	Dryland	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Depreciation				
Crop Machinery	$ 2,529.00	$ 2,803.46	$ 2,806.65	$ 2,781.11
Livestock Facility	3,934.00	6,165.94	6,200.49	5,924.56
Irrigation System		3,137.08	3,640.42	3,998.97
Total Depreciation	$ 6,463.00	$ 12,106.48	$ 12,647.56	$ 12,704.64
Interest				
Annual Operating	$ 2,143.00	$ 3,111.42	$ 3,103.52	$ 2,990.53
Period 2 Operating	244.00	384.45	387.15	365.58
Livestock Animal	9,840.00	14,101.50	14,160.28	13,690.92
Livestock Facility	3,053.00	4,976.85	5,009.82	4,746.49
Crop Machinery	1,135.00	1,265.61	1,480.55	1,252.08
Irrigation Operating		528.21	646.42	706.92
Irrigation System		1,956.66	2,211.85	2,431.73
Total Interest	$ 16,415.00	$ 26,234.70	$ 26,999.59	$ 26,184.25
TOTAL EXPENSES	$211,009.00	$329.583.70	$333.245.23	$320,374.10

Hired labor expenses increased from $4,926 in the dryland plan to $8,502 in the center pivot plan, $9,142 in the wheel move plan, and $9,336 in the tow line plan. The additional labor expenses can be attributed to four significant changes in activities. They are the increased feeding operation, a third hay crop, labor for irrigation, and the increased yields due to the adoption of irrigation.

Depreciation expenses in the irrigation planning models increased from $6,463 (dryland) to $12,106 (tow line), $12,647 (wheel move), and $12,704 (center pivot). Crop machinery depreciation increased slightly while livestock facility and irrigation system depreciation made up the greatest percentage increase. Livestock facility depreciation increased from $3,934 (dryland) to $6,165 (tow line), $6,200 (wheel move), and $5,924 (center pivot) which was a 35.0 percent, 34.5 percent, and 30.7 percent increase respectively. Irrigation system depreciation amounted to $3,137 for tow line, $3,640 for wheel move, and $3,998 for center pivot.

Interest expenses increased from $16,415 (dryland) to $26,234 (tow line), $26,999 (wheel move), and $26,184 (center pivot). This amounts to an increase of 59.8 percent, 64.4 percent, and 59.5 percent above that in the dryland model respectively. The components making up the largest amount of the interest were livestock animal and facility interest due to the more intensive feeding operation. The added interest for irrigation operating and systems amounted to $2,484 (tow line), $2,858 (wheel move), and $3,138 (center pivot) which amounted to 31.9 percent, 27.0 percent, and 32.1 percent of the total interest increase respectively.

Financial Statements

Table XIV provides a summary of the operating statements and comparison of returns to dryland and irrigated farms in the Eastern Missouri Slope area of South Dakota. Total enterprise returns were $37,742.00 for dryland, $51,325.52 for tow line, $49,677.53 for wheel move, and $46,469.54 for center pivot. The enterprise returns figures were the returns available to cover the non-allocated costs not considered in the planning models. These costs amounted to $20,537 for the dryland planning model and $21,481 for the irrigation planning models. The final returns attributable to farm management and labor were $17,205.00 (dryland), $29,844.52 (tow line), $28,196.53 (wheel move), and $24,988.54 (center pivot), which were the remainder after the deduction of the costs not considered in the planning models. Paying the operator and family two dollars an hour for their labor amounted to $8,752 in each model. The returns to farm management then varied from $8,453 on the dryland planning model to $21,092.52 on the tow line planning model, $19,444.53 on the wheel move planning model, and $16,236.54 on the center pivot planning model.

The percentage increases in irrigated returns to farm management over the dryland returns were 149.5 percent, 130.0 percent, and 92.0 percent respectively for tow line, wheel move, and center pivot.

Table XIV. Operating Statement and Comparison of Returns to Dryland and Irrigation Planning Models with the Adoption of Irrigation at the 320 Acre Level

Item		Dryland	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Gross Income		$248,751.00	$380,909.22	$382.922.76	$366,843.64
Expenses[1]					
Livestock	$163,751.00		$252,141.72	$253,559.76	$242,235.93
Crops	19,454.00		29,764.80	30,896.32	30,747.28
Hired Labor	4,926.00		9,336.00	9,142.00	8,502.00
Depreciation	6,463.00		12,106.48	12,647.56	12,704.64
Interest	16,415.00		26,234.70	26,999.59	26,184.25
Total Expenses		211,009.00	329,583.70	333,245.23	320,374.10
Enterprise Returns		$ 37,742.00	$ 51,325.52	$ 49,677.53	$ 46,469.54
Overhead Expenses[2]					
Non-Allocated Costs	2,425.00		$ 2,425.00	$ 2,425.00	$ 2,425.00
Interest on Land	14,112.00		14,896.00	14,896.00	14,896.00
Land Taxes	3,200.00		3,360.00	3,360.00	3,360.00
Depreciation of Fences	800.00		800.00	800.00	800.00
Total Overhead Expenses		20,537.00	21,481.00	21,481.00	21,481.00
RETURNS TO LABOR AND FARM MANAGEMENT		$ 17,205.00	$ 29,844.52	$ 28,196.53	$ 24,988.54

Table XIV. (Continued)

Item	Dryland	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Operator and Family Labor[3]				
Enterprise	6,952.00	6,952.00	6,952.00	6,952.00
Overhead	1,800.00	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 8,453.00	$ 21,092.52	$ 19,444.53	$ 16,236.54

[1]See Table XII.
[2]See Appendix A, Tables II and III.
[3]$2.00 per hour charge for operator and family labor.

Comparison of Selected Irrigation Systems at the 640 Acre Level vs. Irrigation at the 320 Acre Level

In this section of the study, an analysis of the planning models adopting irrigation at the 640 acre level was made. This was compared with the results of irrigation at the 320 acre level. The analysis yielded information on land use, crop production, livestock organization, labor and capital requirements, and expenses. Other than the restriction that corn and alfalfa buying were not permitted, all other activities were included in the tow line, wheel move, and center pivot planning models at the 640 acre level. The results are given on the following pages.

Land Use Plans

The results of the optimum land use for irrigation at the 640 acre level are given in Table XV. Table XVI shows the grain and forage production along with the total acres of each crop. All crops raised in the 640 acre irrigation planning models were used to satisfy the feeding requirements as was the case in the 320 acre irrigation planning models.

There was no wheat production in the irrigation planning models at the 640 acre level compared to 34.7 acres (tow line), 31.1 acres (wheel move), and 60.0 acres (center pivot) at the 320 acre irrigation level. Barley production continued at the 250.0 acre level as it was in the 320 acre irrigation planning models. Total corn acreage amounted to 541 acres (tow line), 541.9 acres (wheel move), and 534.4 acres (center pivot) at the 640 acre irrigation level. Of this total

Table XV. Optimum Land Use for Planning Models with the Adoption of Irrigation at the 640 Acre Level

Activities	Unit	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Dryland Crops				
Class I Land				
Corn	Acre	72.8	67.6	109.2
Barley	Acre	250.0	250.0	250.0
Class II Land				
Alfalfa	Acre	169.2	166.4	188.8
Total Dryland Acres		492.0	484.0	548.0
Irrigated Crops				
Corn	Acre	468.2	474.3	425.2
Alfalfa	Acre	139.8	141.7	126.8
Total Irrigated Acres		608.0	616.0	552.0
Pasture				
Native	Acre	135.6	135.6	135.8
Improved	Acre	320.0	320.0	320.0
Feed Lot	Acre	4.4	4.4	4.2
Total	Acre	460.0	460.0	460.0

Table XVI. Total Acres of Crops and Crop Production in Planning Models with the Adoption of Irrigation at the 640 Acre Level

Item	Unit	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Total Acres of Crops				
Corn	Acre	541.0	541.9	534.4
Barley	Acre	250.0	250.0	250.0
Alfalfa	Acre	309.0	308.1	315.6
Total	Acre	1,100.0	1,100.0	1,100.0
Grain and Forage Production				
Corn	Bushels	44,463	44,848	41,768
Barley	Bushels	10,000	10,000	10,000
Corn Silage	Ton	2,516	2,533	2,399
Alfalfa	Ton	1,031	1,038	984

468.2 acres, 474.3 acres, and 425.2 acres for the respective models were irrigated while the remaining 72.8 acres (tow line), 67.6 acres (wheel move), and 109.2 acres (center pivot) were raised on dryland Class I cropland. The wheel move planning model had a total of 1,038 tons of alfalfa from 308.1 acres. A total of 141.7 acres was irrigated while 166.4 acres were raised on dryland from Class II cropland. The tow line model's production was just slightly less. A total of 1,031 tons was raised from 309.0 acres. Of this total 139.8 acres were irrigated with the balance (169.2) coming from dryland Class II cropland. The center pivot model had the largest acreage of alfalfa but the smallest production in tons. The center pivot's acreage production under irrigation was the smallest of the three models. A total of 126.8 acres was irrigated while 188.8 acres came from the Class II cropland.

Irrigation at the 640 acre level brought about an increase in the feed supply that amounted to approximately 38 percent above that of the 320 acre irrigation level. Corn production in bushels increased to 44,463 bushels (tow line), 44,848 bushels (wheel move), and 41,768 bushels (center pivot) at the 640 acre level from 28,437 bushels, 28,775 bushels, and 26,070 bushels for the respective models at the 320 acre level. The total acres of corn increased by 67.8, 64.9, and 88.1 acres. The great increase in bushels of corn was due to the additional acres of corn under irrigation which amounted to 468.2 acres (tow line), 474.3 acres (wheel move), and 425.2 acres (center pivot) in the 640 acre irrigation models while only 237.5 acres (tow line), 240.3 acres (wheel move), and 217.7 acres (center pivot) were irrigated in the 320 acre irrigation models. Production of silage increased from

1,885 tons, 1,893 tons, and 1,829 tons at the 320 acre irrigation level to 2,516 tons, 2,533 tons, and 2,399 tons at the 640 acre irrigation level for the tow line, wheel move, and center pivot respectively. Barley production in both acres and bushels remained constant at both irrigation levels. There was an inverse relationship in regard to alfalfa production. At the 640 acre irrigation level, less acres of alfalfa were raised but a larger total production in tons was experienced. The reason for this was that more acres of alfalfa were produced under irrigation. The pasture was fully utilized at both the 320 acre and 640 acre irrigation levels.

Livestock Plans

The optimum livestock plans for irrigation at the 640 acre level are presented in Table XVII. A total of 1,321 calves (tow line), 1,329 calves (wheel move), and 1,261 calves (center pivot) was purchased. This amounted to 345 calves, 346 calves, and 330 calves more than were purchased and fed in the 320 acre irrigation models respectively. The purchase of period 2 feeders increased to 572 head (tow line), 576 head (wheel move), and 545 head (center pivot) from 429 head, 430 head, and 415 head for the respective models.

A total of 284 calves, 283 calves, and 287 calves for tow line, wheel move, and center pivot respectively were raised on pasture for 12 months with roughage ration during the winter. The calves were marketed weighing 800 pounds on October 15. This was a slight decrease in this activity compared to the 320 acre irrigation level. A total of 306 head, 306 head, and 310 head was in this activity at the 320 acre

Table XVII. Optimum Livestock Enterprises for Planning Models with the Adoption of Irrigation at the 640 Acre Level

Livestock Activity	Unit	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	284	283	287
Buy Calves, October, Winter on Light Grain Ration, Sell 650 Pound Feeders in April	Head	465	470	429
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	572	576	545
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	572	576	545
Total Calves Purchased	Head	1,321	1,329	1,261
Total Feeders Purchased	Head	572	576	545

level. The remaining 1,037 calves (tow line), 1,046 calves (wheel move), and 974 calves (center pivot) were fed a grain ration for six months before 545 head, 576 head, and 545 head were transferred to drylot for period 1 (April 15 to October 15) and fed out on a silage ration. These animals were marketed at 1,100 pounds on October 15. The remaining 465 head, 470 head, and 429 head of calves in the respective models which were raised to yearling feeders were sold at 650 pounds on April 15. During period 2, October 15 to April 15, 572 head, 576 head, and 545 head in the respective models were fed a silage ration to slaughter weight and sold at 1,100 pounds.

Labor

In each planning model the available operator and family labor was fully utilized. With the increased number of cattle on feed, and number of acres irrigated at the 640 acre level, the hours hired and total number of hours required for each operation increased considerably. The additional total hours required for this operation in comparison to irrigation at the 320 acre level amounted to 1,806 hours, 2,015 hours, and 2,127 hours for center pivot, wheel move, and tow line respectively. Table XVIII summarizes this information.

The following was the breakdown of hired labor for all planning models by period in the terms of equivalent full-time men. The feeding operation in period one, November 16 to January 31, required two full-time men plus part-time help ranging from six to eight-tenths of one man. Period two, February 1 to March 31, required two full-time men for each planning model. The planting of small grain during period

Table XVIII. Operator and Family Labor and Labor Hired by Period for Planning Models with the Adoption of Irrigation at the 640 Acre Level

Planning Models	Period:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
		Total Man Hours of Operator and Family Labor Available										
		450	483	353	344	218	217	217	218	435	541	3,476
Tow Line												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,259	957	237	641	465	244	447	211	292	2,041	6,794
Total Labor		1,709	1,440	590	985	683	461	664	429	727	2,582	10,270
Wheel Move												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,270	966	239	553	467	163	477	101	297	2,054	6,587
Total Labor		1,720	1,449	592	897	685	380	694	319	732	2,595	10,063
Center Pivot												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,181	894	222	530	407	100	416	99	259	1,949	6,057
Total Labor		1,631	1,377	575	874	625	317	633	317	694	2,490	9,533

three, April 1 to April 30, required only part-time help ranging from six to seven-tenths of one man. The planting of corn from May 1 to May 31 in period four required one and one-half men for the center pivot planning model, one and six-tenths men for the wheel move planning model, and one and nine-tenths men for the tow line planning model. Periods six and eight, June 16 to June 30 and July 16 to July 31 respectively, the help demanded ranges from one-half (center pivot), and three-fourths (wheel move), to one full-time man (tow line). Period seven, July 1 to July 15, required two full-time men in each solution. Harvesting small grain and a third crop of alfalfa in period nine, August 1 to August 31, required part-time help equivalent to six-tenths of one man. The harvesting of corn and corn silage in period ten, September 1 to November 15, required just slightly less than four men.

Capital

Capital requirements are listed in Table XIX. These range from $471,011 (center pivot), $471,860 (tow line), to $484,285 (wheel move) for total annual capital and from $693,611, $694,460, to $706,885 for total capital required respectively. This represented an increase in total annual capital of $125,456, $123,539, and $129,499 for the respective models or a percentage increase of approximately 36 percent.

As more acres were irrigated, an additional enlargement in the feeding operation occurred. Capital for the purchase of livestock increased to $225,823 (tow line), $227,107 (wheel move), and $216,859 (center pivot) from $176,268, $177,003, and $171,136 at the 320 acre

Table XIX. Total Annual Capital and Types of Capital Required for Planning Models with the Adoption of Irrigation at the 640 Acre Level

Capital	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Annual Operating	$ 51,605.00	$ 51,415.00	$ 48,540.00
Period 2 Operating	10,095.70	10,090.80	10,130.20
Livestock Facility	105,867.30	106,604.90	100,714.40
Livestock Animal	225,823.80	227,107.10	216,859.40
Crop Machinery	16,334.90	17,599.00	16,275.30
Irrigation Operating	13,217.10	16,171.90	17,698.90
Irrigation System	48,916.60	55,296.30	60,793.20
Total Annual Capital	$471,860.40	$484,285.00	$471,011.60
Land Capital:			
Dryland	72,000.00	72,000.00	72,000.00
Irrigable	118,400.00	118,400.00	118,400.00
Pasture	32,200.00	32,200.00	32.200.00
Total Land Capital	$222,600.00	$222,600.00	$222,600.00
TOTAL CAPITAL REQUIRED	$694,460.40	$706,885.00	$693,611.60

irrigation level, respectively. This amounts to a 28 percent increase in livestock animal capital. Livestock facilities capital increased to $105,867 (tow line), $106,604 (wheel move), and $100,714 (center pivot). This amounts to an increase of $29,301, $29,530, and $27,691 respectively. Annual operating capital increased by $12,713 in the tow line planning model, and $12,621 in the wheel move planning model and $11,159 in the center pivot planning model which is a 32 percent increase. Period 2 operating capital and crop machinery capital increased just slightly.

Irrigation operating capital increased from $6,602 (tow line), $8,080 (wheel move), and $8,836 (tow line) at the 320 acre irrigation level to $13,217, $16,171, and $17,698 for the respective models at the 640 acre level. Irrigation system capital amounted to $48,916 (tow line), $55,296 (wheel move), and $60,793 (center pivot) at the 640 acre irrigation level compared to $24,458, $27,648, and $30,396 at the 320 acre irrigation level for the respective systems.

Fixed investment in land increased from $212,600 at the 320 acre level to $222,600 at the 640 acre irrigation level.

Expenses

Table XX gives a detailed breakdown of different expenses at the 640 acre level. Total crop and livestock expenses increased by $115,554 (tow line), $118,236 (wheel move), and $111,648 (center pivot) over those at the 320 irrigation level. This represented a 35 percent increase. The component making up the biggest increase was livestock

Table XX. Summary of Expenses in Planning Models with the Adoption of Irrigation at the 640 Acre Level

Expenses	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Livestock			
Purchase of Livestock	$292,939.15	$294,845.96	$279,619.20
Operating Expenses	37,975.53	38,201.81	36,394.89
Insurance and Taxes	7,058.10	7,105.58	6,726.44
Total Livestock Expenses	$337,972.78	$340,153.35	$322,740.53
Crops			
Dryland Operating	$ 3,428.19	$ 3,358.49	$ 3,918.78
Irrigation Operating	14,281.04	14,876.40	16,029.56
Total Variable Expenses	$ 17,709.23	$ 18,234.89	$ 19,948.34
Dryland Fertilizer	$ 4,324.56	$ 4,269.59	$ 4,708.54
Irrigation Fertilizer	12,033.06	12,199.25	10,872.15
Total Fertilizer Expense	$ 16,357.62	$ 16,468.84	$ 15,580.69
Insurance and Taxes-Machinery	709.31	708.82	712.74
Insurance and Taxes-Irrigation	1,852.52	3,449.47	2,759.81
Crop Insurance	3,929.97	3,949.74	3,791.84
Total Insurance and Taxes	$ 6,491.80	$ 8,108.03	$ 7,264.39
Total Crop Expenses	$ 40,558.65	$ 42,811.76	$ 42,793.42
Total Hired Labor	$ 13,588.00	$ 13,170.00	$ 12,112.00

Table XX. (Continued)

Expenses	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Depreciation			
Crop Machinery	$ 2,654.59	$ 2,649.17	$ 2,692.46
Livestock Facility	8,302.28	8,356.77	7,921.65
Irrigation System	6,274.15	7,280.85	7,997.93
Total Depreciation	$ 17,231.02	$ 18,286.79	$ 18,612.04
Interest			
Annual Operating	$ 4,128.40	$ 4,113.19	$ 3,883.22
Period 2 Operating	403.83	403.63	405.21
Livestock Facility	6,881.37	6,929.32	6,546.43
Livestock Animal	18,065.90	18,168.56	17,348.75
Crop Machinery	1,306.79	1,727.91	1,302.02
Irrigation Operating	1,057.37	1,293.74	1,415.91
Irrigation System	3,913.32	4,423.70	4,863.45
Total Interest	$ 35,756.98	$ 37,060.05	$ 35,764.99
TOTAL EXPENSES	$445,137.43	$451,481.95	$432,022.98

purchases which ranged from $70,745 (center pivot), $75,257 (tow line), to $75,902 (wheel move).

Each expense component under the heading of crops experienced an increase. The total crop expenses amounted to $40,558 (tow line), $42,811 (wheel move), and $42,793 (center pivot). Total variable expenses amounted to $17,709, $18,234, and $19,948 in the respective models. This was an increase of $5,832, $5,090, and $6,006 respectively. Fertilizer expense increased from $12,103 (tow line), $12,162 (wheel move), and $11,687 (center pivot) to $16,357, $16,468, and $15,580 respectively. This, of course, is all related to the increased acres under irrigation.

The labor expenses increased by $4,252 (tow line), $4,028 (wheel move), and $3,610 (center pivot) over those at the 320 acre irrigation level. Depreciation amounted to $17,231 (tow line), $18,286 (wheel move), and $18,612 (center pivot) at the 640 acre irrigation level compared with $12,106, $12,647, and $12,704 respectively.

The interest expense amounted to $35,756, $37,060, and $35,764 at the 640 irrigation level. This was an increase of $11,522, $11,051, and $9,580 respectively.

Livestock animal interest made up the largest component of total interest which amounted to $18,065 (tow line), $18,168 (wheel move), and $17,348 (center pivot) at the 640 acre irrigation level. This was an increase of $3,964, $4,008, and $3,658 in the respective models above that of irrigation at the 320 acre level. Annual operating interest increased approximately $1,000 in each of the planning models at the 640 acre level above that at the 320 acre level.

Livestock facility interest increased approximately $1,800 in the respective models. Irrigation system interest amounted to $1,057 (tow line), $1,293 (wheel move), and $1,415 (center pivot) at the 640 acre level compared to $528, $646, and $706 for the respective models at the 320 acre level. Irrigation system interest increased from $1,956 (tow line), $2,211 (wheel move), and $2,431 (center pivot) at the 320 acre level to $3,913, $4,423, and $4,863 respectively at the 640 acre level.

Financial Statements

Table XXI summarizes the operating statements and compares the returns to management for irrigation at the 640 acre level. The total enterprise returns were $61,852.47 (tow line), $58,731.20 (wheel move), and $52,451.04 (center pivot). The non-allocated costs at the 640 acre level were $22,327. The returns to labor and farm management were $39,525.47 (tow line), $36,404.20 (wheel move), and $30,124.04 (center pivot).

The returns to farm management were $30,773, $27,652, and $21,372 for tow line, wheel move, and center pivot, respectively. This was an increase of $9,681, $8,208, and $5,146 for the respective models above those at the 320 acre irrigation level. The percentage increases of irrigated returns to farm management at the 640 acre level over dry-land returns were 264.0 percent (tow line), 227.1 percent (wheel move), and 152.8 percent (center pivot).

Table XXI. Operating Statement and Comparison of Returns in Planning Models with the Adoption of Irrigation at the 640 Acre Level

Item		Tow Line Irrigation		Wheel Move Irrigation		Center Pivot Irrigation
Gross Income		$506,989.90		$510,213.15		$484,474.02
Expenses[1]						
Livestock	$337,972.78		$340,153.35		$322,740.53	
Crops	40,558.65		42,811.76		42,793.42	
Hired Labor	13,588.00		13,170.00		12,112.00	
Depreciation	17,231.02		18,286.79		18,612.04	
Interest	35,756.98		37,060.05		35,764.99	
Total Expenses		445,137.43		451,481.95		432,022.98
NET RETURNS		$ 61,852.47		$ 58,731.20		$ 52,451.04
Overhead Expenses[2]						
Non-Allocated Costs	$ 2,425.00		$ 2,425.00		$ 2,424.00	
Interest on Land	15,582.00		15,582.00		15,582.00	
Land Taxes	3,520.00		3,520.00		3,520.00	
Depreciation-Fences	800.00		800.00		800.00	
Total Overhead Expenses		22,327.00		22,327.00		22,327.00
RETURNS TO LABOR AND FARM MANAGEMENT		$ 39,525.47		$ 36,404.20		$ 30,124.04

Table XXI. (Continued)

Item	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Operator and Family Labor[3]			
Enterprise	6,952.00	6,952.00	6,952.00
Overhead	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 30,773.47	$ 27,652.20	$ 21,372.04

[1]See Table XVII.
[2]See Appendix A, Tables II and III.
[3]$2.00 per hour charge for operator and family labor.

Comparison of Selected Irrigation Systems at the 960 Acre Level vs. Irrigation at the 640 Acre Level

In this section of the study, an analysis of inaugurating irrigation at the 960 acre level is made. The results obtained from the optimum solution are compared with the results of irrigation at the 640 acre level. There are four irrigation planning models in this section. As before, they are the tow line, wheel move, and center pivot. The fourth planning model has all three types of systems. It has two of each type.

These planning models did not allow the purchase of feed grain or alfalfa hay. Information on land use, crop production, livestock organization, labor and capital requirements, and expenses are given on the following pages.

Land Use Plans

The activities selected for the optimum land use programs are given in Table XXII. Table XXIII summarizes the grain and forage production along with the total acres of each crop. The model with all three types of systems (in the remainder of this section--this model will be called choice of systems) irrigated 888 acres, while tow line covered 912 acres, wheel move 924 acres, and center pivot 828 acres.

The greatest shift in the organization of crop enterprises occurred at the 960 acre irrigation level. All corn and alfalfa production was raised under irrigation with the exception of 22 acres of alfalfa in the center pivot irrigation model. Total corn acreage amounted to 660.2 acres (choice), 679.4 acres (tow line), 689.1 acres

Table XXII. Optimum Land Use for Planning Models with the Adoption of Irrigation at the 960 Acre Level

Activities	Unit	Three Systems (Tow Line, Wheel Move, Center Pivot) Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Dryland Crops					
Class I Land					
Barley	Acre	140.8	125.2	117.4	179.8
Class II Land					
Barley	Acre	71.2	62.8	58.6	70.0
Alfalfa	Acre				22.2
Total Dryland Acres		222.0	188.0	176.0	272.0
Irrigated Crops					
Corn--towline		304.0	679.4		
Corn--wheel move		80.2		689.1	
Corn--center pivot		276.0			616.9
Alfalfa--wheel move		227.8			
Alfalfa			232.6	234.9	211.1
Total Irrigated Acres		888.0	912.0	924.0	828.0
Pasture					
Native	Acre	134.6	134.5	134.4	134.8
Improved	Acre	320.0	320.0	320.0	320.0
Feed Lot	Acre	5.4	5.5	5.6	5.2
Total		460.0	460.0	460.0	460.0

Table XXIII. Total Acres of Crops and Crop Production in Planning Models with the Adoption of Irrigation at the 960 Acre Level

Item	Unit	Three Systems (Tow Line, Wheel Move, Center Pivot) Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Total Acres of Crops					
Corn	Acre	801.0	679.4	689.1	616.9
Barley	Acre	212.0	188.0	176.0	248.8
Alfalfa	Acre	227.8	232.6	234.9	233.3
Total	Acre	1,100.0	1,100.0	1,100.0	1,100.0
Grain and Forage Production					
Corn	Bushels	60,431	62,467	63,487	55,962
Barley	Bushels	7,981	7,145	6,689	9,579
Corn Silage	Ton	3,104	3,149	3,171	2,985
Alfalfa	Ton	1,295	1,322	1,335	1,199

(wheel move), and 616.9 acres (center pivot). In the choice model 304 acres were irrigated under the tow line, 80.2 acres under the wheel move, and 276.0 acres under the center pivot. The remaining 227.8 acres irrigated in the choice planning model were alfalfa. Alfalfa acreage amounted to 232.6 acres, 234.9 acres, and 233.3 acres for tow line, wheel move, and center pivot respectively. Comparing this to irrigation at the 640 acre level, corn acreages increased by 138.4 acres, 147.2 acres, and 82.5 acres and alfalfa acreages decreased by 76.4 acres, 73.2 acres, and 82.3 acres for tow line, wheel move, and center pivot respectively.

A decrease in barley acreage was experienced. This was the only crop grown on dryland with the exception of alfalfa in the center pivot model. Barley production amounted to 212.0 acres, 188.0 acres, 176 acres, and 248.8 acres for the choice, tow line, wheel move, and center pivot respectively. Barley production at the 640 acre irrigation level was 250 acres on dryland cropland in each of the respective models. The pasture was completely utilized as was the case at the 640 acre level.

Irrigation at the 960 acre level increased the total feed supply by approximately 27 percent over that at the 640 acre level. Total bushels of corn increased to 62,467 bushels, 63,487 bushels, and 55,962 bushels at the 960 acre level from 44,463 bushels, 44,848 bushels, 41,768 bushels, at the 640 acre level for tow line, wheel move, and center pivot respectively. The choice planning model's corn production amounted to 60,431 bushels. The corn silage production was 3,104 tons (choice), 3,149 tons (tow line), 3,171 tons (wheel move), and 2,985 tons (center pivot) at the 960 acre irrigation level. This was an increase of 633

tons, 638 tons, and 586 tons for tow line, wheel move, and center pivot respectively over that at the 640 acre irrigation level. Alfalfa production at the 960 acre level totaled 1,295 tons (choice), 1,322 tons (tow line), 1,355 tons (wheel move), and 1,199 tons (center pivot) compared to 1,031 tons (tow line), 1,038 tons (wheel move), and 984 tons (center pivot) at the 640 acre irrigation level. Barley production amounted to 10,000 bushels in all models at the 640 acre level. At the 960 acre level, barley production amounted to 7,981 bushels (choice), 7,145 bushels (tow line), 6,689 bushels (wheel move), and 9,579 bushels (center pivot).

Livestock Plans

Optimum livestock plans for irrigation at the 960 acre level are presented in Table XXIV. A total of 1,665 calves (choice), 1,702 calves (tow line), 1,721 calves (wheel move), and 1,576 calves (center pivot) was purchased. This was 381 calves (tow line), 402 calves (wheel move), and 315 calves (center pivot) more than were purchased and fed in the 640 acre irrigation planning models. A total of 706 head (choice), 716 head (tow line), 721 head (wheel move), and 679 head (center pivot) period 2 yearlings was purchased and fed in the 960 acre irrigation planning models. This was 144 head (tow line), 145 head (wheel move), and 134 head (center pivot) more than were purchased and fed in the respective models at the 640 acre irrigation level. The expanded feeding operation at the 960 acre irrigation level showed an increase of approximately 28 percent over the 640 acre level.

Table XXIV. Optimum Livestock Enterprises for Planning Models with the Adoption of Irrigation at the 960 Acre Level

Livestock Activity	Unit	Three Systems Irrigation Planning Model	Tow Line Irrigation Planning Model	Wheel Move Irrigation Planning Model	Center Pivot Irrigation Planning Model
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	262	260	258	267
Buy Calves, October, Winter on Light Grain Ration, Sell 650 Pound Feeders in April	Head	697	726	742	630
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	706	716	721	679
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	706	716	721	679
Total Calves Purchased	Head	1,665	1,702	1,721	1,576
Total Feeders Purchased	Head	706	716	721	679

A slight decrease in the number of calves raised to heavy yearlings on pasture was experienced. A total of 262 calves (choice), 260 calves (tow line), 258 calves (wheel move), and 267 calves (center pivot) was raised on pasture for 12 months. This was a decrease of 24 head (tow line), 25 head (wheel move), and 20 head (center pivot). The remaining 1,403 calves, 1,442 calves, and 1,463 calves and 1,309 calves in the choice, tow line, wheel move, and center pivot respectively were fed a grain ration for six months before 706 head, 716 head, 721 head, and 679 head in the respective models were transferred to drylot for feeding in period 1 (April 15 to October 15) and fed out on a silage ration. These animals were marketed at 1,100 pounds on October 15. The remaining 697 head, 726 head, 742 head, and 630 head of calves in the respective models were raised to yearling feeders and sold at 650 pounds on April 15. During period 2, October 15 to April 15, 706 head, 716 head, 721 head, and 679 head of calves in the respective models are fed in drylot. They are marketed at 1,100 pounds on April 15.

Labor

Table XV summarizes the requirements for operator and hired labor per period. Operator and family labor were completely utilized. A total of 8,591 (three systems), 9,077 (tow line), 8,779 (wheel move), and 7,874 (center pivot) hours was hired during the year for each respective model.

Labor demands were greatest during period ten, September 1 to November 15, when the harvesting of corn and corn silage took place. Approximately five full-time men were required in this period. Period

Table XXV. Operator and Family Labor and Labor Hired by Period for Planning Models with the Adoption of Irrigation at the 960 Acre Level

Model Farms	Period:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
		Total Man Hours of Operator and Family Labor Available										
		450	483	353	344	218	217	217	218	435	541	3,476
Three Systems												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,680	1,297	304	780	449	285	462	225	465	2,644	8,591
Total		2,130	1,780	657	1,124	667	502	679	443	900	3,185	12,067
Tow Line												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,720	1,329	302	886	488	392	484	306	464	2,706	9,077
Total		2,170	1,812	655	1,230	706	609	701	524	899	3,247	12,553
Wheel Move												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,740	1,345	300	760	493	271	532	139	463	2,736	8,779
Total		2,190	1,828	653	1,104	711	488	749	357	898	3,277	12,255
Center Pivot												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,584	1,218	301	679	402	170	423	156	449	2,492	7,874
Total		2,034	1,701	654	1,023	620	440	640	374	884	3,033	11,350

one, November 16 to January 31, had the next greatest demand for labor. The intensified feeding operation required the equivalent of 3.5 to 4 full-time men. The equivalent of 2.5 to 2.8 full-time men were needed in period two, February 1 to March 31. The planting of small grain along with feeding during period three, April 1 to April 30, demanded slightly less than one full-time man. Periods four, five, and seven, May 1 to May 31, June 1 to June 15, and July 1 to July 15, all demanded 2 to 2.5 full-time men. Periods six, eight, and nine, June 15 to June 30, July 16 to July 31, and August 1 to August 31, required nearly the equivalent of one full-time man.

The hired labor requirements for tow line at this level compared to the 640 acre level increased to 9,077 hours from 6,794 hours, while wheel move increased to 8,779 from 6,587. A total of 7,874 hours was hired in the center pivot model at the 960 acre level compared to 6,057 hours at the 640 acre irrigation level.

Capital

The individual types of capital, total annual capital, and total capital requirements are given in Table XXVI. Total capital required at this level was $842,833 (choice), $837,957 (tow line), $847,984 (wheel move), and $832,242 (center pivot). This was an increase of $143,497, $141,099, $138,631 for tow line, wheel move, and center pivot respectively above the capital required at the 640 acre irrigation level. This amounts to an increase of approximately 20 percent.

Table XXVI. Total Capital and Types of Capital Required for Planning Models with the Adoption of Irrigation at the 960 Acre Level

Capital	(Three System) Tow Line, Wheel Move, Center Pivot	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Annual Operating	$ 62,908.10	$ 64,456.80	$ 64,152.60	$ 59,942.10
Period 2 Operating	12,040.60	12,322.00	12,463.00	11,329.30
Livestock Facility	134,532.70	137,407.80	138,849.10	127,641.20
Livestock Animal	273,353.90	277,428.70	279,521.80	262,763.80
Crop Machinery	18,543.10	17,901.80	18,555.60	17,574.70
Irrigation Operating	23,543.10	19,865.50	24,298.10	26,601.80
Irrigation System	82,502.50	73,374.80	82,944.40	91,189.70
Total Annual Capital	$607,633.20	$602,757.40	$610,784.00	$597,042.60
Land Capital:				
Dryland	24,000.00	24,000.00	24,000.00	24,000.00
Irrigable	177,600.00	177,600.00	177,600.00	177,600.00
Pasture	33,600.00	33,600.00	33,600.00	33,600.00
Total Land Capital	$235,200.00	$235,200.00	$235,200.00	$235,200.00
TOTAL CAPITAL REQUIRED	$842,833.20	$837,957.40	$845,984.60	$832,242.60

The two components requiring the most capital were livestock facility and livestock animal. Livestock animal capital amounted to $273,353 (choice), $277,428 (tow line), $279,521 (wheel move), and $262,763 (center pivot). This was an increase of $51,605, $52,414, $45,904 for tow line, wheel move, and center pivot respectively above that needed at the 640 irrigation level. Livestock facility capital at the 960 acre irrigation level was $134,532 (choice), $137,407 (tow line), $138,849 (wheel move), and $127,641 (center pivot) compared to $105,867, $106,604, and $100,714 for tow line, wheel move, and center pivot respectively at the 640 acre irrigation level. This was an increase of 29 percent for livestock facility capital.

Annual operating capital amounted to $62,908, $64,456, $64,152, and $59,942 for choice, tow line, wheel move, and center pivot respectively at the 960 acre irrigation level. This was an increase of $12,851 (tow line), $9,737 (wheel move), and $11,402 (center pivot) over annual operating capital at the 640 acre irrigation level. Period 2 operating capital increased from $10,095 (tow line), $10,090 (wheel move), $10,130 (center pivot) at the 640 acre level to $12,040 (choice), $12,322 (tow line), $12,463 (wheel move), and $11,329 (center pivot) at the 960 acre level. Crop machinery capital increased just slightly. The increase amounted to $1,567 for tow line, $956 for wheel move, and $1,499 for center pivot.

Irrigation operating capital at the 960 acre level amounted to $23,543 (choice), $19,865 (tow line), $24,298 (wheel move), and $26,601 (center pivot) compared to $13,217 (tow line), $16,171 (wheel move), and $17,698 (center pivot) at the 640 acre level. Irrigation system

capital increased to $82,502 (choice), $73,374 (tow line), $82,944 (wheel move), and $91,189 (center pivot) at the 960 acre level. The increase from the 640 acre level to the 960 acre level amounted to $24,458 for tow line, $27,648 for wheel move, and $30,396 for center pivot. Fixed investment in land increased from $222,600 at the 640 acre irrigation level to $235,200 at the 960 acre irrigation level. This is an increase of 5.7 percent.

Expenses

A breakdown of the expense components for irrigation at the 960 acre level is given in Table XXVII. Total expenses increased to $562,565 for choice, $567,801 for tow line, $578,280 for wheel move, and $542,569 for center pivot. Total livestock expenses made up approximately three-quarters of the total expenses. Total livestock expenses amounted to $421,376 (choice), $429,423 (tow line), $433,457 (wheel move), and $401,824 (center pivot). This was an increase in livestock expenses of $91,451, $93,304, and $79,084 for tow line, wheel move, and center pivot respectively over the 640 acre irrigation level.

Total crop expenses amounted to $54,074, $51,904, $55,348, and $55,055 for choice, tow line, wheel move, and center pivot respectively. Total variable costs made up $24,171, $22,869, $23,670, and $26,131 of this total in the respective models. Fertilizer costs were $20,259, $20,551, $20,792, and $19,395 in each of the respective models compared to $16,357, $16,468, and $15,580 in tow line, wheel move, and center pivot respectively at the 640 acre irrigation level.

Table XXVII. Summary of Expenses in Planning Models with the Adoption of Irrigation at the 960 Acre Level

Expenses	Three Systems	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Livestock				
Purchase Livestock	$366,238.11	$373,399.19	$376,988.88	$348,915.64
Operating Expense	46,285.01	47,003.11	47,363.08	44,468.34
Insurance and Taxes	8,853.34	9,021.53	9,105.84	8,440.38
Total Livestock Expenses	$421,376.46	$429,423.00	$433,457.80	$401,824.36
Crops				
Dryland Operating	1,618.94	1,460.65	1,381.01	1,966.19
Irrigation Operating	22,552.68	21,408.63	22,289.41	24,165.65
Total Variable Expenses	$ 24,171.62	$ 22,869.28	$ 23,670.42	$ 26,131.84
Dryland Fertilizer	2,810.82	2,629.09	2,632.57	3,093.28
Irrigation Fertilizer	17,449.06	17,922.49	18,159.81	16,302.27
Total Fertilizer Expense	$ 20,259.88	$ 20,551.58	$ 20,792.38	$ 19,395.55
Insurance and Taxes-Machinery	718.80	719.65	720.08	714.89
Insurance and Taxes-Irrigation	4,040.88	2,808.78	5,174.21	4,139.72
Crop Insurance	4,883.17	4,955.29	4,991.44	4,673.59
Total Insurance and Taxes	$ 9,642.85	$ 8,483.72	$ 10,885.73	$ 9,528.20
Total Crop Expenses	$ 54,074.35	$ 51,904.58	$ 55,348.53	$ 55,055.59
Total Hired Labor	$ 17,182.00	$ 18,152.00	$ 17,558.00	$ 15,746.00

Table XXVII. (Continued)

Expenses	Three Systems	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Depreciation				
Crop Machinery	$ 2,683.68	$ 2,688.08	$ 2,690.29	$ 2,660.10
Livestock Facility	10,369.41	10,564.74	10,662.65	9,891.29
Irrigation System	10,776.23	9,411.23	10,921.27	11,996.90
Total Depreciation	$ 23,829.49	$ 22,664.05	$ 24,274.21	$ 24,548.29
Interest				
Annual Operating	$ 5,032.65	$ 5,156.54	$ 5,132.21	$ 4,795.36
Period 2 Operating	481.62	492.88	498.52	453.17
Livestock Facility	8,744.62	8,931.51	9,025.19	8,296.68
Livestock Animal	21,860.26	22,194.30	22,361.74	21,021.10
Crop Machinery	1,500.23	1,432.14	2,044.44	1,405.98
Irrigation Operating	1,883.44	1,589.23	1,943.85	2,128.14
Irrigation System	6,600.20	5,869.98	6,635.55	7,295.17
Total Interest	$ 46,103.02	$ 45,666.58	$ 47,641.50	$ 45,395.60
TOTAL EXPENSES	$562,565.32	$567,810.21	$578,280.04	$542,569.84

The labor expenses increased to $17,182 (choice), $18,152 (tow line), $17,558 (wheel move), and $15,746 (center pivot) at the 960 acre irrigation level from $13,588 (tow line), $13,170 (wheel move), and $12,112 (center pivot) at the 640 acre irrigation level.

Depreciation increased to $23,829, $22,664, $24,274, and $24,548 for choice, tow line, wheel move, and center pivot respectively at the 960 acre level. Crop machinery depreciation remained relatively the same at both the 640 acre and 960 acre levels. Livestock facility depreciation increased over the 640 acre irrigation level by an amount of $2,262 for tow line, $2,306 for wheel move, and $1,970 for the center pivot. Irrigation system depreciation amounted to $10,776 (choice), $9,411 (tow line), $10,921 (wheel move), and $11,996 (center pivot) at the 960 acre level compared to $6,274 (tow line), $7,280 (wheel move), and $7,997 (center pivot) at the 640 acre level.

The interest expense amounted to $46,103, $45,666, $47,641, and $45,395 for choice, tow line, wheel move, and center pivot respectively. This was an increase of approximately $10,000 in the respective models above that of irrigation at the 640 acre level. Livestock animal was the largest interest component which totaled $21,860, $22,194, $22,361, and $21,021 for choice, tow line, wheel move, and center pivot respectively. Annual operating interest increased approximately $1,000 in the respective models going from the 640 acre level to the 960 acre level. Period 2 operating, crop machinery, and irrigation operating interest all increased by small margins. Irrigation system interest amounted to $6,600 (choice), $5,869 (tow line), $6,635 (wheel move),

and $7,295 (center pivot) at the 960 acre level. This was an increase of $1,956 for tow line, $2,212 for wheel move, and $2,432 for center pivot above that of irrigation at the 640 acre level.

Financial Statements

Table XXVIII gives a summary of the operating statements and a comparison of returns to management for irrigation at the 960 acre level. The greatest returns to management continued to be the tow line irrigation model. The total enterprise returns were $66,646 (three systems), $72,401.54 (tow line), $67,646.18 (wheel move), and $58,239.99 (center pivot). The non-allocated costs were $23,369. Returns to labor and farm management were $42,877.61 (three systems), $49,032.54 (tow line), $44,277.18 (wheel move), and $34,870.99 (center pivot).

Paying the operator and family $2.00 per hour for their labor, returns to management amounted to $34,125.61 for the choice planning model, $40,280.54 for the tow line planning model, $35,525.18 for the wheel move planning model, and $26,118.99 for the center pivot planning model. This was a 30.8 percent (tow line), 28.4 percent (wheel move), and 23.3 percent (center pivot) increase over the respective irrigation planning models at the 640 acre level.

Table XXVIII. Operating Statement and Comparison of Returns for Planning Models with the Adoption of Irrigation at the 960 Acre Level

Item	(Three Systems)	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Gross Income	$628,811.93	$640,211.75	$645,926.22	$600,809.83
Expenses[1]				
Livestock	421,376.46	429,423.00	433,457.80	401,824.36
Crop	54,074.35	41,904.58	55,348.53	55,055.59
Hired Labor	17,182.00	18,152.00	17,588.00	15,746.00
Depreciation	23,829.49	22,664.05	24,274.21	24,548.29
Interest	46,103.02	45,666.58	47,641.50	45,395.60
Total Expenses	$562,565.32	$567,810.21	$578,280.04	$542,569.84
NET RETURNS	$ 66,246.61	$ 72,401.54	$ 67,646.18	$ 58,239.99
Overhead Expenses[2]				
Non-Allocated Costs	$ 2,425.00	$ 2,425.00	$ 2,425.00	$ 2,425.00
Interest on Land	16,464.00	16,464.00	16,464.00	16,464.00
Land Taxes	3,680.00	3,680.00	3,680.00	3,680.00
Depreciation-Fences	800.00	800.00	800.00	800.00
Total Overhead Expenses	$ 23,369.00	$ 23,369.00	$ 23,369.00	$ 23,369.00
RETURNS TO LABOR AND FARM MANAGEMENT	$ 42,877.61	$ 49,032.54	$ 44,277.18	$ 34,870.99

Table XXVIII. (Continued)

Item	(Three Systems)	Tow Line Irrigation	Wheel Move Irrigation	Center Pivot Irrigation
Operator and Family Labor[3]				
Enterprise	$ 6,952.00	$ 6,952.00	$ 6,952.00	$ 6,952.00
Overhead	1,800.00	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 34,125.61	$ 40,280.54	$ 35,525.18	$ 26,118.99

[1]See Table XXII.
[2]See Appendix A, Tables II and III.
[3]$2.00 per hour charge for operator and family labor.

Summary

The comparison between the dryland and irrigation planning models that provided the greatest differences in income was the tow line system at each irrigation level. The wheel move, center pivot models in that order provided the next largest difference. Thus, if the firm's labor supply is not restricted, the rational decision for the firm is to adopt the tow line system because of its lower investment costs, fixed costs, and variable costs per acre which lead to the greatest returns to management.

No cash crop sales appeared in the optimum solution for any planning model at the dryland, 320 acre, 640 acre, and 960 acre irrigation levels. Feeding of livestock was the dominant enterprise which became more intensified as the intensity of irrigation increased. The individual planning models fully utilized every available resource in the optimum organization of each model.

The analysis in this chapter showed strong evidence that the adoption of irrigation was economically profitable. Table XXIX shows a comparison of returns to management between the dryland and irrigation models at each irrigation level. The returns to farm management were $8,453 in the dryland model. Irrigation at the 320 acre level yielded returns to management of $21,092 in the tow line planning model, $19,444 in the wheel move planning model, and $16,236 in the center pivot planning model. This was a percentage increase over the dryland returns of 149.4 percent, 130.0 percent, and 92.0 percent respectively for tow line, wheel move, and center pivot.

Table XXIX. Comparison of Returns to Management

Irrigation Levels	Dryland	Tow Line	Wheel Move	Choice	Center Pivot
Dryland	$8,453				
320 Irrigation Level		$21,092	$19,444	-----	$16,236
640 Irrigation Level		$30,773	$27,652	-----	$21,372
960 Irrigation Level		$40,280	$35,525	$34,125	$26,118

Irrigation at the 640 acre level, yielded returns to farm management of $30,773 (tow line), $27,652 (wheel move), and $21,372 (center pivot). Comparing these returns to irrigation at the 320 acre level, returns to management increased by 45.8 percent, 42.2 percent, and 31.6 percent for tow line, wheel move, and center pivot respectively. The percentage increase of irrigated returns to farm management at the 640 acre level over dryland returns were 264.0 percent (tow line), 227.1 percent (wheel move), and 152.8 percent (center pivot).

The greatest returns to management from irrigation at the 960 acre level were also yielded by the tow line irrigation planning model. The tow line returns were 13.3 percent, 18.0 percent, and 54.2 percent greater than those for the wheel move, choice of systems, and center pivot planning models respectively. Returns to management amounted to $40,280 (tow line), $35,525 (wheel move), $34,125 (choice of systems), and $26,118 (center pivot). This was 30.8 percent (tow line), 28.4 percent (wheel move), and 23.3 percent (center pivot) increase over the

respective planning models at the 640 acre level, while it was 90.0 percent, 82.7 percent, and 60.8 percent increase over the adoption of irrigation at the 320 acre level respectively. Returns to management at the 960 acre level were 376.5 percent (tow line), 320.2 percent (wheel move), and 208.9 percent (center pivot) greater than the dryland planning model.

Family labor was fully utilized in each of these planning models. Annual labor requirements increased in every instance with the adoption of irrigation. Total labor required ranged from 5,938 man-hours for the dryland planning model to 12,553 man-hours for the tow line irrigation model at the 960 acre level.

Capital requirements rose with each successive increase in the acres irrigated. A comparison of capital requirements is presented in Table XXX. The total annual capital requirements ranged from $217,078 (dryland) to $610,784 (wheel move planning model at 960 acre level). Total capital required amounted to $418,678 in the dryland planning model. The wheel move planning model had the largest capital requirement at each irrigation level. This was due to the fact that the wheel move system irrigated the greatest number of acres at each irrigation level. Thus it raised the greatest feed supply and there was a direct relationship between the feed supply and number of cattle on feed. Therefore, the largest component of total annual capital was for purchasing livestock. The purchase of livestock required 56.6 percent of total annual capital in the dryland planning model. In the irrigation planning model at the 320 acre level, livestock capital made up one-half (50.6 percent in tow line, 49.6 percent in wheel move, and 49.5 percent in center pivot) of

Table XXX. Comparison of Capital Requirements

	Dryland	Tow Line	Wheel Move	Choice	Center Pivot
Dryland					
Total Annual	$217,078				
Total Capital	$418,678				
320 Irrigation Level					
Total Annual Capital		$348,221	$354,786	-----	$345,565
Total Capital Required		$561,021	$567,586	-----	$558,365
640 Irrigation Level					
Total Annual Capital		$471,860	$484,285	-----	$471,011
Total Capital Required		$694,460	$706,885	-----	$693,611
960 Irrigation Level					
Total Annual Capital		$602,757	$610,784	$607,633	$597,042
Total Capital Required		$837,957	$845,584	$842,833	$832,242

the total annual capital in each case. Irrigation at the 640 acre level increased livestock animal capital by 28 percent over the 320 acre irrigation level. The adoption of irrigation at the 960 acre level increased animal capital by approximately 22 percent over the 640 acre level.

The optimum crop organizations were altered with the adoption of irrigation. The intensive feeding operations under irrigation at each acreage level, showed a significant increase in total production of corn and alfalfa. The only major alteration among the organization of crops was a decrease in wheat production from 294.2 acres (dryland) to 34.7 acres (tow line), 31.1 acres (wheel move), and 60.0 acres (center pivot) at the 320 acre irrigation level. Irrigation at the 640 and 960 acre levels showed no wheat production at all. Barley

production increased from 0 acres in the dryland model to 250 acres in the 320 acre and 640 acre irrigation models to satisy the balance of the feed grain requirements. Barley production decreased slightly at the 960 acre irrigation level compared to the 320 and 640 acre levels. This was due to the decrease in dryland cropland at the high irrigation level. The optimum solution in the irrigation planning models brought in more livestock at each acreage level because of the rise in the feed base provided by the irrigated yields.

CHAPTER IV

COW-CALF OPERATIONS UNDER IRRIGATION

A particular firm may not want to operate under a plan where ll stockers and feeders are purchased as described in the previous hapter. In this and the following chapter alternative planning odels are examined. A firm may prefer to operate a certain type of arm such as a cow-calf operation because resources and managerial kills may be different. To understand how the adoption of irriga- ion affects a straight cow-calf operation, three different alternatives re analyzed in this chapter. The cow-calf planning models examined ere (1) dryland, (2) an irrigation planning model that had the oppor- unity to irrigate 960 acres with two tow line, two wheel move, and wo center pivot systems, and (3) an irrigation planning model that as forced to irrigate 960 acres with wheel move systems. The planning odels in this chapter were restricted from purchasing livestock for eeding and the buying of feed. After reviewing this chapter, the portance that enterprise organization has on returns to management ll be evident.

nd Use Plans

The activities selected in the optimum land use plans are ven in Table XXXI. Table XXXII gives the total acres of crops, total ain and forage production, and amount of grain sold. As a cow-calf eration, the firm became more diversified in livestock and grain rming. The beef cow herd together with the feeding activities

Table XXXI. The Optimum Land Use Plans for Dryland and Irrigation Cow-Calf Planning Models, Eastern Missouri Slope, South Dakota

Activities	Unit	Dryland	Choice of Systems		Wheel Move Irrigation
Dryland Crops					
Class I Land					
Corn	Acre	58.5		43.2	------
Wheat	Acre	350.0		------	------
Oats	Acre	59.2		26.2	------
Barley	Acre	250.0		250.0	117.4
Alfalfa	Acre	-----		149.2	------
Class II Land					
Alfalfa	Acre	299.5		247.7	58.6
Oats	Acre	82.5		-----	------
Total Dryland	Acre	1,100.0		716.3	176.0
Irrigated Crops					
Corn	Acre	-----	Tow	33.6	19.2
Alfalfa	Acre	-----		-----	59.5
Wheat	Acre	-----	Tow	270.4	350.0
			Wheel	79.6	
Soybeans	Acre	-----		-----	362.6
Barley	Acre	-----		-----	132.7
Total Irrigated	Acre	-----		383.6	924.0
Pasture					
Native	Acre	39.3		111.6	26.2
Improved	Acre	320.0		320.0	320.0
Feed Lot	Acre	0.5		0.8	0.4
Total	Acre	359.6		432.4	356.7

Table XXXII. Total Acres of Crops, Grain and Forage Production, and Grain Sold on Dryland and Irrigation Cow-Calf Planning Models, Eastern Missouri Slope, South Dakota

Activities	Unit	Dryland	Choice of Systems	Wheel Move Irrigation
Total Acres of Crops				
Corn	Acre	58.8	76.8	19.2
Wheat	Acre	350.0	350.0	350.0
Oats	Acre	141.7	26.2	-----
Barley	Acre	250.0	250.0	250.0
Alfalfa	Acre	299.5	396.9	118.1
Soybeans	Acre	-----	-----	362.6
Total	Acre	1,100.0	1,100.0	1,100.0
Grain and Forage Production				
Corn	Bushels	1,669	4,028	1,548
Wheat	Bushels	9,450	20,142	20,142
Barley	Bushels	9,999	9,999	15,501
Oats	Bushels	6,587	1,311	-----
Soybeans	Bushels	-----	-----	12,056
Silage	Tons	136	345	125
Alfalfa	Tons	419	585	420
Grain Sold				
Wheat	Bushels	9,450	20,142	20,142
Barley	Bushels	7,589	4,615	13,234
Oats	Bushels	6,587	1,311	-----
Soybeans	Bushels	-----	-----	12,056

accounting for the remaining 37 percent. Livestock sales were 65 percent of gross sales in the planning model with a choice of irrigation systems. Livestock and crop sales represented 37 percent and 63 percent of gross sales respectively in the wheel move planning model.

The optimum combination of crop enterprises was altered (in the different models) from one model to another. In the dryland model, alfalfa was produced on Class II land while oats were produced on both land classes. Wheat and barley were produced to their limit. Only enough corn was produced to satisfy the corn grain and silage requirements for feeding.

Tow line and wheel move systems were adopted in the transition from the dryland to an irrigation model choosing among three systems. This model had the choice of irrigation with either one or a combination of all three systems and the opportunity to irrigate 960 acres. However, only 383.7 acres were irrigated in the optimum plan. The tow line system was used to irrigate 304 of the total 384 acres. Wheat (270.4 acres) and corn (33.6 acres) were raised using the tow line systems. The wheel move system irrigated 79.7 acres of wheat for cash grain sales. Corn, oats, barley, and alfalfa remained under dryland conditions.

One programming solution was obtained in which the wheel move system was forced to irrigate 960 acre limit. This was done to show that irrigation alone is not the answer to low income levels, and that the reorganization of resources must be considered also when contemplating the adoption of irrigation. This particular system was selected

because its profitability in the previous chapter was in the mid-range along with labor requirements and investment.

A total of 924 acres was irrigated with the balance of 176 acres remaining under dryland conditions. Barley and wheat were again produced at their acreage limit. Barley production was divided between dryland (117.4 acres) and irrigated (132.6 acres). A total of 118 acres of alfalfa was produced for livestock feeding with about half the production coming from irrigation and half from dryland. The total production of corn, wheat and soybeans was derived from irrigation. Soybeans (42) and wheat sales (40) amounted to a total of 82 percent of grain sales with the balance coming from barley.

In each planning model the improved pasture was completely utilized. However, the native pasture was never fully used. A total of 100 acres, 28 acres, and 114 acres was unused in the dryland, choice of systems, and wheel move planning models, respectively. This unused resource was assumed to have the option of being rented out at $4.00 per AUM which would be added revenue to the firm.

Livestock Plans

The optimum livestock plans are presented in Table XXXIII. The cow-calf herd in the dryland model was 160 head. The planning model with a choice of systems experienced an increase of 53 head in the size of the cow-calf herd. The optimum cow-calf herd in the wheel move model was only one head larger than in the dryland model. The dryland and wheel move planning models raised some calves to yearling feeders on pasture for 12 months. Fifty-three head (dryland) and 59 head (wheel

Table XXXIII. The Optimum Livestock Enterprises on Dryland and Irrigation Cow-Calf Planning Models, Eastern Missouri Slope, South Dakota

Livestock Activity	Unit	Dryland	Choice of Systems	Wheel Move Irrigation
Cows Calve Out, February-March	Head	160	218	161
Transfer Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	53	---	59
Transfer Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, April	Head	62	157	57
Transfer 650 Pound Feeder, April, Feed Out in Period I, Silage Ration and Sell for Slaughter, October	Head	62	157	57

move) were sold on October 15 at 800 pounds. The remaining 62 and 57 calves in the respective models were fed a grain ration for six months before being transferred to drylot in period one (April 15 to October 15). The 157 calves remaining after cull sales in the irrigation planning model with a choice of systems also went into the six month grain feeding activity and then later transferred to drylot. The feeding requirements between the dryland and wheel move planning models were very close. The irrigation model having fewer cattle on feed demanded 6.4 percent less grain for feed than the dryland model. The choice irrigation planning model demanded a 146.7 percent increase in grain for feed compared to the dryland planning model.

The opportunity costs are of interest since they indicate a cost comparison of activities in and not in the current optimum plan. The opportunity cost of selling 425 pound calves was $24.25. This amounts to $5.71 per hundred weight. The opportunity cost of calf selling in the wheel move planning model was $5.44 per hundred weight while the calf selling opportunity was $5.44 per hundred weight in the dryland planning models. Thus, for calf selling to compete with the current feeding program in the optimum plan, calves would have to bring in excess of $37.71, $37.38, and $37.44 per hundred weight in the choice, the wheel move, and the dryland planning models, respectively. Slaughter animals weighing 1,050 to 1,100 pounds were sold for $28.50 per hundred weight in the optimum plans.

Labor

A summary of labor demanded per period is presented in Table XXXIV. Family and operator labor was not fully utilized in the three

Table XXXIV. Operator and Family Labor and Labor Hired by Period for Cow-Calf Model Farms, Eastern Missouri Slope, South Dakota

Model Farms — Periods:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
	Total Operator and Family Labor Available in Hours										
	450	483	353	344	218	217	217	218	435	541	3,476
Dryland											
Family Labor	450	483	353	115	218	39	217	218	435	541	3,069
Hired Labor	88	4	176	---	192	---	134	29	33	---	656
Total	538	487	529	115	410	39	351	247	468	541	3,725
Choice of Systems											
Family Labor	450	483	353	132	218	145	217	218	435	541	3,192
Hired Labor	392	239	209	---	393	---	333	19	25	150	1,760
Total	842	722	562	132	611	145	550	237	460	690	4,952
Wheel Move											
Family Labor	450	483	353	344	218	188	217	218	435	541	3,447
Hired Labor	83	---	99	13	129	---	63	54	112	373	926
Total	533	483	452	357	347	188	280	272	547	914	4,373

planning models analyzed in this chapter. The operator and family labor was fully utilized in all periods except four and six, May 1 to May 31 and June 16 to June 30, in the dryland and choice of systems planning models with only period six not completely utilized in the wheel move planning model.

A total of 656 hours was hired in the dryland model. The demand for this hired labor varied seasonally. No full-time help was required except in period five, June 1 to June 15, during the first cutting of alfalfa. Half-time help was required in period seven, July 1 to July 15, during the second cutting of alfalfa.

The greatest amount of hired labor was experienced in the irrigation model with the choice of systems. A total of 1,760 hours was hired which amounted to a 164.0 percent increase. During periods one, two, and three the equivalent of .9, .5, and .6 of a full-time man was required in the respective periods. Period five and seven, June 1 to June 15 and July 1 to July 15, utilized the equivalent of 1.8 and 1.5 full-time men. Periods eight and nine required just a few hours of part-time help in the model. A total of 150 hours was hired in period ten for fall work.

The wheel move planning model hired a total of 926 hours. Part-time help was hired in all periods except two and six. The largest amount of labor was hired during period ten, September 1 to November 15.

Capital

The individual capital requirements, total annual capital, and total capital required are presented in Table XXXV. The total annual

Table XXXV. Total Capital and Individual Capital Requirements for Cow-Calf Models, Eastern Missouri Slope, South Dakota

Capital	Dryland	Choice of Systems	Wheel Move Irrigation
Annual Operating	$ 17,752.00	$ 22,854.60	$ 24,214.00
Period 2 Operating	699.00	1,951.80	1,199.00
Livestock Facility	15,958.00	27,518.70	15,615.90
Livestock Animal	57,944.00	81,006.60	58,108.40
Crop Machinery	13,852.00	14,324.60	16,191.70
Irrigation Operating	-------	7,624.60	22,679.50
Irrigation System	-------	31,609.20	82,944.40
Total Annual Capital	$106,205.00	$186,890.10	$220,953.80
Land Capital			
Dryland	$165,000.00	$106,250.00	$ 24,000.00
Irrigable	-------	71,225.00	177,600.00
Pasture	33,600.00	33,600.00	33,600.00
Total Land Capital	$198,600.00	$212,075.00	$235,200.00
Total Capital Required	$305,003.00	$398,965.10	$456,153.80

capital needed was $106,205 (dryland), $186,890 (choice of systems), and $220,954 (wheel move) while the total capital required was $305,003, and $398,965, and $456,154, respectively.

Livestock animal and facility capital remained about the same in the dryland and wheel move planning models. Livestock facility capital increased to $27,518 in the choice of systems from $15,958 for dryland, and $15,615 for wheel move. Capital for the purchase of livestock amounted to $81,006 (choice of systems), $57,944 (dryland), and $58,108 (wheel move).

Annual operating capital increased from $17,752 in the dryland model to $22,854 in the choice of systems, and $24,214 in the wheel move planning model. Crop machinery capital increased from $13,852 (dryland) to $14,324 (choice of systems) to $16,191 (wheel move). The large increase from the choice to the wheel move planning model was due to the greater amount of acres irrigated and the machinery needed for soybean production.

The irrigation operating capital amounted to $7,624 in the choice of systems and $22,679 in the wheel move model. Irrigation system capital totaled $31,609 in the choice of systems model and $82,944 in the wheel move model. A percentage increase of 37.1 percent occurred in total irrigation capital going from the choice to the wheel move planning model. The amount of fixed capital was $198,600 (dryland), $212,075 (choice of systems), and $235,200 (wheel move).

Expenses

The expense components of the dryland and irrigated cow-calf operations are given in Table XXXVI. Total expenses amounted to $37,252

Table XXXVI. Summary of Expenses on Dryland and Irrigated Cow-Calf Operation, Eastern Missouri Slope, South Dakota

Expenses	Dryland	Choice of Systems	Wheel Move Irrigation
Livestock			
Operating Expenses	$ 6,976.00	$ 11,056.78	$ 6,899.04
Insurance and Taxes	1,103.00	1,795.62	1,088.13
Total Livestock Expenses	$ 8,079.00	$ 12,852.40	$ 7,987.17
Crops			
Dryland Operating	7,112.00	4,349.94	1,258.33
Irrigation Operating	-------	5,883.20	17,000.55
Total Operating Expenses	$ 7,112.00	$ 10,233.14	$ 18,258.88
Dryland Fertilizer	7,146.00	5,203.13	2,593.89
Irrigation Fertilizer	-------	3,807.91	8,482.22
Total Fertilizer Expenses	$ 7,146.00	$ 9,011.04	$ 11,076.11
Insurance and Taxes-Machinery	671.00	830.44	2,104.27
Insurance and Taxes-Irrigation	-------	1,382.30	5,174.21
Crop Insurance	1,067.00	2,137.37	3,445.13
Total Insurance and Taxes	$ 1,738.00	$ 4,350.11	$ 10,723.61
Total Crop Expenses	$ 15,996.00	$ 23,594.29	$ 40,058.60
Total Hired Labor	1,274.00	3,520.00	1,852.00

Table XXXVI. (Continued)

Expenses	Dryland	Choice of Systems	Wheel Move Irrigation
Depreciation			
Crop Machinery	$ 2,354.00	$ 2,313.72	$ 1,150.99
Livestock Facility	1,322.00	2,235.81	1,297.11
Irrigation System	-------	4,078.62	10,921.27
Total Depreciation	$ 3,676.00	$ 8,628.15	$ 13,369.67
Interest			
Annual Operating	1,420.00	1,828.37	1,937.12
Period 2 Operating	27.00	78.07	47.99
Livestock Facility	1,037.00	1,788.71	1,015.03
Livestock Animal	4,635.00	6,480.55	4,648.67
Crop Machinery	1,108.00	1,145.96	1,295.33
Irrigation Operating	-------	609.97	1,814.36
Irrigation System	-------	2,528.73	6,635.55
Total Interest	$ 8,227.00	$ 14,460.36	$ 17,394.05
TOTAL EXPENSES	$ 37,252.00	$ 63,055.20	$ 80,661.49

(dryland), $63,055 (choice), and $80,661 (wheel move). The crop expenses made up 42.9 percent, 37.4 percent, and 49.7 percent of the total expenses, respectively. Total livestock expense was $8,079 (dryland), $12,852 (choice), and $7,987 (wheel move). The increased expense in the choice of system planning model was due to the increased size of the cow-calf herd. Depreciation increased $4,952 (choice), and $9,693 (wheel move) over the dryland model with the majority of the increase attributed to irrigation depreciation. Interest expense amounted to $8,227 (dryland), $14,460 (choice), and $17,394 (wheel move). The greatest amount of increase was due to irrigation operating expenses and system interest in the respective models.

Financial Statements

Table XXXVII summarizes the operating statements and compares returns to management in the dryland and irrigation cow-calf planning models. The total enterprise returns were $21,184 (dryland), $21,781 (choice), and $18,794 (wheel move). The dryland returns compared to the enterprise returns of the dryland planning model in Chapter III experienced a 53 percent decline. By irrigating 384 acres in the choice of systems planning model, enterprise returns increased by $597.59 or 2.8 percent compared to the dryland model in this chapter. When forcing the wheel move planning model to irrigate at the 960 acre level, enterprise returns decrease to $18,794. This amounted to a decrease of $2,389 compared to the dryland planning model. This illustrates that irrigation alone will not solve the problem of low income levels. The non-allocated costs varied from $20,537 (dryland) to $21,487 (choice),

Table XXXVII. Operating Statement and Comparison of Returns to Dryland and Irrigation Cow-Calf Operations, Eastern Missouri Slope, South Dakota

Item	Dryland	Choice of Systems	Wheel Move Irrigation
Gross Income			
Livestock	$ 35,729.00	$ 54,699.31	$ 35,477.76
Crops	21,807.00	29,882.48	62,953.30
Pasture Revenue	900.00	255.00	1,025.00
Total	$ 58,436.00	$ 84,836.79	$ 99,456.06
Expenses			
Livestock	8,079.00	12,852.40	7,987.17
Crops	15,996.00	23,594.29	40,058.60
Hired Labor	1,274.00	3,520.00	1,852.00
Depreciation	3,676.00	8,628.15	13,369.67
Interest	8,227.00	14,460.36	17,394.05
Total Expenses	$ 37,252.00	$ 63,055.20	$ 80,661.49
ENTERPRISE RETURNS	$ 21,184.00	$ 21,781.59	$ 18,794.57
Overhead Expenses			
Non-Allocated Costs	$ 2,425.00	$ 2,425.00	$ 2,425.00
Interest on Land	14,112.00	14,845.00	16,464.00
Land Taxes	3,200.00	3,417.50	3,680.00
Depreciation-Fences	800.00	800.00	800.00
Total Overhead Expenses	$ 20,537.00	$ 21,487.50	$ 23,369.00
RETURNS TO LABOR AND FARM MANAGEMENT	$ 647.00	$ 294.00	- $ 4,574.00

Table XXXVII. (Continued)

Item	Dryland	Choice of Systems	Wheel Move Irrigation
Operator and Family Labor			
Enterprise	$ 6,952.00	$ 6,952.00	$ 6,952.00
Overhead	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	- $ 8,105.00	- $ 8,457.91	- $ 13,326.43

and $23,369 (wheel move). The greatest part of the variation was due to the differences in the amounts of land capital tied up in the different planning models. Thus the interest on land varied from $14,112 (dryland) to $14,845 (choice) to $16,464 (wheel move). The remaining variation was due to the change in land taxes due to the irrigation at the different levels.

Returns to labor and farm management amounted to $647 (dryland), $294 (choice), and -$574 (wheel move). The operator and family labor was never fully utilized but it was assumed that they didn't want to change their standard of living. The resulting returns to management were -$8,105 (dryland), -$8,457 (choice), and -$13,326 (wheel move).

Interest on land was assumed to be higher for the irrigation models than for the dryland model because of an anticipated higher value for the irrigated land. The interest charge was $733 higher for the choice model and $2,352 higher for the wheel move model. If the same land interest charge were made for all models, the management returns would be -$7,725 for the choice model and -$10,974 for the wheel move model compared to -$8,105 for the dryland model. Even with this adjustment labor management returns would be only slightly better for the choice model than for dryland.

Summary

The analysis in this chapter emphasized the importance of enterprise organization in management of both dryland and irrigation farming. In the cow-calf models, the firm became more diversified in livestock and grain farming. The returns for the dryland model in

Chapter III were $8,453 while returns for the dryland cow-calf model in this chapter amounted to -$8,105. This is a difference of $16,558. The buying of feeder calves and yearlings was restricted in the cow-calf models and all grain production was sold after meeting the feed requirements for the cow-calf operation in each optimum solution. Thus the enterprise organization appears to be highly significant compared to the planning models in Chapter III.

This chapter showed the adoption of irrigation to be uneconomic if the grain production was to be sold rather than fed in an intensified feeding operation as was illustrated in Chapter III. With the adoption of irrigation returns to management decreased below those of the dryland cow-calf planning model. When the choice of systems model irrigated 383.6 acres out of a possible 960 acres, returns decreased to -$8,457 which was a $352 decrease from the dryland cow-calf model. Returns in the wheel move planning model which was forced to irrigate 924 acres decreased to -$13,326. The wheel move and the dryland cow-calf models livestock plans were almost the same. Cash grain sales became a large portion of sales in the wheel move model. This shows, as was pointed out in Chapter III, that the value added from feeding livestock given a feed supply compared to relying on cash grain sales provides the greatest returns to management. This gives further evidence that the organization of livestock enterprises is of great importance when considering the adoption of irrigation.

Table XXXVIII. The Optimum Land Use Plans for Dryland Planning Models with the Option to Buy Feed Grain and Hours Equivalent to Wheel Move Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Activities	Unit	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Dryland Crops				
Class I Land				
Corn	Acre	318.3	465.9	600.6
Wheat	Acre	350.0	42.3	-----
Barley	Acre	49.7	209.8	117.4
Class II Land				
Alfalfa	Acre	382.0	74.3	-----
Wheat	Acre	-----	307.7	350.0
Barley	Acre	-----	-----	32.0
Total Dryland	Acre	1,100.0	1,100.0	1,100.0
Pasture				
Native	Acre	137.1	136.3	135.5
Improved	Acre	320.0	320.0	320.0
Feed Lot	Acre	2.9	3.7	4.5
Total	Acre	460.0	460.0	460.0

Table XXXIX. Total Acres of Crops, Grain and Forage Production, and Grain Purchased in Dryland Planning Models with Hours Equivalent to Wheel Move Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Activities	Unit	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Total Acres of Crops				
Corn	Acre	318.3	465.9	600.6
Wheat	Acre	350.0	350.0	350.0
Barley	Acre	49.7	209.8	149.4
Alfalfa	Acre	382.0	74.3	-----
Total	Acre	1,100.0	1,100.0	1,100.0
Grain and Forage Production				
Corn	Bushels	-----	-----	-----
Wheat	Bushels	9,391	8,219	6,880
Barley	Bushels	2,297	8,389	6,006
Silage	Tons	2,545	3,727	4,805
Alfalfa	Tons	535	104	-----
Feed Purchased				
Corn	Bushels	26,450	38,506	56,508
Alfalfa	Tons	48	574	810

465.0 acres (640 acre level) to 600.6 acres (960 acre level). Corn grain is purchased in all planning models, amounting to 26,450 bushels, 38,506 bushels, and 56,508 bushels for the dryland planning models with hours equivalent to the three irrigation levels. The total acres of wheat production in each planning model is 350 acres. Bushels of wheat production decrease as the hours of labor available in the planning models increase. This reduction in bushels of wheat resulted from shifting wheat production from Class I to Class II land. The remaining acres of cropland are used for barley and alfalfa production. A total of 49.7 acres (320 acre level), 209.8 acres (640 acre level), and 117.4 acres (960 acre level) of barley is raised in the respective planning models. A total of 382 and 74.3 acres of alfalfa was grown in the planning models with hours of labor equivalent to 320 and 640 acres respectively. This resulted in a production of 535 tons and 104 tons while a total of 48 tons and 574 tons was purchased respectively. At the level equivalent to 960 acres, the total amount of alfalfa needed to satisfy feed requirements was purchased.

Livestock Plans

The optimum livestock plans are presented in Table XL. A comparison of the number of cattle purchased and fed between the wheel move irrigation planning models and the dryland planning models with hours equivalent to those in the irrigation models at the three acreage levels is given in Table XLI. With the amount of labor available and the option to buy additional feed, an increase in the total number of cattle purchased and on feed is experienced in each

Table XL. The Optimum Livestock Enterprises in Dryland Planning Models with Hours Equivalent to Wheel Move Irrigation at 320 Acre, 640 Acre, and 960 Acre Levels

Livestock Activities	Unit	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move irrigation at 960 Acre Level
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeder	Head	342	342	339
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	240	219	278
Buy 650 Pound Feeders, April, Feed Out in Period 1, Silage Ration and Sell for Slaughter, April	Head	338	628	814
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	578	847	1,092
Total Calves Purchased	Head	582	562	617
Total Feeders Purchased	Head	916	1,475	1,906

Table XLI. Comparison of Number of Livestock Purchased and on Feed in Wheel Move Irrigation Planning Models and Dryland Planning Models with Hours Equivalent to Wheel Move Irrigation at 320 Acre, 640 Acre, and 960 Acre Level

Planning Models	Calves	Period 1 Yearlings	Period 2 Yearlings	Total
Irrigation 320 Acre Level	983	----	430	1,413
Dryland-Hours Equivalent to 320 Acre Level	582	338	578	1,498
Irrigation 640 Acre Level	1,329	----	576	1,905
Dryland-Hours Equivalent to 640 Acre Level	562	628	847	2,037
Irrigation 960 Acre Level	1,721	----	721	2,442
Dryland-Hours Equivalent to 960 Acre Level	617	814	1,092	2,523

dryland planning model. The increase amounts to an additional 85 head, 132 head, and 81 head in the dryland planning models with hours equivalent to the three irrigation acreage levels, respectively. These models show a decrease in the number of calves purchased, but period one yearlings are purchased which did not occur in the irrigation planning models. An increase in the number of period two yearlings purchased and being fed in drylot amounted to 148 head, 271 head, and 371 head for the dryland planning models with hours of labor equivalent to the three irrigation acreage levels, respectively.

The pasture was fully utilized in each planning model by the raising of feeders. The number of feeders raised on pasture remained relatively constant at 342 (320 acre level), 342 head (640 acre level), and 339 head (960 acre level). The balance of the calves purchased were fed a grain ration for six months before being transferred to drylot to be fed with the yearlings purchased in period one. Thus, a total of 578 head, 847 head, and 1,092 head of yearlings are fed to slaughter weight in this drylot activity in both periods one and two in the respective models.

Labor

Both family and hired labor were fully utilized to their restriction level in all three planning models. Table XLII summarizes how the labor was utilized in each period.

The distribution of hired labor for the planning model with hours of labor equivalent to irrigation at the 320 acre level was as follows: Periods two, three, and four, February 1 to March 31, April 1

Table XLII. Operator and Family Labor and Labor Hired by Period for Dryland Planning Model with Feed Buying Option, Eastern Missouri Slope, South Dakota

Planning Model	Period:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
		Total Operator and Family Labor Available in Hours										
		450	483	353	344	218	217	217	218	435	541	3,476
Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Level												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		796	558	291	384	443	46	404	126	202	1,321	4,571
Total		1,246	1,041	644	728	661	263	621	344	637	1,862	8,047
Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Level												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,189	851	520	662	239	144	200	257	452	2,069	6,585
Total		1,639	1,334	873	1,006	457	361	417	475	887	2,610	10,061
Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Level												
Family Labor		450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor		1,594	1,158	648	913	232	233	217	314	572	2,720	8,591
Total		2,044	1,641	1,001	1,257	450	450	434	532	1,007	3,261	12,067

to April 30, and May 1 to May 31, demand approximately the equivalent of one full-time man; periods one, five, and seven, November 16 to January 31, June 1 to June 15, and July 1 to July 15, each utilized approximately two full-time men; periods six, eight, and nine, June 16 to June 30, July 16 to July 31, and August 1 to August 31, required just part-time help which ranged from .2 to .6 to .5 full-time men equivalents respectively. Period ten, September 1 to November 15, was the period when the largest demand for labor appeared. The greatest portion of the labor demanded in this period was for harvesting silage, which required the equivalent of 2.5 full-time men.

Capital

The individual capital requirements and total annual capital, and total capital required are given in Table XLIII. A comparison of total annual capital required for the wheel move irrigation planning models and the dryland planning models with hours equivalent to the irrigation planning models is given in Table XLIV.

Table XLIV shows the dryland planning models require slightly less total annual capital than the irrigated models. Specifically, the dryland planning models require 97.8 percent, 96.5 percent, and 95.5 percent of the capital required in the wheel move irrigation planning models at the 320 acre, 640 acre, and 960 acre levels, respectively.

Annual operating capital requirements made the greatest change in capital requirements between the irrigation and the dryland planning models at the 320 acre level. An increase of $31,478 was experienced

Table XLIII. Total Annual Capital and Individual Capital Requirements for Dryland Planning Model with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Capital	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Annual Operating	$ 70,273.00	$106,776.40	$143,306.90
Period 2 Operating	9,448.30	14,467.00	18,831.90
Livestock Facility	61,368.80	76,060.20	93,867.90
Livestock Animal	191,329.50	251,091.40	309,208.90
Crop Machinery	14,713.40	18,967.70	20,586.70
Total Annual Capital	$347,133.00	$467,362.70	$585,802.30
Land Capital			
Dryland	$168,000.00	$168,000.00	$168,000.00
Pasture	33,600.00	33,600.00	33,600.00
Total Land Capital	$201,600.00	$201,600.00	$201,600.00
TOTAL CAPITAL REQUIRED	$548,733.00	$668,962.70	$787,402.30

Table XLIV. Comparison of Total Annual Capital for Wheel Move Irrigation Planning Models and Dryland Planning Models with Hours Equivalent to Wheel Move Irrigation at 320, 640, and 960 Acre Levels

Capital	Wheel Move Irrigation 320 Level	Dryland-Hours Equivalent to 320 Acre Level
Annual Operating	$ 38,794.10	$ 70,273.00
Period 2 Operating	9,678.80	9,448.30
Livestock Facility	77,074.20	61,368.80
Livestock Animal	177,003.50	191,329.50
Crop Machinery	16,506.90	14,713.40
Irrigation Operating	8,080.30	---
Irrigation System	27,648.20	---
TOTAL ANNUAL CAPITAL	$354,786.00	$347,133.00

	Wheel Move Irrigation 640 Level	Dryland-Hours Equivalent to 640 Acre Level
Annual Operating	$ 51,415.00	$106,776.40
Period 2 Operating	10,090.80	14,467.00
Livestock Facility	106,604.90	76,060.20
Livestock Animal	227,107.10	251,091.40
Crop Machinery	17,599.00	18,967.70
Irrigation Operating	16,171.90	---
Irrigation System	55,296.20	---
TOTAL ANNUAL CAPITAL	$484,285.00	$467,362.70

	Wheel Move Irrigation 960 Level	Dryland-Hours Equivalent to 960 Acre Level
Annual Operating	$ 64,152.60	$143,306.90
Period 2 Operating	12,463.00	18,831.90
Livestock Facility	138,849.10	93,867.90
Livestock Animal	279,521.80	309,208.90
Crop Machinery	18,555.60	20,586.70
Irrigation Operating	24,298.10	---
Irrigation System	82,944.40	---
TOTAL ANNUAL CAPITAL	$610,784.00	$585,802.30

in annual operating capital by going to the dryland model. This 81.8 percent increase was due to the purchase of the additional feed in order to satisfy the feeding requirements. The change in period 2 operating capital was not significant. There was a decrease of $15,705 in livestock facility capital. This was attributable to fewer calf facilities and a greater concentration of drylot facilities. Crop machinery capital decreased $1,793 or 10.8 percent.

The dryland planning model at the 640 acre level experienced an increase of $55,361 in annual operating capital which is a percentage increase of 107.6 percent. Again as noted above, this was attributable to the purchase of feed. A 43.3 percent increase occurred in period 2 operating capital. Livestock facility capital decreased by $30,544 which was due to a further concentration in drylot facilities. Livestock animal capital increased by $23,984 or 10.5 percent. An increase in crop machinery capital of $1,368 was experienced.

An increase of $79,154 in annual operating capital occurred at the 960 acre level in the dryland planning model. This is a percentage increase of 123.3 percent. This was due to the increased amount of corn and alfalfa purchased to meet the feed requirements for the livestock feeding activities. Period 2 operating capital had a percentage increase of 51.1 percent which amounted to $6,368. Livestock facility capital experienced a percentage decrease of 32.3 percent. This decrease amounted to $49,981. This was attributed to a greater concentration of drylot feeding facilities and a decrease in yearling feeding facilities. Livestock animal capital increased $29,687 or 10.6 percent. There was also an increase of $2,031 or 10.9 percent in crop machinery capital.

The total capital required as shown in Table XLIII amounted to $548,733 (320 acre level), $668,962 (640 acre level), and $787,402 (960 acre level). In each case this was slightly less than the total capital required for the respective irrigation planning models.

Expenses

A breakdown of the different expense components on the dryland planning models is presented in Table XLV. Livestock expenses made up the greatest portion of the total expenses in each planning model. The purchase of livestock was the largest component of total livestock expense followed by the purchase of feed, operating expenses, and insurance and taxes on machinery, respectively. The purchase of livestock increased from $257,547 (320 acre level) to $362,671 (640 acre level), to $453,539 (960 acre level). This represents an increase of $105,124 and $90,868 respectively for each step. The dollar amount of increased feed purchased was $27,168 going from the 320 acre level to the 640 acre level and $27,920 from the 640 acre level to the 960 acre level. A change of $11,287 in operating expenses occurred in the transition from the 320 acre level to the 640 acre level. The 640 acre level to the 960 acre level resulted in an increase of $10,842.

The crop expenses were $19,027 (320 acre level), $21,158 (640 acre level), and $23,158 (960 acre level). These were due to increases in all crop expense components. Dryland operating expenses increased by 12.9 percent and 6.8 percent going from the 320 to the 640 and to the 960 acre levels. Crop insurance increased by $943 going to the 640 acre planning model, a 43.8 percent increase, and the 960 acre planning

Table XLV. Summary of Expenses on Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Expenses	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Livestock			
Purchase of Livestock	$257,547.12	$362,671.21	$453,539.34
Operating Expenses	32,742.39	44,030.03	54,872.75
Purchase Feed	34,166.50	61,334.50	89,265.00
Insurance and Taxes	5,049.73	6,693.46	8,393.55
Total Livestock Expenses	$329,505.74	$474,729.20	$606,070.64
Crops			
Dryland Operating	$ 8,228.64	$ 9,293.33	$ 9,933.52
Dryland Fertilizer	7,923.23	8,458.81	8,929.76
Insurance and Taxes-Machinery	713.99	764.97	794.11
Crop Insurance	2,151.98	3,095.22	3,501.11
Total Crop Expenses	$ 19,017.84	$ 21,612.33	$ 23,158.50
Total Hired Labor	$ 9,142.00	$ 13,170.00	$ 17,182.00

Table XLV. (Continued)

Expenses	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Depreciation			
Crop Machinery	$ 2,846.78	$ 3,270.89	$ 3,548.49
Livestock Facility	5,888.21	7,679.17	9,554.54
Total Depreciation	$ 8,734.99	$ 10,950.06	$ 13,103.03
Interest			
Annual Operating	$ 5,621.84	$ 8,542.11	$ 11,440.55
Period 2 Operating	377.93	578.68	753.27
Livestock Facility	3,988.97	4,943.91	6,101.41
Livestock Animal	15,306.36	20,087.31	24,736.71
Crop Machinery	1,177.07	1,517.41	1,646.94
Total Interest	$ 26,472.17	$ 35,669.42	$ 44,678.88
TOTAL EXPENSES	$392,872.74	$556,130.91	$704,193.05

model increased by an additional 13.3 percent. Insurance and taxes on machinery increased just slightly. Dryland fertilizer expenses increased 6.7 percent (640 acre level) and 5.5 percent (960 acre level).

Depreciation expense increased from $8,734 (320 acre level) to $10,950 (640 acre level) to $13,103 (960 acre level). Livestock facility depreciation made up 80.8 percent and 87.1 percent of the respective increased expense.

The total interest expense increased from $26,472 (320 acre level) to $35,669 (640 acre planning model) to $44,678 (960 acre planning model). This amounts to a percentage increase of 34.7 percent and 25.2 percent respectively. Interest for livestock animal capital made up the greatest portion of this increase amounting to 51.9 percent and 51.6 percent of the respective increases. Interest for annual operating capital made up the next largest amount which amounted to 31.7 percent and 33.9 percent of the total amount of interest. Livestock facility interest increased by $954 at the 640 acre level and $1,157 at the 960 acre level which was a percentage increase of 10.3 percent and 12.8 percent respectively.

Financial Statements

Table XLVI summarizes the operating statements for the dryland planning models with the option to buy feed grain. The enterprise returns were $43,505, $47,250, and $50,322 for the planning models with hours equivalent to wheel move irrigation at the 320 acre, 640 acre, and 960 acre levels, respectively. The non-allocated costs were $20,537. Returns to labor and farm management were $22,968 (320 acre

Table XLVI. Operating Statement and Comparison of Returns to Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Item	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Gross Income	$436,377.85	$603,381.62	$754,515.21
Expenses:			
Livestock	$329,505.74	$474,729.20	$606,070.64
Crops	19,017.84	21,612.33	23,158.50
Hired Labor	9,142.00	13,170.00	17,182.00
Depreciation	8,734.99	10,950.06	13,103.03
Interest	26,472.17	35,669.42	44,678.88
Total Expenses	$392,872.74	$556,130.91	$704,193.05
ENTERPRISE RETURNS	$ 43,505.11	$ 47,250.71	$ 50,322.16
Overhead Expenses:			
Non-Allocated Costs	$ 2,425.00	$ 2,425.00	$ 2,425.00
Interest on Land	14,112.00	14,112.00	14,112.00
Land Taxes	3,200.00	3,200.00	3,200.00
Depreciation-Fences	800.00	800.00	800.00
Total Overhead Expenses	$ 20,537.00	$ 20,537.00	$ 20,537.00
RETURNS TO LABOR AND FARM MANAGEMENT	$ 22,968.11	$ 26,713.71	$ 29,785.16

Table XLVI. (Continued)

Item	Planning Model with Hours Equivalent to Wheel Move Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Wheel Move Irrigation at 960 Acre Level
Operator and Family Labor			
Enterprise	$ 6,952.00	$ 6,952.00	$ 6,952.00
Overhead	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 14,216.11	$ 17,961.71	$ 21,033.16

planning model), $26,713 (640 acre planning model), and $29,785 (960 acre planning model). After deducting $8,752 for family and operator's labor, returns to management were $14,216 (320 acre level), $17,961 (640 acre level), and $21,003 (960 acre level).

Table XLVII shows a comparison of returns to management for the dryland planning model from Chapter III (regular) and the dryland planning model with hours equivalent to wheel move irrigation at the 320 acre, 640 acre, and 960 acre levels, and the adoption of irrigation (wheel move) at the respective levels.

Table XLVII. Comparison of Returns to Management

Planning Models	Returns to Management (320 Acre)	Returns to Management (640 Acre)	Returns to Management (960 Acre)
Dryland (Chapter III)	$ 8,453.00	$ 8,453.00	$ 8,453.00
Dryland with Hours Equivalent to Wheel Move Irrigation	$14,326.11	$17,961.71	$21,033.16
Wheel Move Irrigation	$19,444.53	$27,652.20	$35,525.18

The regular dryland planning model which required that all grain and hay be produced on the farm (Chapter III) had returns of $8,453. Given the option to buy additional feed and the amount of labor that an irrigation planning model demanded when irrigating 320 acres, the returns to management increased to $14,326, a percentage increase of 69.4 percent. The returns to management could be increased by 35.7 percent or an additional $5,118 through the adoption of irrigation at this level.

With the equivalent hours of wheel move irrigation at the 640 acre level, returns to management can be increased to $17,962, an increase of 112.4 percent over the regular dryland planning model from Chapter III. This is an increase of 25.3 percent over the dryland planning model with hours of labor equivalent to irrigation at the 640 acre level. By adopting irrigation at the 640 acre level, returns would increase 53.9 percent or by an additional $9,690 to $27,652.

Returns for the dryland planning model with hours of labor equivalent to irrigation at the 960 acre level were $21,033. This was 148.8 percent greater than the returns in the dryland model in Chapter III. However, by adopting irrigation at this level, returns to management could be increased to $35,525 which is an additional $14,492.

Summary

The planning models in this chapter showed the profitability of purchasing feed while remaining a dryland farmer as compared to adopting irrigation and raising a feed supply. It was assumed that the dryland operator would be able to hire the same hours of labor as the irrigation plans required. Three different labor levels were analyzed. The labor levels were those equivalent to the wheel move planning models at the 320 acre, 640 acre, and 960 acre levels.

The results showed returns to management to be greater than in the dryland planning model in Chapter III. When given the option to buy additional feed and the amount of labor equivalent to the irrigation planning model at the 320 acre, 640 acre, and 960 acre levels, returns

to management increase to $14,326 from $8,453 in the dryland model in Chapter III. This is a percentage increase of 69.4 percent. With the equivalent hours of labor at the 640 acre level, returns to management are increased to $17,961 or 112.5 percent. At the 960 acre level returns were $24,033 which is 148.8 percent greater than the dryland planning model in Chapter III.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to provide data on optimum combinations of enterprises and farm organizations resulting from the adoption of irrigation in North Central South Dakota. It provided information on how the optimum combination of enterprises varied between different systems. The determination of the optimum farm organizations will give the farmers in the area a basis for comparison of their present dryland farming operations against the potentials under irrigation farming. The optimum farm organization was defined as that which yielded maximum returns in terms of labor and management income to the farmer. Another criterion used in this study provided estimates of dollar costs and returns in considerable detail for the selected sprinkler irrigation systems as applied to the three different irrigation levels under conditions widely encountered in the study area. It was intended to provide interested parties with some comparisons between systems and with costs and returns data which could be accepted or modified as required to fit the individual situation.

The findings in Chapter III show the potential profitability of the adoption of irrigation and also the importance of farm organization of enterprises. The unrestricted (in terms of capital and labor) irrigation planning models in Chapter III at the respective irrigation levels experienced gains in returns to farm management. The returns to farm management were $8,453 in the dryland planning models in Chapter

III. Irrigation at the 320 acre level yielded returns to management of $16,236.54 in the center pivot planning model, $19,444.53 in the wheel move planning model, and $21,092.52 in the tow line planning model. This was a percentage increase over dryland returns of 149.5 percent, 130.0 percent, and 92.0 percent respectively for tow line, wheel move, and center pivot.

The adoption of irrigation at the 640 acre level continued to increase returns. Irrigation continued to be most profitable under the tow line system. This was because of its lower investment. Irrigation at this level yielded returns to farm management of $30,773.47 (tow line), $27,652.20 (wheel move), and $21,372.04 (center pivot). Comparing these returns to irrigation at the 320 acre level, returns to management increased by 45.8 percent, 42.2 percent, and 31.6 percent for tow line, wheel move, and center pivot, respectively. The percentage increases of irrigated returns to farm management at this level over dryland returns were 264.0 percent (tow line), 227.1 percent (wheel move), and 152.8 percent (center pivot).

The greatest returns to management for irrigation at the 960 acre level were also yielded by the tow line irrigation planning model. The tow line returns were 13.3 percent, 18.0 percent, and 54.2 percent greater than those for the wheel move, choice of three systems, and center pivot planning models respectively. Returns to management amounted to $40,280.54 (tow line), $35,525.18 (wheel move), and $26,118.99 (center pivot). This was 30.8 percent (tow line), 28.4 percent (wheel move), and 23.3 percent (center pivot) increase over the respective planning models at the 640 acre level, while it was

90.0 percent, 82.7 percent, and 60.8 percent increase over the adoption of irrigation at the 320 acre level respectively. Returns to management at the 960 acre level were 376.5 percent (tow line), 320.2 percent (wheel move), and 208.9 percent (center pivot) greater than the dryland planning model.

No cash crop sales appeared in the optimum solution for any of the planning models in Chapter III. Feeding of livestock was the dominant enterprise which became more intensified with the more acres irrigated. The planning models in Chapter III utilized every available resource in the optimum organization of each model.

The tow line planning model at each respective irrigation acreage level yielded the greatest returns to management. Thus, if the firm's labor supply was unrestricted as long as it was profitable to pay $2.00 per hour, it would be to the firm's advantage to adopt the tow line system because of its lower investment.

Family labor was fully utilized in all planning models in Chapter III. The annual labor requirements were increased in every instance with the adoption of irrigation. The total labor requirements ranged from 5,938 man hours to 12,553 man hours for the dryland and tow line irrigation planning models (960 acre level) respectively.

Capital requirements rose with each successive increase in the acreage level of irrigation. Since all the planning models were oriented towards a feeding operation, the biggest component of total annual capital was for purchasing livestock. The purchase of livestock required 56.6 percent of total annual capital in the dryland planning model. In the irrigation planning model at the 320 acre

level, livestock capital made up approximately one-half (50.6 percent in tow line, 49.6 percent in wheel move, 49.5 percent in center pivot) of the total annual capital in each case. Livestock animal capital at the 640 acre irrigation level increased by 28 percent over the 320 acre level. Capital for the purchase of livestock at the 960 acre irrigation level increased by about 22 percent.

The total annual capital requirements ranged from $217,078 (dryland) to $610,784 (wheel move irrigation planning model at the 960 acre level). At each irrigation level the wheel move planning model had the greatest capital requirements because a greater number of acres were being irrigated with this system, thus a greater feed supply was provided, and more feeder cattle were purchased and fed.

The optimum crop organizations were altered with the adoption of irrigation. The intensive feeding operations under irrigation at each acreage level showed a significant increase in total production of corn and alfalfa. The only major alteration among the organization of crops was a decrease in wheat production from 294.2 acres (dryland) to 34.7 acres (tow line), 31.1 acres (wheel move), and 60.0 acres (center pivot) at the 320 acre irrigation level. Irrigation at the 640 acre and 960 acre levels showed no wheat production at all. Barley production increased from 0 acres in the dryland planning model to 250 acres in the 320 acre and 640 acre irrigation planning models to satisfy the balance of the feed requirements. Barley production decreased just slightly at the 960 acre irrigation level. The optimum solution in the irrigation planning models brought in more livestock at each acreage level because of the rise in the feed base provided by the irrigated yields.

Chapters IV and V examined alternative planning models. Chapter IV gave a comparative analysis of a dryland and irrigation (choice of systems with the option to irrigate 960 acres and wheel move) cow-calf operation. In this chapter the purchase of livestock for feeding was restricted.

In a cow-calf operation, the firm became more diversified in livestock and grain farming. In the dryland planning model, sales were 63 percent (livestock feeding) and 37 percent (grain sales). Livestock sales were 65 percent of gross sales in the planning model with choice of systems. Livestock and crop sales represented 37 percent and 63 percent respectively in the wheel move planning models. The difference between returns to management in the dryland planning model in Chapter III and Chapter IV amounted to $16,558.00. Returns to management were -$8,105 (dryland), -$8,457.91 (choice of systems), and -$13,326.43 (wheel move). The alternative planning models in Chapter IV showed the adoption of irrigation to be uneconomic if the grain production was to be sold rather than fed in an intensified feeding operation as was illustrated in Chapter III. The buying of feeder calves and yearlings was restricted in this chapter and all grain production was sold after meeting the feed requirements for the cow-calf operation in each optimum solution.

The alternative planning models in Chapter V showed the profitability of purchasing feed while remaining a dryland farmer as compared to adopting irrigation and raising a feed supply. It was assumed that the dryland operator would be able to hire the same hours of labor as the irrigation plans required. Three different labor levels

were analyzed. The labor levels were those equivalent to the wheel move planning models at the 320 acre, 640 acre, and 960 acre levels.

The results showed returns to management to be greater than in the dryland planning model in Chapter III. Table XLVIII shows a comparison of returns to management for the regular dryland planning model and the dryland planning model with hours equivalent to wheel move irrigation at the 320 acre, 640 acre, and 960 acre levels, and the adoption of irrigation (wheel move) at the respective levels.

When given the option to buy additional feed and the amount of labor equivalent to the irrigation planning model at the 320 acre, 640 acre, and 960 acre level, returns to management increased to $14,326, a percentage increase of 69.4 percent. The returns to management could be increased by 35.7 percent or an additional $5,118 through the adoption of irrigation at this level.

With the equivalent hours of labor of the wheel move irrigation at the 640 acre level, returns to management are increased to $17,961, an increase of 112.4 percent over the regular dryland planning model. This is an increase of 25.3 percent over the dryland planning model with hours equivalent to the 320 acre irrigation level. By adopting irrigation at this particular level, returns would be increased by an additional $9,690 or 53.9 percent.

At the 960 acre level returns were $24,033 which is 148.8 percent greater than the dryland planning model in Chapter III. Adopting irrigation at this level, returns to management would be increased by an additional $14,492, which was a 68.9 percent increase.

Table XLVIII. Comparison of Returns to Management

Planning Models	Returns to Management (320 Acre)	Returns to Management (640 Acre)	Returns to Management (960 Acre)
Dryland (Chapter III)	$ 8,453.00	$ 8,453.00	$ 8,453.00
Dryland with Hours Equivalent to Wheel Move Irrigation	$14,326.11	$17,961.71	$21,033.16
Wheel Move Irrigation	$19,444.53	$27,652.20	$35,525.18

It is evident that the value added from feeding livestock is the rational decision for the farm firm to make. The analysis in Chapter V shows that a dryland farm can increase its returns to management by expanding its feeding operation and purchasing the additional feed required. However, with the same labor requirements and just slightly more total capital required in each instance (see Table XLIX), the adoption of irrigation shows the highest returns to managment.

It is the author's contention that feed supplies can best be utilized for the highest income returns by using them to finish livestock within the state. The firm has the option to improve returns to management through the adoption of irrigation. This argument is supported by the results found in this study. Partial control of the moisture variable with irrigation water would stabilize forage production and reduce the risk of short-run feed shortages. Forage production would be expected to be the dominant cropping pattern under the adoption of irrigation. Forage grown under irrigation would provide for the expansion of present livestock production and for better balanced and more flexible livestock operations.

Table XLIX. Comparison of Total Annual Capital for Wheel Move Irrigation Planning Models and Dryland Planning Models with Hours of Labor Equivalent to Wheel Move Irrigation at 320, 640, and 960 Acre Levels

Capital	Wheel Move Irrigation 320 Level	Dryland-Hours Equivalent to 320 Acre Level
Annual Operating	$ 38,794.10	$ 70,273.00
Period 2 Operating	9,678.80	9,448.30
Livestock Facility	77,074.20	61,368.80
Livestock Animal	177,003.50	191,329.50
Crop Machinery	16,506.90	14,713.40
Irrigation Operating	8,080.30	---
Irrigation System	27,648.20	---
TOTAL ANNUAL CAPITAL	$354,786.00	$347,133.00

	Wheel Move Irrigation 640 Level	Dryland-Hours Equivalent to 640 Acre Level
Annual Operating	$ 51,415.00	$106,776.40
Period 2 Operating	10,090.80	14,467.00
Livestock Facility	106,604.90	76,060.20
Livestock Animal	227,107.10	251,091.40
Crop Machinery	17,599.00	18,967.70
Irrigation Operating	16,171.90	---
Irrigation System	55,296.20	---
TOTAL ANNUAL CAPITAL	$484,285.00	$467,362.70

	Wheel Move Irrigation 960 Level	Dryland-Hours Equivalent to 960 Acre Level
Annual Operating	$ 64,152.60	$143,306.90
Period 2 Operating	12,463.00	18,831.90
Livestock Facility	138,849.10	93,867.90
Livestock Animal	279,521.80	309,208.90
Crop Machinery	18,555.60	20,586.70
Irrigation Operating	24,298.10	---
Irrigation System	82,944.40	---
TOTAL ANNUAL CAPITAL	$610,784.00	$585,802.30

There is a need for further research on the strategies of managing capital flows in a manner that allows the farm firm to increase the acreage levels of irrigation. The trend towards larger dryland farms suggests the same trend may occur on irrigation farms. Research is needed to determine the most efficient size irrigation farm. In turn this research could be extended to determine what the minimum land requirements are along with other resources required to attain a specified income level. Thus, one could hypothesize what the role that irrigation could play in the survival of the firm.

Research is needed to determine the potential production of horticultural crops under irrigation. The costs of producing these crops in South Dakota as compared to costs in areas presently producing these crops would have to be determined. In addition, the cost of marketing these specialty crops would have to be found in order to determine their feasibility.

The survival of the farm firm is a most crucial question in today's agricultural world. In order to achieve economies of scale in the complex world of agriculture, many firms are expanding in acres and growing in net worth. Thus, a high priority should be placed upon an irrigation simulation study. Such a study would be designed to analyze the strategies used to achieve growth in the most efficient manner. In analyzing such a problem, a picture of growth and the role that irrigation plays in this process could be given over a time span.

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APPENDIX A

Appendix A, Table I. Average Dates for Selected Cropping Operations, Eastern Missouri Slope, South Dakota

Item	Date
Start field work	April 1
Start seeding spring wheat	April 10
Finish seeding wheat and oats and barley	April 25
Plow for corn	April 25
Plant Corn	May to June 1
Small grain spraying	June 5
First crop alfalfa hay	June 10
Row crop spraying	June 15
First row crop cultivation	July 5
Second crop alfalfa hay	July 15
Swath small grain	July 20
Third crop of alfalfa (irrigation)	August 15
Start cutting corn silage	September 10
Pick corn	October 5
Start fall field work	September 15 and continued in October

Source: Records of the Crop and Livestock Reporting Service

Appendix A, Table II. Estimate of Non-Allocated Overhead Costs for Representative Farms in the Eastern Missouri Slope, South Dakota

Item		Cost (Dollars)
Pickup Truck		$ 1,175
Fuel Storage		50
Wagons		200
Miscellaneous Tools and Equipment		150
Total Overhead -- Equipment		$ 1,575
Miscellaneous Overhead		
Telephone and Electricity	$ 400	
Tax Service and Farm Records	200	
Farm Liability Insurance	250	
Total Miscellaneous Overhead		850
Total Non-Allocated Overhead Costs		$ 2,425

Appendix A, Table III. Assumed Per Acre Annual Overhead Costs, Eastern Missouri Slope, South Dakota

Item	Cost (Dollars)
Interest on land*	
Dryland Cropland	$ 10.50
Pasture	4.90
Irrigable Cropland	12.95
Land tax and insurance	
Dryland	2.00
Irrigable	2.50
Depreciation and Maintainance of Fences	.50

*Assumed land value was $150 per acre for dryland, $70 per acre for pasture, and $185 per acre for irrigable land. An interest rate of 7 percent was assumed in this study.

Appendix A, Table IV. Assumed Prices Paid and Received by Farmers, Eastern Missouri Slope, South Dakota

Item	Unit	Price (Dollars)
Prices Paid		
Seed:		
Corn	Bushel	$15.30
Oats	Bushel	.65
Soybeans	Bushel	2.60
Wheat	Bushel	2.25
Barley	Bushel	.95
Flax	Bushel	2.75
Alfalfa	Pound	.50
Feed:		
Corn	Bushel	1.20
Alfalfa	Ton	22.50
Livestock:		
Good to Choice Yearling Steers	Cwt.	29.50
Good to Choice Steer Calves	Cwt.	32.50
Labor	Hour	2.00
Fuel and Lubricants:		
Gasoline	Gallon	.25
Motor Oil	Gallon	1.25
Lubricant	Pound	.22
Prices Received		
Crops:		
Corn	Bushel	1.10
Oats	Bushel	.55
Soybeans	Bushel	2.20
Wheat	Bushel	1.25
Barley	Bushel	.85
Flax	Bushel	2.45
Alfalfa	Ton	18.00
Corn Silage	Ton	7.00
Pasture Grazing	A.U.M.	4.00

Table IV. (Continued)

Item	Unit	Price (Dollars)
Prices Received		
Livestock:		
Good to Choice Steer Calf, Sold October 15	Cwt.	$32.00
Good to Choice Heifer Calf, Sold October 15	Cwt.	31.00
Cull Heifer, October 15	Cwt.	25.00
Cull Cow, October 15	Cwt.	16.00
650# Good to Choice Yearling Steer, Sold April 15	Cwt.	29.50
800# Good to Choice Yearling Steer, Sold October 15	Cwt.	29.00
1,025# to 1,100# Good to Choice Slaughter Steer, Sold October 15, April 15.	Cwt.	28.50

Source: The assumed prices paid and received in this study were established in consultation with Marketing and Farm Management experts from the Economics Department, South Dakota State University, October, 1969.

Appendix A, Table V. Labor Requirements for Crop and Livestock Activities by Period, Eastern Missouri Slope, South Dakota

Activity Description	Unit	Man Hours Per Acre Labor Periods #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
Crop Activities												
Corn												
Dryland	Acre	---	---	0.14	0.77	---	0.12	0.12	---	---	1.18	2.33
Tow Line	Acre	---	---	0.14	0.92	0.15	0.42	0.42	---	---	1.93	3.98
Center Pivot	Acre	---	---	0.14	0.791	0.042	0.202	0.162	0.063	---	1.93	3.33
Wheel Move	Acre	---	---	0.14	0.77	0.15	0.27	0.27	---	---	1.93	3.53
Corn Silage												
Dryland	Acre	---	---	0.13	0.74	---	0.11	0.10	---	---	2.03	3.11
Tow Line	Acre	---	---	0.13	0.89	0.15	0.41	0.40	---	---	3.42	5.40
Center Pivot	Acre	---	---	0.13	0.761	0.042	0.192	0.142	0.063	---	3.42	4.75
Wheel Move	Acre	---	---	0.13	0.74	0.07	0.19	0.25	0.15	---	3.42	4.95
Small Grain												
Dryland	Acre	---	---	0.44	---	0.11	---	---	0.30	0.57	0.30	1.72
Tow Line	Acre	---	---	0.44	---	0.41	0.30	0.30	0.35	0.73	0.30	2.83
Center Pivot	Acre	---	---	0.44	0.084	0.194	0.082	---	0.35	0.73	0.30	2.18
Wheel Move	Acre	---	---	0.44	---	0.26	0.15	0.15	0.35	0.73	0.30	2.38
Soybeans												
Tow Line	Acre	---	---	---	0.72	---	0.44	0.35	0.30	---	1.28	3.09
Center Pivot	Acre	---	---	---	0.72	0.084	0.182	0.092	0.082	---	1.28	2.44
Wheel Move	Acre	---	---	---	0.72	---	0.29	0.20	0.15	---	1.28	2.64

Appendix A, Table V. (Continued)

Activity Description	Unit	Man Hours Per Acre Labor Periods #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
Alfalfa												
Dryland	Acre	---	---	0.05	---	1.36	---	1.36	---	1.36	---	4.10
Tow Line	Acre	---	---	0.05	0.30	1.44	0.30	1.44	0.30	1.44	---	5.27
Center Pivot	Acre	---	---	0.05	0.09	1.44	0.09	1.44	0.09	1.44	---	4.62
Wheel Move	Acre	---	---	0.05	0.15	1.44	0.15	1.44	0.15	1.44	---	4.92
Improved Pasture												
Dryland	Acre	---	0.25	---	---	---	---	---	---	---	---	0.25
Tow Line	Acre	---	0.25	---	0.10	0.25	0.25	0.20	0.20	0.15	---	1.40
Center Pivot	Acre	---	0.25	---	0.05	0.05	0.05	0.05	0.05	0.05	---	0.55
Wheel Move	Acre	---	0.25	---	0.09	0.09	0.09	0.09	0.09	0.10	---	0.85
Livestock Activities												
621 Cow-Calf	Head	2.31	1.77	0.90	0.31	0.15	0.15	0.15	0.112	0.218	0.95	7.02
623 & 624 Drylot Calves, No Silage and Silage	Head	1.08	1.00	0.57	0.87	0.42	0.42	0.42	0.264	0.51	0.84	6.39
625 & 626 Pasture Calves, No Silage and Silage	Head	0.97	0.94	0.46	0.69	0.28	0.28	0.28	0.213	0.41	0.66	5.18
628 & 629 Yearling Feeders	Head	0.64	0.55	---	---	---	---	---	---	---	0.40	1.59
631 & 632 Drylot Yearlings, Period 1, No Silage and Silage	Head	1.51	1.16	0.38	---	---	---	---	---	---	0.49	3.54

Appendix A, Table V. (Continued)

Activity Description	Unit	Man Hours Per Acre Labor Periods #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
622 Raise Feeders, Pasture	Head	0.64	0.55	0.22	0.38	0.20	0.15	0.10	0.13	0.20	0.35	2.92
641 & 642, Drylot Yearlings, Period 2, No Silage and Silage	Head	---	0.123	0.189	0.612	0.336	0.336	0.336	0.296	0.712	0.60	3.54
661 & 662, Drylot Yearlings, Period 1 and Period 2, No Silage and Silage	Head	1.51	1.13	0.57	0.61	0.30	0.30	0.30	0.31	0.59	1.45	7.07

Appendix A, Table VI. Expected Service Life for Various Machines on 1,600 Acre Farm in the Eastern Missouri Slope, South Dakota

Machine	Years[1]
Tractor	10
Field Cultivator	16
Disk	16
Plow	16
Harrow	20
Cultivator--Row Crops	16
Chisel Plow	14
Corn Picker	10
Corn Chopper	10
Combine	10
Sprayer	8
Truck	10
Pickup	4
Corn Planter	15
PTO Baler	10
Mower	18
Press Drill	18
Self Propelled Swather	8

[1]American Society of Agricultural Engineers, Agricultural Engineer's Yearbook, 1967, p. 255.

Appendix A, Table VII. Hours of Labor Available Per Month for a Representative Farm in the Eastern Missouri Slope, South Dakota

Month	Operator Hours Worked Per Day	No. of Days Worked Per Month	Total Operator Hours Per Month	Family Hours Worked Per Day	Total Family Hours Per Month	Total Hours	Minus Overhead Hours[1]	Hours Available for Enterprises
January	8	24	192	2.5	60	252	54	198
February	10	24	240	2.5	60	300	54	246
March	10	24	240	2.5	60	300	63	237
April	13	26	338	3.0	78	416	63	353
May	13	26	338	3.0	78	416	72	344
June	13	25	325	8.0	200	525	90	435
July	13	25	325	8.0	200	525	90	435
August	13	25	325	8.0	200	525	90	435
September	13	25	325	2.5	60	385	90	295
October	8	24	192	2.5	60	252	90	162
November	8	24	192	2.0	48	240	72	168
December	8	24	192	2.0	48	240	72	168
Total			3,224		1,152	4,376	900	3,476

[1]Overhead labor is 900 hours for a Beef Ranch and Grain Farm. This figure was established in consultation with Wallace G. Aanderud, Professor of Economics, September 15, 1969, (South Dakota State University, Brookings).

APPENDIX B

Appendix B, Table I. Beef Cow Unit, Feeder Calf Sold, October Replacements First Calf as 2 Year Old, 92% Calf Crop, 16% Replacement Rate, One Bull Per 25 Cows

ACTIVITY 621

I.	Receipts		
	Good to Choice Steer Calf (450 lb. x 32.5 x .46)	$ 67.28	
	Heifer Calf (400 lb. x 31.0 x .26)	32.24	
	Cull Cow (1,000 lb. x .17 x .16)	27.20	
	Cull Heifer (600 lb. x .25 x .04)	6.00	
	Gross Sales	$132.72	
II.	Operating Expenses		
	Corn 2 bushel @ $1.10	$ 2.20	
	Oats 4 bushel @ .60	2.40	
	Alfalfa Hay 2.1 ton @ $18	37.80	
	Pasture 8 A.U.M. @ 4.00	32.00	$74.40
	Supplement 1.5 cwt 4.60	6.90	
	Mineral and Salt 60 lb. @ .03	1.80	
	Breeding Charge	6.00	
	Veterinary and Drugs	3.00	
	Equipment Repairs (4% of 6.00)	.24	
	Building Repairs (3.5% of 35.00)	1.23	
	Taxes and Insurance (1.5% of 250.00)	3.75	
	Transportation and Cost of Marketing	3.00	$25.92
	Total Direct Costs	$100.32	
III.	Income over Direct Costs (I minus II)	$ 32.40	
IV.	Average Operating Capital Requirements		
	Average Cow Value	$250.00	
	1/25 Bull @ $800	32.00	
	Replacement Charge Per Cow (16% of 250)	40.00	
	Grain and Forage (.2 x 74.40)	14.80	
	Other Direct Costs (.5 x 25.92)	12.96	
	Total	$349.76	
V.	Fixed Capital (1/2 new cost)		
	Equipment	$ 6.00	
	Buildings	35.00	
	Total	$ 41.00	

Appendix B, Table II. Wintering and Summering Grazing Steer Calves, 12 Months, October to October, Average Daily Gain .75 Pounds for 7 Months, 1.5 Pounds for 5 Months

ACTIVITY 622

I.	Receipts		
	Stocker or Feeder Steer 8 cwt. @ $29.00	$232.00	
	Minus Death Loss (2.5% of @ $228.00)	5.80	
	Gross Sales	$226.20	
II.	Operating Expenses		
	Steer Calf 425 pound @ 32.50	$138.13	$138.13
	Alfalfa Hay .6 ton @ 18.00	10.80	
	Pasture 5 AUM @ 4.00	20.00	
	Supplement 2 cwt. @ 4.60	9.20	
	Mineral and Salt 20 pounds @ .03	.60	
	Veterinary and Drugs	1.50	
	Equipment Repairs (4% of $3)	.12	
	Building Repairs (3.5% of 35.00)	1.23	
	Taxes and Insurance (1.5% of 138.13)	2.06	
	Transportation and Cost of Marketing	5.30	$20.11
	Total Direct Costs	$189.04	
III.	Income over Direct Costs (I minus II)	$ 37.16	
IV.	Average Operating Capital Requirements		
	Steer Calf Investment (1.0 x $138.13)	$138.13	
	Forage (.5 x 30.80)	15.14	
	Other Direct Costs (.6 x 20.11)	12.07	
	Total	$165.34	
V.	Fixed Capital (1/2 new cost)		
	Equipment	$ 3.00	
	Building	35.00	
	Total	$ 38.00	

Appendix B, Table III. Yearling Feeder, 6 Months, October to April, Average Daily Gain 1.5 Pounds

ACTIVITY 628 & 629

I.	Receipts		
	Feeder Yearling 6.5 cwt. @ $30.00	$191.75	
	Minus Death Loss (1.5% of 191.50)	2.88	
	Gross Sales	$188.87	
II.	Operating Expenses		
	Calf 425 lb. @ $ .325	$138.13	$138.13
	Corn 8 bu. @ 1.10	8.80	
	Oats 14 bu. @ .60	8.40	
	Alfalfa Hay .61 ton @ 18.00	10.98	
	Pasture .9 AUM @ 4.00	3.60	$ 31.78
	Mineral and Salt 10 lb. @ .03	.30	
	Veterinary and Drugs	1.00	
	Equipment Repairs (4% of 22.10)	.88	
	Building Repairs (3.5% of 37.00)	1.30	
	Taxes and Insurance (1.5% of 182.33)	2.73	
	Transportation and Cost of Marketing	4.75	$10.96
	Total Direct Costs	$180.87	
III.	Income over Direct Costs (I minus II)	$ 11.20	
IV.	Average Operating Capital Requirements		
	Calf Investment (.4 x $138.13)	$ 55.25	
	Forage and Grain (.3 x 31.78)	9.53	
	Other Direct Costs (.5 x 10.97)	5.49	
	Total	$ 70.27	
V.	Fixed Capital (1/2 new cost)		
	Equipment	$ 22.10	
	Building	37.00	
	Total	$ 59.10	

Appendix B, Table IV. Fed Good to Choice Yearling Steer on Silage, Deferred in Drylot, Gain 450 Pounds in 6 Months on the Farm, 180 Days at 2.5 Daily Gain to 1,100 Slaughter Weight, Period 1, October to April

ACTIVITY 632

I.	Receipts		
	Slaughter Steer 11 cwt. @ 28.50	$313.50	
	Minus Death Loss (1% of 313.50)	3.14	
	Gross Sales	$310.36	
II.	Operating Expenses		
	Purchase Good to Choice Steer 6.5 cwt. @ $29.50	$191.75	$191.75
	Corn 12.5 lb. daily 30 bu. @ 1.10	33.00	
	Corn Silage, 25 pounds daily 2.2 ton @ 7.00	15.40	
	Hay, 1 pound daily .2 ton @ 18.00	3.60	$ 52.00
	Supplement 4.2 cwt. @ 4.60	19.32	
	Mineral and Salt 20 lb. @ 0.03	.60	
	Veterinary and Drugs	2.00	
	Building Repairs (3.5% of 22.10)	.88	
	Equipment Repairs (4% of 37.00)	1.30	
	Taxes and Insurance (1.5% of 232.70)	3.49	
	Transportation and Cost of Marketing	7.25	$ 34.84
	Total Direct Costs	$278.59	
III.	Income over Direct Costs (I minus II)	$ 32.77	
IV.	Average Operating Capital Requirements		
	Steer Investment (.6 x $191.75)	$115.05	
	Grain and Forage (.3 x 52.00)	15.60	
	Other Direct Costs (.5 x 34.84)	17.42	
	Total	$148.52	
V.	Fixed Capital (1/2 new cost)		
	Equipment	$ 22.10	
	Buildings	37.00	
	Total	$ 59.10	

Appendix B, Table V. Fed Good to Choice Yearling Steer on Silage, Deferred in Drylot, Gain 450 Pounds in 6 Months, 180 Days at 2.5 Pound Daily Gain to 1,100 Slaughter Weight, Period 1 and Period 2

ACTIVITY 662

I.	Receipts		
	Slaughter Steer 11 cwt. @ $28.40	$627.00	
	Minus Death Loss (1% of 627.00)	6.27	
	Gross Sales	$620.73	
II.	Operating Expenses		
	Purchase of Good to Choice Steer (6.5 cwt.@ $29)	$383.50	$383.50
	Corn 60 bu. @ 1.10	66.00	
	Corn Silage 4.4 ton @ 7	30.80	
	Hay .35 ton @ 18.00	6.40	$103.20
	Supplement 4.5 cwt. @ 4.60	20.70	
	Mineral and Salt 40 lb. @ .03	1.20	
	Veterinary and Drugs	4.00	
	Building Repairs (3.5% of 37.00)	1.30	
	Equipment Repairs (4% of 22.10)	.88	
	Taxes and Insurance (1.5% of 427.70)	6.42	
	Transportation and Cost of Marketing	14.50	$ 49.00
	Total Direct Costs	$535.70	
III.	Income over Direct Costs (I minus II)	$ 85.03	
IV.	Average Operating Capital Requirements		
	Steer Investment (.6 x $383.50)	$230.04	
	Grain and Forage (.3 x 103.20)	30.96	
	Other Direct Costs (.5 x 48.90)	24.45	
	Total	$285.45	
V.	Fixed Capital (1/2 new cost)		
	Equipment	$ 22.10	
	Buildings	37.00	
	Total	$ 59.10	

Appendix B, Table VI. Activity Budgets Per Acre of Cropland for Corn by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 5.55	$ 5.55	$ 7.05	$ 7.05	$ 7.05
Irrigation System and Pumping	---	---	9.28	13.60	9.60
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	8.39	7.54	21.50	21.50	21.50
Seed	2.50	2.50	6.00	6.00	6.00
Crop Insurance	4.00	4.00	6.00	6.00	6.00
Subtotal	20.44	19.59	51.14	57.54	51.77
Interest (6%)	1.23	1.18	3.07	3.39	3.11
Subtotal	21.67	20.77	54.21	59.93	54.88
Fixed Costs, Machinery					
Insurance and Taxes	.62	.62	.66	.66	.66
Depreciation	2.22	2.22	2.39	2.39	2.39
Interest	1.22	1.22	1.40	1.40	1.40
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	25.73	24.83	77.70	91.80	83.21

Appedix B, Table VI. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	40	33	125	125	125
Price (per bushel)	1.10	1.10	1.10	1.10	1.10
Gross Return	44.00	36.30	137.50	137.50	137.50
Net Return	$18.27	$11.47	$59.80	$45.70	$54.29

Appendix B, Table VII. Activity Budgets Per Acre of Cropland for Corn Silage by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil Grease, and Repairs					
Field Operation	$ 7.69	$ 7.69	$10.12	$10.12	$10.12
Irrigation System and Pumping	---	---	9.28	13.60	9.60
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	10.57	9.62	26.40	26.40	26.40
Seed	2.50	2.50	6.00	6.00	6.00
Crop Insurance	4.00	4.00	6.00	6.00	6.00
Subtotal	24.76	23.81	59.11	64.51	59.74
Interest (6%)	1.49	1.43	3.55	3.87	3.58
Subtotal	26.25	25.24	62.66	68.38	63.32
Fixed Costs, Machinery					
Insurance and Taxes	.60	.60	.66	.66	.66
Depreciation	2.32	2.32	2.50	2.50	2.50
Interest	1.27	1.27	1.47	1.47	1.47
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	30.44	29.63	86.33	100.43	91.83

Appendix B, Table VII. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield (ton)	8	6.6	21	21	21
Price (per ton)	7.00	7.00	7.00	7.00	7.00
Gross Return	56.00	46.20	144.00	144.00	144.00
Net Return	$25.56	$16.57	$57.67	$43.57	$48.17

Appendix B, Table VIII. Activity Budgets Per Acre of Cropland for Oats by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 4.66	$ 4.66	$ 5.48	$ 5.48	$ 5.48
Irrigation System and Pumping	---	---	5.80	8.50	6.00
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	5.37	4.74	10.20	10.20	10.20
Seed	1.80	1.80	2.70	2.70	2.70
Crop Insurance	2.20	2.20	3.30	3.30	3.30
Subtotal	14.03	13.40	28.79	32.57	29.30
Interest (6%)	.84	.80	1.72	2.44	1.76
Subtotal	14.87	14.20	30.51	35.01	31.06
Fixed Costs, Machinery					
Insurance and Taxes	.60	.60	.66	.66	.66
Depreciation	2.21	2.21	2.39	2.39	2.39
Interest	1.24	1.24	1.44	1.44	1.44
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	18.92	18.25	54.04	66.92	59.43

Appendix B, Table VIII. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	50	43	110	110	110
Price (per bushel)	.55	.55	.55	.55	.55
Gross Return	27.50	23.65	60.50	60.50	60.50
Net Return	$ 8.58	$ 5.40	$ 6.46	-$6.42	$ 1.07

Appendix B, Table IX. Activity Budgets Per Acre of Cropland for Wheat by System of Operation, Eastern Missouri Slope, South Dakota

Item / Land Class	Dryland Operation 1	Dryland Operation 2	Tow Line 1	Center Pivot 1	Wheel Move 1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 4.46	$ 4.46	$ 4.98	$ 4.98	$ 4.98
Irrigation System and Pumping	---	---	5.80	8.50	6.00
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	4.88	3.95	9.19	9.19	9.19
Seed	2.60	2.60	2.75	2.75	2.75
Crop Insurance	2.20	2.20	3.30	3.30	3.30
Subtotal	14.14	13.21	27.33	31.11	27.84
Interest (6%)	.85	.79	1.64	1.87	1.67
Subtotal	14.99	14.00	28.97	32.98	29.51
Fixed Costs, Machinery					
Insurance and Taxes	.60	.60	.66	.66	.66
Depreciation	2.21	2.21	2.39	2.39	2.39
Interest	1.24	1.24	1.44	1.44	1.44
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	19.04	18.05	52.50	64.89	57.88

Appendix B, Table IX. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	27	23	60	60	60
Price (per bushel)	1.25	1.25	1.25	1.25	1.25
Gross Return	33.75	28.75	75.00	75.00	75.00
Net Return	$14.71	$10.70	$22.50	$10.11	$17.12

Appendix B, Table X. Activity Budgets Per Acre of Cropland for Barley by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 4.56	$ 4.56	$ 5.18	$ 5.18	$ 5.18
Irrigation System and Pumping	---	---	5.80	8.50	6.00
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	5.10	4.67	9.27	9.27	9.27
Seed	2.00	2.00	2.25	2.25	2.25
Crop Insurance	2.20	2.20	3.30	3.30	3.30
Subtotal	13.86	13.43	27.11	30.89	27.62
Interest (6%)	.83	.81	1.63	1.85	1.66
Subtotal	14.69	14.24	28.74	32.74	29.28
Fixed Costs, Machinery					
Insurance and Taxes	.60	.60	.66	.66	.66
Depreciation	2.21	2.21	2.39	2.39	2.39
Interest	1.24	1.24	1.44	1.44	1.44
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	18.74	18.29	52.27	64.65	57.65

Appendix B, Table X. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	40	34	85	85	85
Price (per bushel)	.85	.85	.85	.85	.85
Gross Return	34.00	28.90	72.25	72.25	72.25
Net Return	$15.26	$10.61	$19.98	$ 7.60	$14.60

Appendix B, Table XI. Activity Budgets Per Acre of Cropland for Flax by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 4.31	$ 4.31	$ 4.41	$ 4.41	$ 4.41
Irrigation System and Pumping	---	---	5.80	8.50	6.00
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	3.19	2.96	3.79	3.79	3.79
Seed	3.50	3.50	3.85	3.85	3.85
Crop Insurance	1.10	1.10	2.20	2.20	2.20
Subtotal	12.10	11.87	21.36	25.14	21.87
Interest (6%)	.73	.71	1.28	1.51	1.31
Subtotal	12.83	12.58	22.64	26.65	23.18
Fixed Costs, Machinery					
Insurance and Taxes	.60	.60	.66	.66	.66
Depreciation	2.21	2.21	2.39	2.39	2.39
Interest	1.24	1.24	1.44	1.44	1.44
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	16.88	16.63	46.17	58.56	52.55

Appendix B, Table XI. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	11	9	23	23	23
Price (per bushel)	2.45	2.45	2.45	2.45	2.45
Gross Return	26.95	22.05	56.35	56.35	56.35
Net Return	$10.07	$ 5.42	$10.18	-$2.21	$ 3.80

Appendix B, Table XII. Activity Budget Per Acre of Cropland for Alfalfa by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	$ 3.90	$ 3.90	$ 6.72	$ 6.72	$ 6.72
Irrigation System and Pumping	---	---	11.60	17.00	12.00
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	4.50	4.50	13.50	13.50	13.50
Seed	1.00	1.00	1.00	1.00	1.00
Crop Insurance	---	---	2.00	2.00	2.00
Subtotal	9.40	9.40	36.13	42.61	37.84
Interest (6%)	.56	.56	2.17	2.56	2.27
Subtotal	9.96	9.96	38.30	45.17	40.11
Fixed Costs, Machinery					
Insurance and Taxes	.54	.54	.66	.66	.66
Depreciation	1.89	1.89	2.61	2.61	2.61
Interest	.96	.96	1.47	1.47	1.47
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	13.35	13.35	62.08	77.33	68.73

Appendix B, Table XII. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield (ton)	1.6	1.4	6.0	6.0	6.0
Price	18.00	18.00	18.00	18.00	18.00
Gross Return	28.80	25.20	108.00	108.00	108.00
Net Return	$15.45	$11.85	$45.92	$30.67	$39.27

Appendix B, Table XIII. Activity Budgets Per Acre of Cropland for Soybeans by System of Operation, Eastern Missouri Slope, South Dakota

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Fuel, Oil, Grease, and Repairs					
Field Operations	---	---	$ 5.33	$ 5.33	$ 5.33
Irrigation System and Pumping	---	---	9.28	13.60	9.60
Repairs on System	---	---	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	---	---	8.42	8.42	8.42
Seed	---	---	5.20	5.20	5.20
Crop Insurance	---	---	3.75	3.75	3.75
Subtotal	---	---	33.29	38.69	34.84
Interest (6%)	---	---	2.00	2.32	2.09
Subtotal	---	---	35.29	41.01	36.93
Fixed Costs, Machinery					
Insurance and Taxes	---	---	.62	.62	.62
Depreciation	---	---	2.12	2.12	2.12
Interest	---	---	1.28	1.28	1.28
Fixed Costs, Irrigation					
Insurance and Taxes	---	---	3.08	5.00	5.60
Depreciation	---	---	10.32	14.49	11.82
Interest	---	---	5.64	7.93	6.46
Total	---	---	58.35	72.45	65.45

Appendix B, Table XIII. (Continued)

Item	Dryland Operation		Tow Line	Center Pivot	Wheel Move
Land Class	1	2	1	1	1
Yield	---	---	35	35	35
Price (per bushel)	---	---	2.20	2.20	2.20
Gross Return	---	---	77.00	77.00	77.00
Net Return	---	---	$18.65	$ 4.55	$11.55

Appendix B, Table XIV. Activity Budgets Per Acre of Cropland for Improved Pasture by System of Operation, Eastern Missouri Slope, South Dakota

Item	Tow Line	Center Pivot	Wheel Move
Fuel, Oil, Grease, and Repairs			
Field Operations	$ 1.75	$ 1.75	$ 1.75
Irrigation System and Pumping	8.12	11.90	8.40
Repairs on System	1.31	2.39	1.62
Fertilizer, Weed and Insect Chemicals	14.00	14.00	14.00
Seed	3.30	3.30	3.30
Subtotal	28.48	33.34	29.07
Interest (6%)	1.70	2.00	1.74
Subtotal	30.18	35.34	30.81
Fixed Costs, Machinery			
Insurance and Taxes	.30	.30	.30
Depreciation	1.33	1.33	1.33
Interest	.92	.92	.92
Fixed Costs, Irrigation			
Insurance and Taxes	3.08	5.00	5.60
Depreciation	10.32	14.49	11.82
Interest	5.64	7.93	6.46
Total	51.87	65.31	57.24
Yield (AUM)	10	10	10
Price ($4 per AUM)	4.00	4.00	4.00
Gross Return	40.00	40.00	40.00
Net Return	-$11.87	-$25.31	-$17.24

APPENDIX C

Appendix C, Table I. Estimated Irrigation Investment Costs for 160 Acres of Irrigable Land, Eastern Missouri Slope, South Dakota

Cost Item	Tow Line	Wheel Move	Center Pivot
	Estimated New Cost of Well and System		
	- - - - - - - -Dollars - - - - - - - - -		
100 foot well @ $24	$ 2,400.00	$ 2,400.00	$ 2,400.00
Gearhead, Pump and Motor	5,600.00	5,600.00	6,200.00
Mainline	4,400.00	4,400.00	800.00
Water Distribution System	9,600.00	12,500.00	18,000.00
Land Shaping and Leveling	500.00	500.00	500.00
TOTAL NEW INVESTMENT	$22,500.00	$25,400.00	$27,900.00
Acres Irrigated	152	154	138
INVESTMENT PER ACRE	$ 148.00	$ 165.00	$ 202.00

Source: Data were compiled by Ralph Sorensen, Extension Irrigation Specialist and Wallace Aanderud, Professor of Economics and Extension Farm Management Specialist, (South Dakota State University), September, 1969.

Appendix C, Table II. Annual Fixed Costs of Selected Irrigation Systems for 160 Acres of Irrigable Land, Eastern Missouri Slope, South Dakota

Fixed Cost Item	Tow Line	Wheel Move	Center Pivot
Interest on development investment (8% on average investment)	$ 880.00	$ 995.00	$1,095.00
Land grading (Amortized @ 7% for 30 years)	40.00	40.00	40.00
Depreciation 14 years average life of system	1,570.00	1,780.00	1,960.00
Insurance on system	160.00	200.00	300.00
Personal property tax (1.25%)	240.00	280.00	310.00
Estimated added real estate tax	80.00	80.00	80.00
TOTAL ADDED ANNUAL FIXED COSTS	$2,970.00	$3,375.00	$3,785.00
Acres Irrigated	152	154	138
FIXED COSTS PER ACRE	$ 19.04	$ 21.92	$ 27.42

Source: Data compiled by Wallace Aanderud, Professor of Economics and Extension Farm Management Specialist, (South Dakota State University), September, 1969.

Appendix C, Table III. Variable Irrigation System and Pumping Costs of Selected Irrigation Systems for 160 Acres of Irrigable Land, Eastern Missouri Slope, South Dakota

Crops	Tow Line	Wheel Move	Center Pivot	Gross Water Applied
	Variable Water Pumping Costs in Dollar per Acre*			
Corn for Grain	$ 9.28	$ 9.60	$13.60	16
Corn for Silage	9.28	9.60	13.60	16
Small Grain	5.80	6.00	8.50	10
Alfalfa	11.60	12.00	17.00	20
Pasture	8.12	8.40	11.90	14
	Cost of Repairs on System in Dollars per Acre			
Average for All Crops	$ 1.31	$ 1.62	$ 2.39	
Percent of New Investment Excluding Land Shaping Cost	0.9	1.0	1.2	

Source: Data were compiled by S. W. Black, Extension Irrigation Specialist, Agricultural Engineering Department, Ralph Sorensen, Extension Irrigation Specialist, and Wallace Aanderud, Professor of Economics and Extension Farm Management Specialist, (South Dakota State University), September, 1969.

* Note: Pumping cost computed using a power rate of $6.25 for first 100 Kilowatt-hours (KWH) per rate Horsepower (HP) and $0.015 for each additional KWH.

Appendix C, Table IV. Plant Food Required for Each Bushel of Grain or Ton of Forage

Crop	Lbs. of N	Lbs. of P_2O_5	Lbs. of K_2O
Corn Silage	7.5	2.5	5.0
Corn Grain	1.5	0.5	1.0
Oats	0.8	0.4	0.8
Barley	1.2	0.5	1.0
Soybeans	5.5	1.2	1.8
Flax	4.0	1.1	1.8
Wheat	1.8	0.75	1.0
Alfalfa Hay	55.0	12.0	32.0

Source: Lyle A. Derscheid and Fred C. Westin, Soil Atlas and Crop Production Guide, Extension Circular 660, Cooperative Extension Service (South Dakota State University, Brookings, 1968), p. 23.

Appendix C, Table V. Estimated Rate of Fertilizer Application for Each Crop

Crop	Nitrogen[1]		Phosphate[1]	
	percent[2]	lbs.	percent[2]	lbs.
Corn	75	1.12	80	0.40
Oats	75	0.60	100	0.40
Barley	50	0.60	100	0.50
Wheat	50	0.90	100	0.75
Flax	f	0.42	f	0.28
Soybeans	10	0.55	50	0.60
Sorghum	75	1.12	80	0.40
Alfalfa	0	0	80	9.6

[1]Pounds of plant food removed by each bushel of grain or ton of forage given in Appendix C, Table IV.

[2]Percent of plant food that will come from fertilizer--remainder will come from soil.

f = 70% of that recommended for oats.

Source: Lyle A. Derscheid and Fred C. Westin, Soil Atlas and Crop Production Guide, Extension Circular 660, Cooperative Extension Service (South Dakota State University, Brookings, 1968), p. 32.

Appendix C, Table VI. Fertilizer Costs[1]

Nitrogen	$.07 a unit
Phosphate	$.09 a unit
Potash	$.06 a unit

[1]Established in consultation with (1) Art Sogn, Assistant Professor of Economics, July 24, 1969, and (2) Wallace G. Aanderud, Professor of Economics, August 26, 1969, (South Dakota State University, Brookings), and (3) South Dakota Crop and Livestock Reporting Service, 1968, Sioux Falls, South Dakota.

Appendix C, Table VII. Estimated Fertilizer Needs to Give Anticipated Crop Yields in Eastern Missouri Slope, South Dakota

Crops	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	Pounds of Nitrogen		Pounds of P_2O_5		Pounds of K_2O	
Corn Grain	44.8	140.0	16.0	50.0	10.0	30.0
Corn Silage	52.5	150.0	17.5	50.0	35.0	100.0
Soybeans		19.25		21.0		6.0
Wheat	24.3	54.0	21.0	45.0	6.0	6.0
Alfalfa			50.0	150.0		
Flax	5.88	10.5	3.9	7.0	6.0	6.0
Barley	24.0	51.0	20.0	42.5	6.0	6.0
Oats	28.8	66.0	19.2	44.0	6.0	6.0

Source: Lyle A. Derscheid and Fred C. Westin, Soil Atlas and Crop Production Guide, Extension Circular 660, Cooperative Extension Service (South Dakota State University, Brookings, 1968, p. 40.

Appendix C, Table VIII. Estimated Costs for Fertilizer, Weed, and Insect Chemicals Per Acre, Eastern Missouri Slope, South Dakota

Crops	Dryland-Irrigated Nitrogen		Dryland-Irrigated P_2O_5		Dryland-Irrigated K_2O		Dryland-Irrigated Herbicides[1]		Dryland-Irrigated Total	
Corn Grain	$3.14	$9.80	$1.44	$4.50	$ .60	$1.80	$3.00	$5.00	$8.39	$21.50
Corn Silage	3.68	10.50	1.58	4.50	2.10	6.00	3.00	5.00	10.57	26.40
Soybeans		1.62		2.27		.36		4.82		8.42
Wheat	1.77	3.78	1.90	4.05	.36	.36	.85	1.00	4.88	9.19
Alfalfa					4.50	13.50			4.50	13.50
Flax	.42	.74	.35	.63	.30	.30	2.12	2.12	3.19	3.79
Barley	1.68	3.57	1.80	3.83	.36	.36	1.26	1.51	5.10	9.27
Oats	2.02	4.62	1.73	3.96	.36	.36	1.26	1.26	5.37	10.20

[1]Lyle A. Derscheid and Fred C. Westin, Soil Atlas and Crop Production Guide, Extension Circular 660, Cooperative Extension Service (South Dakota State University, Brookings, 1968), p. 40.

Data were compiled from Tables IV, V, VI, and VII in Appendix C.

Appendix C, Table IX. Corn Production--Average Yield Per Acre

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	12.0	11.0	10.0	10.0	9.0
1950	17.5	22.0	22.0	16.0	16.0
1951	17.0	15.0	11.5	19.0	16.0
1952	17.0	17.0	18.5	16.0	14.0
1953	24.0	27.5	13.0	29.0	35.0
1954	19.5	16.5	17.5	16.5	16.5
1955	19.5	12.0	32.0	10.0	10.5
1956	18.5	21.5	17.5	18.0	18.5
1957	31.5	37.5	34.0	31.5	32.5
1958	20.0	24.0	21.5	16.0	16.5
1959	14.0	9.0	7.0	8.5	5.0
1960	17.5	14.5	15.0	16.0	12.0
1961	13.0	18.0	19.5	23.0	24.0
1962	39.0	40.0	36.0	33.5	35.0
1963	35.0	39.0	35.5	31.0	25.0
1964	20.5	25.0	20.0	19.5	20.5
1965	28.0	30.0	23.5	13.5	24.0
1966	36.0	42.5	39.0	31.0	27.0
1967	25.0	30.0	23.0	18.5	27.0
1968	34.0	33.0	35.0	34.0	50.0

Appendix C, Table X. Oats Production--Average Yield Per Acre

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	13.0	15.5	20.0	20.0	18.0
1950	20.0	18.0	16.0	13.0	13.0
1951	39.0	39.0	36.0	39.0	38.0
1952	23.5	17.5	17.0	21.0	17.0
1953	30.5	32.5	34.5	33.3	26.5
1954	22.0	20.5	22.5	25.5	23.0
1955	25.0	23.5	22.0	22.5	21.0
1956	17.5	18.0	17.0	10.0	8.5
1957	39.5	39.0	34.0	41.0	36.0
1958	37.0	45.0	21.5	40.0	41.0
1959	20.5	17.5	10.0	9.0	12.5
1960	28.5	31.0	40.0	39.5	38.0
1961	12.5	15.0	20.0	27.0	25.0
1962	55.5	55.5	59.0	55.0	52.0
1963	31.0	39.0	39.0	39.0	28.5
1964	38.5	41.5	37.5	39.5	32.5
1965	50.5	52.0	50.0	46.5	36.0
1966	29.0	30.0	30.0	20.0	18.0
1967	43.0	51.5	47.0	45.5	37.5
1968	48.0	52.0	57.0	53.0	51.0

Appendix C, Table XI. Wheat Production--Average Yield Per Acre

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	7.0	7.0	8.5	8.5	9.0
1950	9.5	10.0	9.5	9.0	9.0
1951	15.5	13.5	13.0	15.0	13.5
1952	8.0	8.0	8.0	8.0	6.1
1953	9.5	9.5	8.6	11.4	8.2
1954	8.0	8.0	8.7	10.8	9.6
1955	13.0	12.5	10.5	12.2	11.5
1956	9.5	11.4	8.9	6.0	6.2
1957	20.5	21.0	21.6	19.6	17.9
1958	20.5	22.2	25.4	26.6	22.7
1959	10.1	10.8	6.6	6.0	8.4
1960	13.5	15.6	17.3	23.0	23.9
1961	8.1	11.1	11.9	17.0	14.0
1962	23.6	21.6	19.6	15.4	11.9
1963	13.0	17.0	15.7	15.6	13.0
1964	15.1	16.7	16.7	18.1	17.9
1965	19.0	19.6	18.4	17.6	16.6
1966	15.1	15.1	15.4	12.4	13.1
1967	20.6	26.1	25.8	27.5	29.5
1968	24.6	26.7	27.8	31.5	29.8

Appendix C, Table XII. Barley Production--Average Yield Per Acre

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	8.0	11.5	11.0	13.0	10.0
1950	12.0	12.0	11.0	11.0	10.0
1951	25.0	25.0	23.0	25.0	25.0
1952	13.5	13.0	12.5	12.0	12.0
1953	17.0	18.5	16.5	16.5	14.5
1954	19.0	12.0	14.0	18.0	15.0
1955	16.5	16.5	15.5	15.5	15.5
1956	13.5	12.0	11.5	8.5	8.0
1957	24.0	26.0	25.0	25.0	15.5
1958	24.0	30.0	34.0	26.0	30.0
1959	12.0	12.5	10.0	6.0	6.5
1960	18.5	22.0	29.5	34.5	33.0
1961	8.0	13.5	15.0	19.5	19.0
1962	31.0	34.0	34.0	31.0	30.5
1963	23.0	27.0	28.0	26.0	22.0
1964	28.0	32.0	31.0	27.0	18.0
1965	39.0	44.0	42.5	32.0	30.0
1966	20.0	20.0	25.5	13.0	15.0
1967	32.5	32.5	36.0	34.0	35.0
1968	39.0	39.0	46.0	42.0	41.0

Appendix C, Table XIII. Hay Production--Average Yield Per Acre (Tons)

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	0.58	0.53	0.47	0.42	0.41
1950	.55	.72	.52	.52	.52
1951	.87	.71	.63	.54	.58
1952	.72	.63	.58	.48	.50
1953	1.07	.98	.88	.63	.70
1954	.98	.85	.66	.59	.56
1955	.78	.71	.48	.43	.42
1956	.83	.79	.60	.45	.41
1957	1.27	1.20	1.03	.96	.96
1958	1.08	.99	.83	.68	.82
1959	.72	.70	.50	.44	.43
1960	.89	.99	.73	.62	.71
1961	.59	.79	.66	.54	.53
1962	1.16	1.18	1.01	.79	.86
1963	.94	1.01	.74	.64	.62
1964	1.40	1.15	.79	.70	.72
1965	1.18	1.15	.74	.68	.74
1966	.93	.85	.69	.71	.60
1967	1.06	1.09	1.08	.88	.70
1968	1.29	1.22	1.09	1.08	1.02

Appendix C, Table XIV. Alfalfa Production--Average Yield Per Acre (Tons)

YEAR	Campbell	Walworth	Potter	Sully	Hughes
1949	1.10	1.05	1.00	1.00	.90
1950	1.20	1.10	.95	.65	.95
1951	1.35	1.35	1.05	1.00	1.25
1952	1.20	1.10	1.00	1.00	1.00
1953	1.80	1.85	1.90	1.80	1.60
1954	1.45	1.35	1.15	1.30	1.35
1955	1.05	.85	.70	.55	.80
1956	1.15	1.15	.95	.90	1.00
1957	1.65	1.65	1.55	2.00	1.90
1958	1.40	1.45	1.40	1.20	1.40
1959	.80	.85	.55	.60	.65
1960	1.15	1.35	1.20	1.30	1.15
1961	.70	1.10	.90	.90	.95
1962	1.40	1.65	1.50	1.50	1.75
1963	1.10	1.25	1.00	1.00	.95
1964	1.80	1.55	1.20	1.30	1.10
1965	1.55	1.60	1.10	1.20	1.30
1966	1.00	.90	.80	.90	.75
1967	1.30	1.60	1.30	1.00	.90
1968	1.60	1.70	1.75	1.55	1.45

APPENDIX D

Appendix D, Table I. The Optimum Farm Organization for Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Activities	Unit	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Dryland Crops				
Class I Land				
Corn	Acre	315.3	427.1	553.8
Wheat	Acre	350.0	126.2	-----
Barley	Acre	31.6	165.7	164.2
Alfalfa	Acre	21.1	-----	-----
Class II Land				
Alfalfa	Acre	382.0	155.2	-----
Wheat	Acre	-----	226.8	350.0
Barley	Acre	-----	-----	32.0
Total Dryland Acres		1,100.0	1,100.0	1,100.0
Pasture				
Native	Acre	137.2	136.5	135.8
Improved	Acre	320.0	320.0	320.0
Feed Lot	Acre	2.8	3.5	4.2
Total		460.0	460.0	460.0

Appendix D, Table II. Total Acres of Crops, Crop Production, and Feed Purchased in Dryland Planning Models with Hours Equivalent to Center Pivot Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Item	Unit	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Total Acres of Crops				
Corn	Acre	315.3	427.1	553.8
Wheat	Acre	350.0	350.0	350.0
Barley	Acre	31.6	165.7	198.2
Alfalfa	Acre	403.1	155.2	-----
Total	Acre	1,100.0	1,100.0	1,100.0
Grain and Forage Production				
Corn	Bushels	876.0	-----	-----
Barley	Bushels	1,265.0	6,708.0	7,654.0
Wheat	Bushels	9,450.0	8,542.0	8,050.0
Silage	Tons	2,347.0	3,417.0	4,430.0
Alfalfa	Tons	568.0	217.0	-----
Feed Purchased				
Corn	Bushels	23,559.0	35,339.0	49,382.0
Alfalfa	Tons	-----	436.0	759.0

Appendix D, Table III. Optimum Livestock Enterprises for Dryland Planning Models with the Hours Equivalent to Center Pivot Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Livestock Activities	Unit	Planning Model with Hours Equivalent to Center Pivot Irrigation at the 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	342	342	341
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	246	224	248
Buy 650 Pound Feeders, April Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	287	551	759
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	533	776	1,007
Total Calves Purchased	Head	587	567	589
Total Feeders Purchased	Head	820	1,327	1,766

Appendix D, Table IV. Operator and Family Labor and Labor Hired by Period for Dryland Planning Models with Feed Buying Option, Eastern Missouri Slope, South Dakota

Planning Models — Periods:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
	Total Operator and Family Labor Available										
	450	483	353	344	218	217	217	218	435	541	3476
Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	732	510	258	354	451	32	414	106	166	1,228	4,251
Total	1,182	993	611	698	669	249	631	324	601	1,769	7,727
Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	1,086	774	460	589	293	8	254	222	387	1,873	6,056
Total	1,536	1,257	813	933	511	335	471	440	822	2,414	9,532
Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	1,448	1,046	614	826	212	203	186	302	538	2,498	7,873
Total	1,898	1,529	967	1,170	430	420	403	520	973	3,039	11,349

Appendix D, Table V. Total Annual Capital and Individual Capital Requirements for Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Capital	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Annual Operating	$ 64,131.90	$ 97,188.50	$130,065.70
Period 2 Operating	8,789.30	13,148.80	17,342.10
Livestock Facility	59,057.70	72,201.50	87,130.50
Livestock Animal	181,445.50	253,394.50	288,568.10
Crop Machinery	14,366.10	17,850.20	20,307.10
Total Annual Capital	$327,790.50	$453,783.50	$543,413.50
Land Capital			
Dryland	$168,000.00	$168,000.00	$168,000.00
Pasture	33,600.00	33,600.00	33,600.00
Total Land Capital	$201,600.00	$201,600.00	$201,600.00
TOTAL CAPITAL REQUIRED	$529,390.50	$655,383.50	$745,013.50

Appendix D, Table VI. Summary of Expenses on Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Expenses	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Livestock			
Purchase of Livestock	$239,777.58	$335,059.37	$422,599.59
Operating Expenses	30,870.99	41,065.25	51,037.64
Purchase Feed	29,448.75	54,201.75	79,184.50
Insurance and Taxes	4,781.30	6,261.73	7,777.84
Total Livestock Expenses	$304,878.62	$436,588.10	$560,599.57
Crops			
Dryland Operating	$ 8,139.42	$ 9,010.53	$ 9,740.02
Dryland Fertilizer	7,901.30	8,318.15	8,775.90
Insurance and Taxes-Machinery	709.70	751.58	786.15
Crop Insurance	2,100.78	2,847.46	3,141.69
Total Crop Expenses	$ 18,851.20	$ 20,927.72	$ 22,443.76
Total Hired Labor	$ 8,502.00	$ 12,112.00	$ 15,746.00
Depreciation			
Crop Machinery	$ 2,794.90	$ 3,159.48	$ 3,465.71
Livestock Facility	5,596.51	7,208.77	8,872.81
Total Depreciation	$ 8,391.41	$ 10,368.25	$ 12,338.52

Appendix D, Table VI. (Continued)

Expenses	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Interest			
Annual Operating	$ 5,130.55	$ 7,775.07	$ 10,405.25
Period 2 Operating	351.57	525.95	693.68
Livestock Facility	3,838.75	4,693.09	5,663.48
Livestock Animal	14,515.64	18,831.56	23,085.45
Crop Machinery	1,149.29	1,428.01	1,624.56
Total Interest	$ 24,985.80	$ 33,253.68	$ 41,472.42
TOTAL EXPENSES	$365,609.03	$513,249.75	$652,600.27

Appendix D, Table VII. Operating Statement and Comparison of Returns to Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Item	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Gross Income	$408,377.01	$559.516.64	$702,161.44
Expenses[1]			
Livestock	$304,878.62	$436,588.10	$560,599.57
Crops	18,851.20	20,927.72	22,443.76
Hired Labor	8,502.00	12,112.00	15,746.00
Depreciation	8,391.41	10,368.25	12,338.52
Interest	24,985.80	33,253.68	41,472.42
Total Expenses	$365,609.03	$513,249.75	$652,600.27
ENTERPRISE RETURNS	$ 42,767.98	$ 46,266.89	$ 49,561.17
Overhead Expenses[2]			
Non-Allocated Costs	$ 2,424.00	$ 2,425.00	$ 2,425.00
Interest on Land	14,112.00	14,112.00	14,112.00
Land Taxes	3,200.00	3,200.00	3,200.00
Depreciation-Fences	800.00	800.00	800.00
Total Overhead Expenses	$ 20,537.00	$ 20,537.00	$ 20,537.00
RETURNS TO LABOR AND FARM MANAGEMENT	$ 22,230.98	$ 25,729.89	$ 29,024.17

Appendix D, Table VII. (Continued)

Item	Planning Model with Hours Equivalent to Center Pivot Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Center Pivot Irrigation at 960 Acre Level
Operator and Family Labor			
Enterprise	$ 6,952.00	$ 6,952.00	$ 6,952.00
Overhead	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 13,478.98	$ 16,977.89	$ 20,272.17
Returns to Farm Management under the Adoption of Irrigation at the Respective Levels	$(16,236.54)	$(21,372.04)	$(26,118.99)

[1]See Table IV.

[2]See Appendix A, Tables II and III.

Appendix D, Table VIII. The Optimum Farm Organization for Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Activities	Unit	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Dryland Crops				
Class I Land				
Corn	Acre	325.3	481.3	612.8
Wheat	Acre	335.3	10.4	-----
Barley	Acre	57.4	226.4	105.2
Class II Land				
Alfalfa	Acre	367.3	339.6	350.0
Wheat	Acre	14.7	42.4	32.0
Barley	Acre	-----	-----	32.0
Total Dryland Acres		1,100.0	1,100.0	1,100.0
Pasture				
Native	Acre	137.0	136.25	135.4
Improved	Acre	320.0	320.0	320.0
Feed Lot	Acre	3.0	3.75	4.6
Total		460.0	460.00	460.0

Appendix D, Table IX. Total Acres of Crops, Crop Production, and Feed Purchased in Dryland Planning Models with Hours Equivalent to Tow Line Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Item	Unit	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Total Acres of Crops				
Corn	Acre	325.3	481.3	612.8
Wheat	Acre	350.0	268.8	350.0
Barley	Acre	57.4	226.4	137.2
Alfalfa	Acre	367.3	339.6	-----
Total	Acre	1,100.0	1,100.0	1,100.0
Grain and Forage Production				
Corn	Bushels	-----	-----	-----
Wheat	Bushels	9,391	8,091	8,050
Barley	Bushels	2,297	9,054	5,293
Silage	Tons	2,602	3,850	4,903
Alfalfa	Tons	514	59	-----
Feed Purchased				
Corn	Bushels	27,031	39,757	58,374
Alfalfa	Tons	73	629	823

Appendix D, Table X. Optimum Livestock Enterprises for Dryland Planning Models with Hours Equivalent to Tow Line Irrigation at the 320 Acre, 640 Acre, and 960 Acre Levels

Livestock Activities	Unit	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Buy Calves, October, Winter on Roughage Ration, Summer Graze and Sell 800 Pound Feeders	Head	342	342	338
Buy Calves, October, Winter on Light Grain Ration, Transfer to Feed Lot, Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	239	217	286
Buy 650 Pound Feeders, April Feed Out in Period 1, Silage Ration and Sell for Slaughter, October	Head	352	658	828
Buy 650 Pound Feeders, October, Feed Out in Period 2, Silage Ration and Sell for Slaughter, April	Head	591	875	1,114
Total Calves Purchased	Head	581	560	624
Total Feeders Purchased	Head	943	1,533	1,942

Appendix D, Table XI. Operator and Family Labor and Labor Hired by Period for Dryland Planning Models with Feed Buying Option, Eastern Missouri Slope, South Dakota

Planning Models / Periods:	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
	Total Operator and Family Labor Available										
	450	483	353	344	218	217	217	218	435	541	3,476
Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	815	572	302	397	433	51	394	132	216	1,357	4,668
Total	1,265	1,055	655	741	651	268	611	350	651	1,898	8,144
Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	1,230	881	544	691	218	155	179	270	478	2,147	6,794
Total	1,680	1,364	897	1,035	436	372	396	488	913	2,668	10,270
Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level											
Family Labor	450	483	353	344	218	217	217	218	435	541	3,476
Hired Labor	1,632	1,187	657	936	237	241	225	318	568	2,778	8,779
Total	2,082	1,670	1,010	1,280	455	458	442	536	1,003	3,319	12,255

Appendix D, Table XII. Total Annual Capital and Individual Capital Requirements for Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Capital	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Annual Operating	$ 72,031.50	$110,564.40	$146,395.30
Period 2 Operating	9,690.00	14,987.80	19,222.00
Livestock Facility	62,076.90	77,584.70	95,632.00
Livestock Animal	194,208.70	257,293.00	314,613.50
Crop Machinery	14,918.10	19,409.20	20,660.00
Total Annual Capital	$352,925.20	$479,839.10	$596,522.80
Land Capital			
Dryland	$168,000.00	$168,000.00	$168,000.00
Pasture	33,600.00	33,600.00	33,600.00
Total Land Capital	$201,600.00	$201,600.00	$201,600.00
TOTAL CAPITAL REQUIRED	$554,525.20	$681,439.10	$798,122.80

Appendix D, Table XIII. Summary of Expenses on Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Expenses	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Livestock			
Purchase of Livestock	$262,610.90	$373,580.24	$461,640.55
Operating Expenses	33,286.19	45,201.37	55,876.93
Purchase Feed	35,467.75	64,163.25	91,896.50
Insurance and Taxes	5,128.93	6,864.03	8,554.77
Total Livestock Expences	$336,493.77	$489,808.89	$617,968.75
Crops			
Dryland Operating	$ 8,287.47	$ 9,394.36	$ 9,992.14
Dryland Fertilizer	7,949.08	8,514.38	8,970.05
Insurance and Taxes-Machinery	716.44	770.26	796.19
Crop Insurance	2,197.39	3,193.11	3,523.15
Total Crop Expenses	$ 19,150.38	$ 21,872.11	$ 23,281.53
Total Hired Labor	$ 9,336.00	$ 13,588.00	$ 17,558.00
Depreciation			
Crop Machinery	$ 2,867.17	$ 3,314.90	$ 3,570.16
Livestock Facility	5,974.51	7,865.02	9,733.04
Total Depreciation	$ 8,841.68	$ 11,179.92	$ 13,303.20

Appendix D, Table XIII. (Continued)

Expenses	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Interest			
Annual Operating	$ 5,762.51	$ 8,845.15	$ 11,711.62
Period 2 Operating	387.60	599.51	768.88
Livestock Facility	4,034.99	5,043.01	6,216.08
Livestock Animal	15,536.70	20,583.44	25,169.07
Crop Machinery	1,193.44	1,552.74	1,652.79
Total Interest	$ 26,915.24	$ 36,623.85	$ 45,518.44
TOTAL EXPENSES	$400,737.07	$573,072.77	$717,629.92

Appendix D, Table XIV. Operating Statement and Comparison of Returns to Dryland Planning Models with Option to Buy Feed Grain, Eastern Missouri Slope, South Dakota

Item	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Gross Income	$444,422.88	$620,712.02	$768.223.44
Expenses[1]			
Livestock	$336,493.77	$489,808.89	$617,968.75
Crops	19,150.38	21,872.11	23,281.53
Hired Labor	9,336.00	13,588.00	17,558.00
Depreciation	8,841.68	11,179.92	13,303.20
Interest	26,915.24	36,623.85	45,518.44
Total Expenses	$400,737.07	$573,072.77	$717,629.92
ENTERPRISE RETURNS	$ 43,685.81	$ 47,639.25	$ 50,593.52
Overhead Expenses[2]			
Non-Allocated Costs	$ 2,425.00	$ 2,425.00	$ 2,425.00
Interest on Land	14,112.00	14,112.00	14,112.00
Land Taxes	3,200.00	3,200.00	3,200.00
Depreciation-Fences	800.00	800.00	800.00
Total Overhead Expenses	$ 20,537.00	$ 20,537.00	$ 20,537.00
RETURNS TO LABOR AND FARM MANAGEMENT	$ 23,148.81	$ 27,102.25	$ 30.056.52

Appendix D, Table XIV. (Continued)

Item	Planning Model with Hours Equivalent to Tow Line Irrigation at 320 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 640 Acre Level	Planning Model with Hours Equivalent to Tow Line Irrigation at 960 Acre Level
Operator and Family Labor			
Enterprise	$ 6,952.00	$ 6,952.00	$ 6,952.00
Overhead	1,800.00	1,800.00	1,800.00
Total	$ 8,752.00	$ 8,752.00	$ 8,752.00
RETURNS TO FARM MANAGEMENT	$ 14,396.81	$ 18,350.25	$ 21,304.52
Returns to Farm Management Under the Adoption of Irrigation at the Respective Levels	$(21,092.52)	$(30,773.47)	$(40,280.54)

[1]See Table XI.

[2]See Appendix A, Tables II and III.