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An Economic Analysis of the Apple Creek Irrigation Unit

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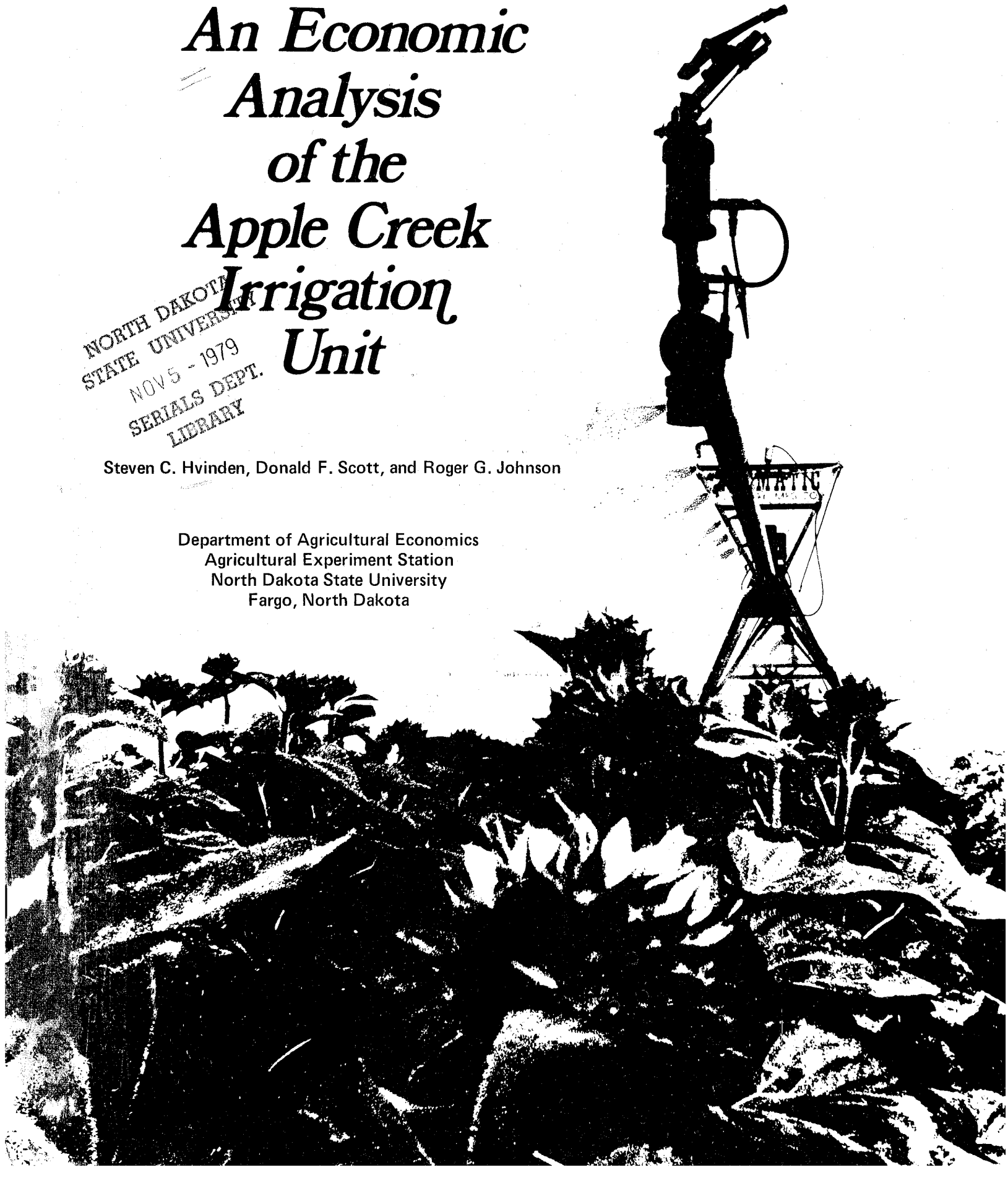

FOREWORD

This report provides information concerning the expected agricultural benefits resulting from the proposed Apple Creek Irrigation Project in Burleigh County, North Dakota. The authors thank the farm operators who provided information about their costs and production practices. The cooperation of the Bureau of Reclamation is also appreciated. The authors acknowledge the help of Jay Leitch in designing the questionnaire and in interviewing farmers. The valuable assistance and suggestions of staff members in the Department of Agricultural Economics and Dr. Duane Bergland, Extension Agronomist, are greatly appreciated.

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Highlights

The proposed 32,000 acre Apple Creek Irrigation Project would divert water from the Missouri River southeast of Bismarck, North Dakota through a system of pipes and open canals for sprinkler application. This area is subject to frequent droughts. Irrigation is seen by many as a means to stabilize and for some crops increase yields, possibly leading to an increase in farm income.

Thirty-seven operators of both dryland and irrigated farms were visited to obtain information about their farming operations. The survey farms ranged in size from 200 to 12,000 total acres and averaged 3,129 acres. The most common grown crops under dryland conditions included wheat, oats, alfalfa, corn, and summer fallow, while corn and alfalfa were the major irrigated crops. Ninety percent of the survey farms had beef cattle operations since over one-half of the average farm was native hay and pasture.

The net income for a 1920 acre model farm was projected over a 100 year period both with and without the irrigation project. Irrigation increased the present value of the net income stream of the dryland model farm by three times, from $298,500 to $888,100. The increase in net return to land and water associated with the project was 49 million dollars for the entire irrigation district.

AN ECONOMIC ANALYSIS OF THE APPLE CREEK IRRIGATION UNIT

by

Steven C. Hvinden, Donald F. Scott, and Roger G. Johnson*

Introduction

Interest in irrigation in Burleigh, Emmons, and Kidder Counties of North Dakota has grown in recent years. Total acres irrigated in the tri-county area almost doubled between 1974 and 1977, from 10,729 acres to 20,464 (Lundstrom). Both the North Dakota Legislature and the U.S. Congress have authorized feasibility studies of an irrigation project in the tri-county area (Apple Creek Unit). A preliminary project has been proposed that would divert water from the Missouri River southeast of Bismarck, North Dakota through a system of pipes and open canals for sprinkler application.

The Bureau of Reclamation has appraised the land resources in the Apple Creek area and conducted preliminary engineering investigations to assess the feasibility of delivering water to irrigable acreage. To date, the Bureau has concentrated on the Burleigh County segment of the Apple Creek Unit. Approximately 40,000 acres in the county have been defined as irrigable, with 32,000 acres being readily accessible by the delivery system under consideration at the time this study was conducted (Figure 1).

Approximately 95 percent of Burleigh County is in farms, and almost all agricultural lands are operated as dryland farms. About 50 percent of the farmland is cultivated and the remainder is native hay and pasture. The principal crops are wheat, oats, and alfalfa, plus minor quantities of barley, flax, and corn. Most of the farms have cow-calf operations. The average growing season is 133 days and average annual precipitation is about 16 inches, with variations ranging from 5 to 26 inches.

Interest in irrigation in the Apple Creek Unit is the result of several factors. Drought conditions in some parts of the area occurred in 1973, 1974, and 1976, as annual precipitation in those years was about 11 inches. The variability in precipitation and length of growing season restrict diversity in farming and livestock operations. Yields also fluctuate from year to year

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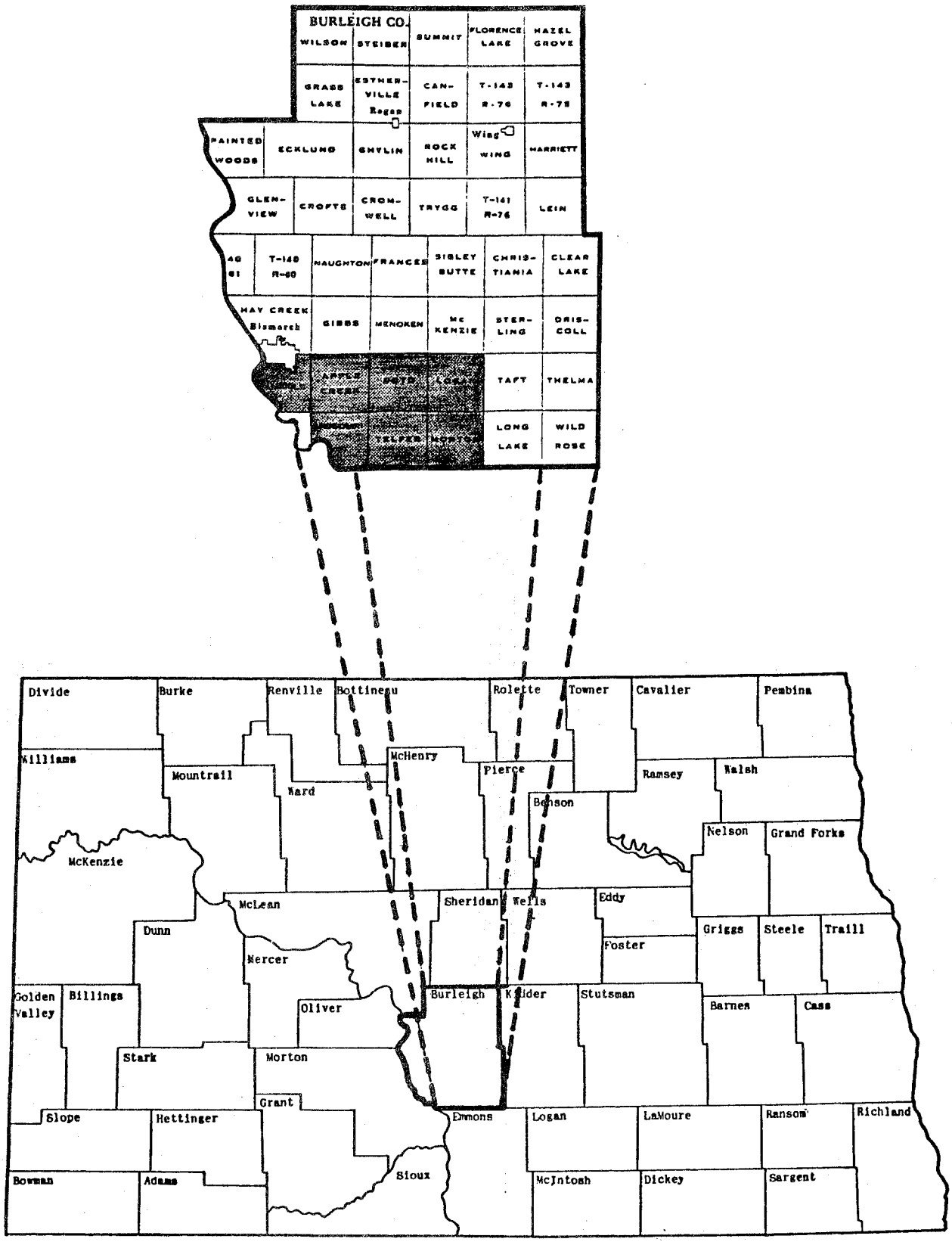

Figure 1. Location of Burleigh County Segment of Proposed Apple Creek Irrigation Unit

with variations in precipitation which in turn contributes to fluctuations in agricultural production and farm income. Maximum returns from new technologies, such as better seed, fertilizer, and weed control, are not always possible because of a lack of moisture. Irrigation is viewed as a means to both stabilize and increase agricultural production and possibly farm income besides allowing greater diversity in farm operations.

The delivery of water as presently proposed would represent a substantial investment to those farm operators who would directly benefit. Initial costs of constructing the project features and the annual operating and maintenance costs must ultimately be paid by the users of the water. In addition, farm operators would face added investment costs for irrigation equipment. The decision to construct the project, therefore, depends primarily on the net returns to agriculture resulting from the delivery of water.

Objective

The objective of this study was to estimate the increase in net agricultural income associated with a proposed 32,000-acre irrigation development in southwest Burleigh County (Apple Creek Unit).[1]

Procedures

The change in net agricultural income associated with the irrigation project requires an estimate of net income under both dryland and irrigated conditions. The project will provide benefits over a long period (the project life is assumed to be 100 years); so knowledge is required of existing and future cropping patterns and livestock enterprises, yields, and management practices.

The delivery of water for irrigation would alter farm enterprise organizations. Presently grown dryland crops and pasture would still represent a significant part of the total farm enterprise, but the potential would exist to increase forage crop production, thus allowing an increase in livestock numbers. In addition, other crops that respond well to water could be produced. Farm enterprise organizations representing irrigated

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[1]The cost of building and operating the irrigation project is being estimated by the Bureau of Reclamation.

conditions must be developed that reflect a transitional period of adjustment, as well as the long-run adjustment to the delivery of water. Although it is impossible to project precisely the farm enterprise organizations under irrigated conditions, it is possible to develop representations of what will most likely occur by analyzing the organizations of existing irrigators and taking into account cropland and pasture limitations, trends in yield, and the potential for introduction (or increased production) of new crops like sunflower.

Thirty-seven farm operators in the Apple Creek Unit and adjacent area were surveyed during July, 1978, to obtain information on cropping patterns and livestock enterprises, yields, and machinery complements. Twenty-seven of those surveyed farmed within the proposed Apple Creek Unit; 16 had dryland operations and 11 were irrigators. The remaining 10 farm operators were irrigating adjacent to the Apple Creek area.

Farm enterprise organizations (model farms) were developed for both dryland (without project) and irrigated (with project) conditions. The model farms were designed to reflect the overall organization of agricultural activity in the region rather than reflecting the organization of an individual farm operator. The crop and livestock enterprises were based on the farm survey data, the judgment of agricultural specialists, and secondary sources of data. Budgets were developed for each enterprise under dryland and irrigation and used to prepare income statements for the model farms. The budgets reflect expected yields, input requirements, and long-run prices for specific periods during the life of the project and are assumed to represent the <u>average annual net income</u> with and without the project. Each budget is based on a representative year during the life of the project that was selected to coincide with the midpoint of the discounted stream of net income. The representative year during the construction period for both the dryland and irrigated model farms is 1986. The representative year after construction for the dryland model is 2004, and 2008 for the irrigated model.

The fact that the net income for all model farms represents an annual stream of income over a period of time means that the present value of those future income streams must be computed. This must be done for two reasons. First, most of the project costs are incurred before any benefits are received. In other word, benefits are received <u>after</u> the majority of the costs have

been incurred so that a common time frame must be used for comparing benefits and costs; and second, a dollar received in the future is worth less (must be discounted) than a dollar received today because of alterantive uses for today's dollar which presumably will earn a return if invested. For example, the present value of a dollar to be received five years from today, discounted at 7 percent, is 71 cents.

The present value of the annual stream of net income (100-year project life) with and without the project was computed using a 7 percent discount rate.[2] The increase in income associated with irrigation was calculated as the difference between the present value of net income of the dryland and irrigated model farms.

Analysis

Survey Results

Farm organizations based on survey data and reflecting the average of all data collected for dryland and irrigated farms are shown in Table 1. The surveyed irrigator's farms ranged in size from 200 to 12,000 total acres and averaged 3,624 acres. The dryland farms (potential irrigators) ranged in size from 622 to 7,380 acres and averaged 2,480 acres. Approximately 60 percent of the average farm is native pasture and native hay.

TABLE 1. AVERAGE FARM ORGANIZATION OF THE SURVEY FARMS, APPLE CREEK IRRIGATION AREA, 1978

Item	All Farms		Dryland Farms		Irrigators	
	Acres	%	Acres	%	Acres	%
Cropland	810	26	602	24	969	27
Tame Hay and Tame Pasture	399	13	268	11	498	14
Total Tillable Acres	1,209	39	870	35	1,467	41
Native Pasture	1,780	57	1,546	62	1,958	54
Native Hay	80	3	30	1	118	3
Other (Waste, Farmstead, Etc.)	60	2	34	1	81	2
Total Acres	3,129	101[a]	2,480	99[a]	3,624	100

[a]Total does not add to 100 due to rounding.

[2]The Bureau of Reclamation is currently using a 6 7/8 percent discount rate. Representatives of the Burleigh County Water Management Board requested that a 7 percent discount rate be used in this analysis.

The area's agriculture revolves primarily around livestock with the beef cow-calf operation being the most prevalent livestock enterprise. Eighty-eight percent of the potential irrigators and 90 percent of the irrigators had beef cattle on hand at the end of 1977. The irrigators had 224 beef cows per farm (16.2 acres/cow) in a typical year, while the potential irrigators averaged 169 beef cows per farm (14.7 acres/cow). Other livestock enterprises were important for a few farmers. Only 11 percent of all farms surveyed had a dairy operation and only 8 percent had a hog operation.

The most common land use under dryland conditions in 1978 was wheat, oats, alfalfa, corn and summer fallow (Table 2). These crops account for 92 percent of the potential irrigators' cropland and 79 percent of the irrigators' dryland acreage. Much of the tillable acreage is used for forage and grain to feed livestock.

TABLE 2. CROPS GROWN ON THE AVERAGE SURVEY FARMS, APPLE CREEK IRRIGATION AREA, 1978

Crop	Dryland Farm		Irrigated Farm			
			Dryland		Irrigated	
	Acres	%	Acres	%	Acres	%
Alfalfa	223	26	218	19	105	31
Corn	166	19	95	8	138	41
Wheat	149	17	280	25	11	3
Oats	206	24	141	13	18	5
Summer Fallow	58	7	156	14	--	--
Barley	18	2	34	3	15	4
Flax	4	0	0	0	--	--
Sunflower	0	0	27	2	22	6
Brome	13	1	82	7	--	--
Tame Hay/Pasture	32	4	94	8	--	--
Other Crops	0	0	0	0	30	9
Total	869	100	1,127	99a	339	99[a]

[a]Total does not add to 100 due to rounding.

Corn (silage and grain) and alfalfa are the major irrigated crops, accounting for 72 percent of the irrigated acreage. Irrigators reported typical yields of 18.7 tons per acre for corn silage and 4.7 tons per acre for alfalfa. Acres irrigated per farm ranged from 13 to 1,240 and averaged 339 acres, with most of the irrigated acreage used to grow forages for live-

stock. Sprinkler systems are used on 74 percent of the irrigated acreage, and gravity irrigation is used on the remainder. The irrigators had been irrigating for an average of eight years.

Model Farms

Farmers will be continually bringing acreage under irrigation during the construction phase of the project, and they will also be learning the "art" of irrigation. Irrigation development will not occur overnight. The 100-year project life was divided into two periods to more accurately reflect the transition that will occur on these farms as irrigation development occurs. The project construction period (transitional period) is 1983-1990 and the post construction period is 1991-2082. Dryland and irrigated model farms were developed for both time periods to estimate the potential change in net income associated with irrigation in the Apple Creek area.

The year 1986 was selected as the representative year on which to base the crop and livestock budgets for both the dryland and irrigated model farms during the construction phase (1983-1990). The years 2004 and 2008 were selected as representative years during the post construction period (1991-2082) for the dryland and irrigated model farms, respectively.[3]

The organization of the dryland model farm during both time periods (based on the survey of potential irrigators) is shown in Table 3. Approximately one-third of the 1,920-acre farm is tillable, and the balance is native pasture. The size of farm chosen (three sections) is the median size of the surveyed dryland farms.

The organization and size of the irrigated model farms are the same as the dryland model farms except that they have some irrigated crops (Table 3). Twenty percent of the land in the proposed Apple Creek Irrigation District is irrigable according to the Bureau of Reclamation. This suggests that 384 acres (.2 x 1,920) of the model farm could be irrigated. Approximately 135 acres (one center pivot) could be irrigated on the model farm by 1986 if development occurs in a linear fashion during the construction period. All of the potentially irrigable land (384 acres) is assumed to be irrigated on the irrigated model farm during the post construction period.

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[3]During the construction period, one-half of the present value of both the dryland and irrigated model farm's projected net income stream will accrue by 1986 (at a 7 percent discount rate). The same criteria were used to select the representative years for the post construction period.

TABLE 3. FARM ORGANIZATION OF THE DRYLAND AND IRRIGATED MODEL FARMS, APPLE CREEK IRRIGATION UNIT

Item	Dryland Model Farm		Irrigated Model Farm			
			During Construction		After Construction	
	Acres	Percent	Acres	Percent	Acres	Percent
Tillable Land						
Dryland	675	35	540	28	291	15
Irrigated	--	--	135	7	384	20
Total Tillable Land	675	35	675	35	675	35
Native Pasture	1,200	63	1,200	63	1,200	63
Nonproductive	45	2	45	2	45	2
Total Acres	1,920	100	1,920	100	1,920	100

Farming Program on the Model Farms

The difference is time frame and the irrigation factor on the model farms influence crop and livestock enterprises, yields, machinery use, and production practices. The assumptions used in calculating crop and livestock budgets for each of the model farms are discussed in this section.

Livestock

The beef cow-calf operation is an integral part of the farming program on existing farms in the Apple Creek area, and was retained in the farming program of the model farms. One beef cow typically required 8.9 acres of native range for summer pasture on the farms surveyed in the Apple Creek area. The rangeland on the dryland model farm would support 135 beef cows according to this criterion (Table 4).

The question arises as to what changes irrigation development would have on beef cow numbers on the irrigated farms. Information received from present irrigators is inconclusive concerning this matter. Three-fourths of the potential irrigators planned to increase the size of their herd if irrigation development occurred, but most could not specify the extent of the increase. Present irrigators had 8.7 acres of native range per cow, only a slightly more intensive stocking rate than the dryland farmers. The amount of native range on the model farm limits the potential increase in beef cow numbers.

Irrigation development would provide the farmer with a stable feed supply which would reduce the risks associated with higher stocking rates. Beef cow numbers were, therefore, increased 10 percent on the irrigated model farm during the construction period and 25 percent during the post construction period.[4]

Calves are sold in the fall in the model farm analysis, rather than kept and fed during the winter (backgrounding). Sales as calves is the most common practice currently followed in the area. Also, backgrounded animals

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[4]The maximum carrying capacity for this area is one cow per seven acres of native pasture, according to Warren Whitman, Range Management Specialist at North Dakota State University. A higher stocking rate would require an intensified pasture management program.

TABLE 4. LIVESTOCK ENTERPRISES FOR DRYLAND AND IRRIGATED MODEL FARMS, APPLE CREEK IRRIGATION UNIT[a]

	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Mature Cows	111	111	117	139
Bred Heifers	24	24	31	31
Total # of producers	135	135	148	170
Production Information				
Steer calves sold	60.75	60.75	66.60	76.50
Heifer calves sold	36.75	36.75	35.60	45.50
Heifer calves kept	24.00	24.00	31.00	31.00
Total calves produced	121.50	121.50	133.20	153.00
Weaning weight, steers (cwt.)	4.80	5.40	4.80	5.50
Weaning weight, heifers (cwt.)	4.60	5.20	4.60	5.30
Weight of cull cows (cwt.)	11.00	11.00	11.00	11.00
Other Information				
Cull cows sold	20	20	22	26
Cow death loss (1%)	1	1	2	2
Bred heifers sold (2%)	3	3	3	3

[a]All livestock enterprises assume 90 percent calf crop, 24 cows per bull, and a six-month winter feeding period.

do not show more profit than fall calves based on long term price relationships.[5] Calf weaning weights were predicted based on a 15-year trend of weaning weights recorded by farmers participating in production testing of their beef herd.

Feedstuffs on the model farms include alfalfa, corn silage, oats, straw, and chaff. Typical rations were obtained for a beef cow enterprise utilizing these feeds (Appendix Table 1). Total feed requirements for each model farm were calculated using these rations to determine the acreage required for livestock feed (Appendix Table 2).

Crop Rotations

The acreage available for dryland and irrigated cash crops was determined by deducting the forage acreage requirements for livestock from total tillage acreage (Table 5). Dryland crops grown on farms in the Apple Creek area and used in the model farm analysis include hard red spring wheat, oats, summer fallow, and other cash crops. Sunflower was chosen as representative of other cash crops (such as barley and flax) since it is expected to become an important cash crop in this area even though few acres are presently grown. The percentage of wheat, oats, summer fallow, and other cash crops on all dryland acres surveyed (adjusted upward for lower forage acreage requirements) was used to determine the acreage of these crops on the dryland portion of all model farms (Table 6).

Present irrigators in the Apple Creek area are primarily irrigating forage crops both for their own livestock and for sale. Utilization of all the irrigated acreage on the irrigated model farms necessitates irrigation of cash crops.[6]

Livestock forage requirements (alfalfa and corn silage) can be grown on 43 acres on the irrigated model farm during project construction. Sunflower (46 acres) and corn grain (46 acres) were chosen to be grown on the remaining 92 irrigated acres. They were selected for irrigation because

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[5]Based on livestock budgets prepared by the Marketing Irrigation Production (MIP) team, an interdisciplinary research team at North Dakota State University charged with the responsibility of evaluating the market potential of agricultural production from the Garrison Irrigation Project.

[6]Irrigation of forage crops above livestock requirements is possible, but uncertainty concerning markets for these crops precluded more acres in the model farm.

TABLE 5. ACREAGE AVAILABLE FOR DRYLAND AND IRRIGATED CASH CROPS BY MODEL FARM, APPLE CREEK IRRIGATION UNIT

Item	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Dryland Acreage	675	675	540	291
Dryland Acreage for Forages	-138	-115	-0	-0
Dryland Acreage for Cash Crops	537	560	540	291
Irrigated Acreage	--	--	135	384
Irrigated Acreage for Forages	--	--	-43	-36
Irrigated Acreage for Cash Crops	--	--	92	348

TABLE 6. CROPPING SYSTEM FOR DRYLAND AND IRRIGATED MODEL FARMS, APPLE CREEK IRRIGATION UNIT

Item	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Dryland Acreage				
Wheat (Continuous Crop)	130	136	132	72
Wheat (Fallow)	78	81	78	42
Oats	134	140	134	72
Sunflower	117	122	118	63
Alfalfa	95	82	--	--
Corn Silage	43	33	--	--
Summer Fallow	78	81	78	42
Total Dryland Acres	675	675	540	291
Irrigated Acreage				
Alfalfa	--	--	30	25
Corn Silage	--	--	13	11
Sunflower	--	--	46	126
Corn Grain	--	--	46	126
Pinto Beans	--	--	--	96
Total Irr. Acres	0	0	135	384
Total Crop Acres	675	675	675	675

of profitability, market availability, and the fact that farmers would have experience growing these crops under dryland conditions. Although some small grains are currently being irrigated in the Apple Creek area, budgets prepared by the MIP team suggest this practice is usually not profitable.

Livestock forage requirements can be grown on 36 acres on the irrigated model farm during the post construction period. Sunflower (126 acres), corn grain (126 acres), and pinto beans (96 acres) are grown on the remaining 348 irrigated acres. Pinto beans were included in the rotation as representative of high value specialty crops, such as potatoes, sugarbeets, soybeans, alfalfa for seed, etc. A limitation of 25 percent of irrigated acreage in specialty crops was assumed. Specialty crops may be grown more intensely be some producers; however, other irrigators may not grow any specialty crop.

Crop Yields

Crop yields used in the model farm analysis are shown in Table 7. Dryland yields were predicted based on trend analysis of Burleigh County yield data (Appendix Table 3). Irrigated yields were predicted by Dr. Duane Berglund, Extension Agronomist at North Dakota State University, and do not exceed yield presently being obtained in test plots.

Prices

Commodity price gyrations during 1973-74 demonstrate the difficulty of trying to predict farm prices. In any one year, relative prices of commodities may deviate from their long-term average relationship to each other. However, the present study is concerned with average price relationships that are expected to exist several years into the future.

Average commodity prices occurring over the 15-year period, 1963-77, were used as a basis for determining product price relationships. It was assumed that average prices occurring over this period would represent price relationships that can be projected into the future. The base period selected is long enough to reflect long-term trends in relative prices, and yet not be influenced unduly by cyclical price patterns.

TABLE 7. DRYLAND AND IRRIGATED CROP YIELDS PER ACRE BY MODEL FARM, APPLE CREEK IRRIGATION UNIT

Item	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Dryland Crops[a]				
Wheat (Continuous Crop)	20.4 bu.	24.9 bu.	20.4 bu.	25.9 bu.
Wheat (Fallow)	25.8 bu.	29.4 bu.	25.8 bu.	30.2 bu.
Oats	40.7 bu.	49.9 bu.	40.7 bu.	51.9 bu.
Sunflower	9.5 cwt.	12.75 cwt.	9.5 cwt.	13.5 cwt.
Straw	.58 tons	.67 tons	.56 tons	.69 tons
Alfalfa	1.67 ton	1.92 ton	--	--
Corn Silage	6.1 ton	7.9 ton	--	--
Irrigated Crops[b]				
Alfalfa	--	--	5.7 ton	8.0 ton
Corn Silage	--	--	24.0 ton	30.0 ton
Sunflower	--	--	24 cwt.	30 cwt.
Corn Grain	--	--	120 bu.	165 bu.
Pinto Beans	--	--	--	28 cwt.

[a]Predicted yields of dryland crops based on the 1955-1977 trend of Burleigh County yields.
[b]Irrigated yields estimated by Duane Bergland, North Dakota State University Extension Agonomist.

Commodity prices were set at a level to generate approximately the same net farm income as occurred during the 1963-77 base period. This was done by adjusting the average price for each commodity to account for increases in prices paid for farm inputs.

The average 1963-1977 price for each commodity was increased by the percent change in the index of prices paid by farmers (parity index) between the base period and July, 1978. The increase in 1963-77 average prices paid by farmers was calculated as follows:

Index of prices paid, July, 1978	220
Average 1963-77 index	-130
Increase in index	90
Percent increase in average prices paid	69

Product prices computed in the manner outlined are presented in Table 8. The prices do not represent predictions for a particular year in the future. They simply represent normalized 1978 product prices needed to give the 1963-1977 level of return based on 1978 input prices.

Current input prices (1978) used in the model farm analysis are shown in Appendix Table 4.

TABLE 8. COMMODITY PRICES, APPLE CREEK IRRIGATION STUDY

Commodity	Price
Wheat	$ 3.70 bu.
Oats	1.25 bu.
Sunflower	11.80 cwt.
Corn Grain	2.55 bu.
Pinto Beans	17.10 cwt.
Feeder Heifers (3-5 cwt.)	52.50 cwt.
Feeder Steers (3-5 cwt.)	60.00 cwt.
Cows (All Grades)	33.50 cwt.
Bulls (Comm. & Utility)	43.00 cwt.

Cultural Practices and Machinery Costs

The application rates of seed, fertilizer, and herbicides are shown in Appendix Tables 5, 6, and 7. Seed and herbicide application rates are based on the MIP study. Fertilizer rates are based on the yield goal and on average soil test analysis of Burleigh County Soils.

Machinery operations are based on the survey of farm operators and the MIP study (Appendix Table 8). The machinery complement was assembled given the required machinery operations, the survey of area farmers, and the results of a 1977 mail questionnaire[7] of farmers (Appendix Table 9).

Machinery ownership costs include replacement cost, interest on average investment, and insurance.[8] Machinery replacement cost is calculated in a manner similar to straight line depreciation except that purchase price and salvage value are in 1978 prices. This differs from the procedure often used by accountants, which is based on the price in the year purchased. The interest cost was established by multiplying the average amount of capital invested in the machine over the ownership period by the interest rate (9 percent). Insurance was calculated at .6 percent of average value. Machinery ownership costs were allocated to each enterprise based on hours of use.

Machinery operating costs include repairs, fuels, and lubricants. Repair costs were based on studies conducted by agricultural engineers on the incidence of repairs for various types of machines. Fuel costs were calculated from fuel consumption rates based on the tractor's horsepower. Lubricant costs were assumed to be 15 percent of fuel costs.

The amount of machinery labor was based on the size of machinery used and speed of travel. All machinery labor, including that of the operator, was figured at $3.75 per hour.

Investment requirements and annual operating costs for an irrigation system (135 acre self-propelled electrically powered circular sprinkler) were based on information received from North Dakota irrigation dealers and from Darnell Lundstrom, Extension Agricultural Engineer at North Dakota State University (Appendix Table 10). Grain storage and handling costs were based on a study (Egge and Anderson) of the profitability of farm storage of grain (Appendix Table 11).

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[7]The Agricultural Economics Department at North Dakota State University conducted a mail survey of North Dakota farmers in 1977 to gain information on production practices and machinery requirements.

[8]Machinery costs for each crop enterprise were calculated by a computerized budget generator developed at Oklahoma State University (Walker and Kletke) and widely used for cost studies by the USDA and agricultural experiment station.

Results

Budgets were developed for each crop and livestock enterprise on the four model farms given the rotations, yields, prices, and cultural practices (Appendix Tables 14, 15, 16, 17, and 18). An income statement was prepared for each model farm (Tables 9 and 10) given the crop and livestock budgets, the grain storage and handling costs (Appendix Table 12), and the management and overhead charge (Appendix Table 13). Caution is advised when comparing income and cost items among model farms since yields and associated costs are based on different years.

The percentage of gross income from crops increased with irrigation. About one-half of both dryland model farms' gross sales are from crops compared to 88 percent for the irrigated model farm (after project construction). Net income as a percentage of gross income increased from 19 percent for the dryland model farm during the construction period to 42 percent for the irrigated model farm after project construction.

The average annual net income for the dryland model[9] farm during construction is $13,421 and $26,324 after construction (Table 9). The present value of those two streams (8 years during construction and 92 years after construction) is $80,100 and $218,400, respectively, for a total of $298,500 (Table 11). The average annual net income for the irrigated model farm[10] during construction is $23,084 and $90,422 after construction (Table 10). The present value of those two streams is $137,800 and $750,300, respectively, for a total of $888,100 (Table 11).

The difference in the present value of the net income streams under dryland and irrigated conditions is $589,600 per model farm. It is $49 million ($1,531/irrigated acre) for the entire irrigation district, assuming 83 model farms in the district. This represents the increase in net return to land and water associated with the project.

Summary and Conclusions

Model farms were developed under dryland conditions (without project) and irrigated conditions (with project) to estimate the change in net income attributable to the delivery of water in the Apple Creek Unit. The model farms were not intended to describe a particular farm, but to represent

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[9]The net income for the dryland model farms is computed by deducting all costs except a land charge from gross income.

TABLE 9. INCOME STATEMENT FOR THE DRYLAND MODEL FARM, APPLE CREEK IRRIGATION UNIT

	During Construction (1986)	After Construction (2004)
Gross Income		
Wheat	$17,258.28	$21,340.86
Oats	6,054.72	7,984.64
Sunflower	13,115.70	18,354.90
Cattle	34,846.63	38,191.25
Gross Income	$71,275.33	$85,871.65
Cash Costs		
Seed	3,658.15	3,630.18
Fertilizer	1,796.12	3,203.15
Chemicals	2,024.09	2,051.58
Fuel and Lube	3,612.68	3,561.26
Repairs	5,005.94	4,714.22
Custom Operations	1,854.28	1,871.81
Hail Insurance	1,764.00	1,772.50
Custom Drying	244.53	341.60
Salt and Minerals	259.20	259.20
Vet. and Medicine	742.50	742.50
Misc. Livestock Expense	621.00	621.00
Hauling and Marketing	850.50	850.50
Total Cash Cost	$22,432.99	$23,619.50
Interest Cost		
Int. on Operating Capital	951.57	1,007.55
Int. on Investment	6,685.08	6,720.30
Int. on Breeding Stock	5,597.10	5,597.10
Total Interest Cost	$13,233.75	$13,324.95
Depreciation and Insurance		
Depreciation on Bulls	945.00	945.00
Depreciation and Insurance on Machinery and Buildings	7,730.65	7,773.63
Total Depreciation and Insurance	$ 8,675.65	$ 8,718.63
Labor	8,538.51	8,450.48
Management and Overhead Charge	4,973.26	5,433.75
Total Cost	$57,854.16	$59,547.31
Return to Land	$13,421.17	$26,324.34

TABLE 10. INCOME STATEMENT FOR THE DRYLAND MODEL FARM, APPLE CREEK IRRIGATION UNIT

	During Construction (1986)	After Construction (2004)
Gross Income		
Wheat	$ 17,409.24	$ 11,592.84
Oats	5,952.96	3,763.04
Sunflower	13,227.80	10,035.90
Livestock	36,990.70	48,591.88
Irrigated Corn Grain	14,076.00	53,014.50
Irrigated Pinto Beans	--	45,964.80
Irrigated Sunflower	13,027.20	44,604.00
Gross Income	$101,683.90	$217,566.96
Cash Costs		
Seed	4,331.95	6,865.55
Fertilizer	3,017.35	8,818.12
Chemicals	2,368.17	2,869.49
Fuel and Lube	3,945.82	4,908.56
Repairs	4,919.70	5,931.03
Custom Operations	2,663.47	2,691.36
Hail Insurance	2,862.75	6,697.75
Custom Drying	1,593.50	5,176.71
Irrigation Power	3,285.45	9,185.85
Irrigation Repairs	882.00	2,466.00
Salt and Minerals	284.16	326.40
Vet. and Medicine	814.00	935.00
Misc. Livestock Expense	680.80	782.00
Hauling and Marketing	932.40	1,071.00
Total Cash Cost	$ 32,581.52	$ 58,724.82
Interest Cost		
Int. on Operating Capital	1,315.57	2,382.45
Int. on Investment	7,192.85	9,397.16
Int. on Breeding Stock	6,136.08	7,048.20
Int. on Irr. System Inv.	2,433.90	6,924.52
Total Interest Cost	$ 17,078.40	$ 25,752.33
Depreciation and Insurance		
Depreciation on bulls	1,036.00	1,190.00
Depreciation and Ins.	8,332.70	10,969.98
Depreciation on Irr. System	3,116.40	8,858.72
Total Depreciation & Ins.	$ 12,485.10	$ 21,018.70
Labor		
Machinery Labor	9,121.42	10,737.94
Irrigation Labor	446.10	1,247.15
Total Labor Cost	$ 9,567.52	$ 11,985.09
Management and Overhead	5,887.66	9,663.65
Total Cost	$ 77,600.20	$127,144.59
Return to Land and Water	$ 23,083.70	$ 90,422.37

TABLE 11. PRESENT VALUE OF NET INCOME ASSOCIATED WITH DRYLAND AND IRRIGATED MODEL FARMS, APPLE CREEK IRRIGATION UNIT

Time Period	Dryland Farm	Irrigated Farm
During Construction	$ 80,100	$137,800
After Construction	218,400	750,300
Total Present Value	$298,500	$888,100

the group of farms in the irrigation area. Irrigation development increased net farm income (return to land and water) of farm operators in the Apple Creek Unit. The present value of this stream of increased net income is $590,000 (assuming a 100 year project life and a 7% discount rate) on the model farm, or $49 million for the entire irrigation unit.

The model farm analysis may be a bit simplistic; it does not consider all changes likely to occur with irrigation development. For example, the beef cattle operation is the most important livestock operation in the area and is the only livestock operation in the farming program of the model farms. It is probable that irrigation development will result in more beef feedlots, hog, and dairy operations. But these operations will be important for only a few farmers and were not included on the model farm.

The model farm analysis is dependent on many assumptions concerning farm organization, livestock enterprises, crop rotations, yields, prices, and other factors. The fact that these assumptions underly projections related to the model farms in an uncertain future adds to the complexity of the problem. Irrigation is a relatively new technology in North Dakota so there is no long term data base on which to project irrigated yields, rotations, and other changes occurring with irrigation. Model farm assumptions were based on available data whenever possible; however, in some instances a measure of judgment had to be used. For example, the type and acreage of high value specialty crops irrigated on the model farm is very critical in evaluating benefits attributable to irrigation. Pinto beans were selected as a "compromise" specialty crop (potatoes has a higher net return per acre) to be included in the model analysis. Research examining changes that occur before and after irrigation development would greatly enhance the accuracy of results of this type of study.

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APPENDIX

APPENDIX TABLE 1. DAILY BEEF CATTLE RATIONS, APPLE CREEK IRRIGATION UNIT[a]

Feed	Type of Stock				
	Mature Cows				
	Gestation[b]	Lactation[c]	Bred Heifers[b]	Replacements[d]	Bulls[d]
Alfalfa	10 lbs.	15 lbs.	10 lbs.	3 lbs.	20 lbs.
Corn Silage	--	45 lbs.	33 lbs.	24 lbs.	--
Oats	--	2 lbs.	--	2 lbs.	2 lbs.
Straw and Chaff	10 lbs.	--	--	--	--

[a]Based on livestock budgets developed by the "MIP" Interdisciplinary Research Team and Cooperative Extension Service, North Dakota State University, Fargo, North Dakota; and on Cooperative Extension Service, North Dakota Cow-Calf Production, Circular AS-591, North Dakota State University, Fargo, North Dakota, February, 1975.
[b]Feeding period of 150 days.
[c]Feeding period of 30 days.
[d]Feeding period of 180 days.

APPENDIX TABLE 2. FEED REQUIREMENTS BY MODEL FARM, APPLE CREEK IRRIGATION UNIT

Feed	Dryland Farm						Irrigated Farm					
	During Construction (1986)			After Construction (2004)			During Construction (1986)			After Construction (2008)		
	Amount	Yield/Acre	Acres	Amount	Yield/Acre	Acres	Amount	Yield/Acre	Acres	Amount	Yield/Acre	Acres
Alfalfa[a]	158 tons	1.67 tons	95	158 tons	1.92 tons	82	173 tons	5.7 tons	30	198 tons	8.0 tons	25
Corn Silage[b]	263 tons	6.1 tons	43	263 tons	7.9 tons	33	317 tons	24.0 tons	13	326 tons	30.0 tons	11
Straw and Chaff[a,c]	126 tons	.58 tons	218	126 tons	.67 tons	188	134 tons	.56 tons	240	158 tons	.69 tons	229
Oats	591 bu.	40.7 bu.	15	591 bu.	49.9 bu.	12	694 bu.	40.7 bu.	17	746 bu.	51.9 bu.	14

[a] Assumes 5.84 percent loss in feeding and storage.
[b] Assumes 30 percent loss in feeding and storage, based on storage in a pile.
[c] Includes straw and chaff for bedding requirements (.24 tons per cow, heifer, or bull, and .07 tons per replacement animal).

APPENDIX TABLE 3. REGRESSION EQUATIONS USED TO PREDICT DRYLAND YIELDS, APPLE CREEK IRRIGATION UNIT[a]

Dependent Variable	Regression Coefficient[b] Intercept	Year[c]	Precip.[d]	Years	Area[e]	R^2	F Value
Wheat, Fallow (bu./acre)	19.4* (2.55)	.20 (.192)	1.10* (.377)	1955-77	1	.30	4.3**
Wheat, Cont. Crop (bu./acre)	12.4* (2.23)	.25 (.167)	1.28* (.329)	1955-77	1	.43	7.6*
Oats (bu./acre)	24.4* (4.59)	.51 (.346)	3.00* (.680)	1955-77	1	.49	9.7*
Alfalfa (tons/acre)	1.22* (.127)	.014 (.0096)	.082* (.0188)	1955-77	1	.49	9.6*
Corn Silage (tons/acre)	3.33* (.481)	.10** (.04)	--	1959-77	2	.25	5.72**

[a]Linear equations of the form $Y = a + b_1 X_1 + b_2 X_2 + e$.

[b]Standard error of regression coefficient given in parenthesis. Significance at the .01 and .05 levels denoted by * and **, respectively.

[c]1955 = 1 for the wheat, oats, and alfalfa equations; 1959 = 1 for the corn silage equation.

[d]Inches deviation from normal growing season precipitation (April through August).

[e]1 = Burleigh County, 2 = South Central Crop Reporting District.

APPENDIX TABLE 4. 1978 INPUT PRICES, APPLE CREEK IRRIGATION STUDY[a]

Item	Price
Seed	
Wheat	$ 4.80 bu.
Sunflower	1.50 lb.
Oats	2.70 bu.
Alfalfa	2.25 lb.
Corn (Silage)	.625/1000
Corn (Grain)	.625/1000
Pinto Beans	.35 lb.
Fertilizer	
Nitrogen (33.5-0-0)	.19 lb.
Nitrogen (82-0-0)	.10 lb.
Phosphorus (0-46-0)	.17 lb.
Herbicides	
2-4-D Amine	7.48 gal.
Treflan	24.60 gal.
Carbyne	14.42 gal.
Atrazine	2.02 lb.
Custom Operations	
Spreading Fertilizer	1.72 acre
Anhydrous Appl.	3.25 acre
Custom Spraying (Air)	1.94 acre
Stack Move	1.61 ton
Dry Corn	.20 bu.
Dry Sunflower	.22 cwt.
Corn Picker	13.15 acre
Fuel	
Diesel	.46 gal.
Gas	.60 gal.
Interest Rate (Op. Capital and Machinery)	.09
Price of Labor	3.75 hr.

[a]Based on Reff, Tommy L., Custom Farm Work Rates on North Dakota Farms, 1978, Circular EC-499, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, March, 1978, and U.S. Department of Agriculture, Agricultural Prices, Washington, D.C., various monthly issues, 1978.

APPENDIX TABLE 5. SEEDING RATES, APPLE CREEK IRRIGATION STUDY[a]

Crop	Rate/Acre
Wheat	1.25 bu.
Oats	2 bu.
Sunflower	5.0 lb.
Alfalfa	12.0 lb.
Corn Silage (Dryland)	16,000 kernels
Corn Grain and Silage (Irr.)	26,000 kernels
Pinto Beans	60 lb.

[a]Based on crop budgets developed by the "MIP" Interdisciplinary Research Team, North Dakota State University, Fargo, North Dakota.

APPENDIX TABLE 6. CROP FERTILIZER REQUIREMENTS, APPLE CREEK IRRIGATION STUDY[a]

Item	Dryland Crops						Irrigated Crops				
	Wheat (CC)	Wheat (Fallow)	Oats	Sunfl.	Alfalfa	Corn Silage	Alfalfa	Corn Silage	Sunfl.	Corn Grain	Pinto Beans
	(lbs./acre)										
Dryland Farm											
During Construction (1986)											
Nitrogen	0	0	11	0	0	0	--	--	--	--	--
Phosphate	15	16	15	0	30	20	--	--	--	--	--
After Construction (2004)											
Nitrogen	10	0	30	14	0	0	--	--	--	--	--
Phosphate	15	19	20	10	30	20	--	--	--	--	--
Irrigated Farm											
During Construction (1986)											
Nitrogen	0	0	11	0	--	--	0	95	70	70	--
Phosphate	15	16	15	0	--	--	77	63	20	50	--
After Construction (2008)											
Nitrogen	14	0	33	18	--	--	0	130	120	115	27
Phosphate	16	20	20	10	--	--	120	80	25	73	56

[a]Based on circulars S-F-2, S-F-3, S-F-10, S-F-11, and S-F-12, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota.

APPENDIX TABLE 7. HERBICIDE APPLICATION RATES, APPLE CREEK IRRIGATION STUDY[a]

Herbicide	Rate/Acre
2-4-D Amine (4#/gal.)	.38 lb.[b]
Treflan (4#/gal.)	.88 lb.[b]
Carbyne (1#/gal.)	.31 lb.[b]
Atrazine (80% w.p.)	2.5 lb.[c]

[a]Based on crop budgets developed by the "MIP" Interdisciplinary Research Team, North Dakota State University, Fargo, North Dakota.
[b]Active ingredient.
[c]Material.

APPENDIX TABLE 8. MACHINERY OPERATIONS, APPLE CREEK IRRIGATION UNIT [a]

Crop	Plow Pack	Pony Drill	Spray[b]	Swath	Combine	Field Cult.	Grain Drill	Drag	Mech. Stacker	Row Cult.	Row Crop Planter	Forage Harv. & Wagon	Bean Cutter	S. Del. Rake
Wheat (Continuous Crop)	1X	1X	A,B	1X	1X									
Wheat (Fallow)			A,B	1X	1X	1X	1X							
Oats	1X	1X	A	1X	1X									
Sunflowers	1X		C		1X			2X		1X	1X			
Alfalfa				2-4X					2-4X					
Corn Silage	1X		D			1X				1X	1X	1X		
Corn Grain	1X		D		1X	1X				1X	1X			
Pinto Beans	1X		C		1X			2X		2X	1X		1X	1X
Summer Fallow						5X								

[a]Based on survey of farmers in the Apple Creek area and on crop budgets developed by the "MIP" Interdisciplinary Research Team, North Dakota State University, Fargo, North Dakota.
[b]A = 2, 4-d amine, B - carbyne, C = treflan, and D = atrazine.

APPENDIX TABLE 9. MACHINERY COMPLEMENT, APPLE CREEK IRRIGATION UNIT [a]

Machine	Size	List Price	Purchase Price[c]	Expected Life (Yrs)	Speed of Travel[d]
Tractor	60 hp.	$13,267	$ 7,032	15	--
Tractor	100 hp.	25,640	13,589	15	--
Tractor	120 hp.	28,557	15,135	15	--
Field Cultivator	24 ft.	4,368	3,931	20	4.5
Plow	6-16"	5,921	5,329	15	4.5
Packer	8 ft.	1,400	1,260	15	4.5
Pony Drill	8 ft.	5,242	4,718	15	4.5
Grain Drill	16 ft.	10,483	4,316	20	4.5
Stacking Machine (6 ton)[b]	12 ft.	19,384	17,446	10	5.0
Swather	18 ft.	9,240	8,316	15	5.4
Combine (PTO)	15 ft.	24,000	10,920	20	3.0
Pickup	1/2 ton	6,618	5,956	8	--
Truck	2 ton	14,771	6,145	20	--
Sunflower Head (6 row-30" sp)	15 ft.	800	720	20	3.0
Corn Planter (6 row-30" sp)	15 ft.	7,242	6,518	15	4.5
Corn Cultivator (6 row-30" sp)	15 ft.	2,422	2,180	15	4.5
Drag	40 ft.	2,645	2,381	20	5.5
Sprayer (pull type)	40 ft.	1,500	1,350	20	5.0
Forage Harvester (2 row)[b]	5 ft.	8,470	7,623	15	3.0
Forage Wagon	7 ton	3,274	2,947	15	3.0
Corn Head (6 row-30" sp)[b]	15 ft.	7,720	6,948	15	3.0
Side Deliver Rake	15 ft.	1,520	1,368	15	6.0
Bean Cutter	15 ft.	3,000	2,700	15	5.5

[a]Based on the survey of farm operators in the Apple Creek area, a survey of local machinery dealers, and Barrios, Ramon, Statistical Analysis of Regional Differences in Grain Production Technology in North Dakota, Unpublished M.S. Graduate Research Paper, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, May, 1978.

[b]Assumes 1/2 interest in the machine.

[c]All machinery purchased new with a 10 percent discount except for tractors, the truck, and the grain drill.

[d]These implements were purchased at three years of age.

[d]Speed of forage harvester and stacking machine was reduced on irrigated land due to increased yields.

APPENDIX TABLE 10. INVESTMENT REQUIREMENTS AND ANNUAL COSTS FOR AN IRRIGATION SYSTEM, APPLE CREEK IRRIGATION UNIT[a,b]

Item	Cost
Investment Requirements	
Sprinkler Unit (7 Tower-1,289 Feet Lateral)	$33,050.00
Pump and Motor [Centrifugal Pump (950 GPM) and 75 HP Motor]	6,000.00
Pump Panel and Wiring	2,000.00
Mainline (1,320 Feet-8" PVC, 160 p.s.i.)	7,000.00
Electric Cable (1,350 Feet-Three Phase Service)	810.00
Sales Tax-3 Percent on Mainline and Cable, 2 Percent on the Rest	1,055.00
Total Investment	$49,915.00
Investment/Acre	$ 369.74
Annual Fixed Costs	
Depreciation	
Entire Unit Minus Mainline and Buried Electric Cable (15-Year Life and 10 Percent Salvage)	2,512.24
Mainline and Electrical Cable (20-Year Life, No Salvage)	402.22
Interest @ 9 Percent	2,434.59
Insurance	202.50
Total Fixed Cost	$ 5,551.55
Fixed Cost/Acre	$ 41.12
Annual Variable Costs	
Maintenance (.015 x Initial Investment)	748.73
Electricity ($.025/KWH + $15.00/HP) (Adequate for 12 Net Inches of Water)	2,812.50
Labor (.75 HR x $3.75/HR x 135 Acres)	379.69
Int. on Op. Capital (9 Percent for Six Months)	177.34
Total Variable Cost	$ 4,118.26
Variable Cost/Acre	$ 30.51
Total Cost	$ 9,669.81
Total Cost/Acre	$ 71.63

[a]Based on Anheluk, Jerry I., Roger G. Johnson, and Fred R. Taylor, Credit Availability For Potential Irrigators in North Dakota, Agricultural Economics Report No. 129, Department of Agricultural Economics, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, May, 1978 and on an interview with Darnell Lundstrom, Extension Agricultural Engineer, North Dakota State University, Fargo, North Dakota.

[b]The irrigation system is a 135 acre self-propelled electrically powered circular sprinkler unit.

APPENDIX TABLE 11. GRAIN STORAGE AND HANDLING COSTS BY MODEL FARM (CIRCULAR STEEL BINS), APPLE CREEK IRRIGATION UNIT[a]

	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Storage Capacity[b]	16,989 bu.	22,018 bu.	28,290 bu.	58,264 bu.
Erection Cost[c]	$12,741.75	$16,513.50	$21,217.50	$43,698.00
Depreciation and Ins.[d]	773.18	1,002.04	1,287.48	2,651.59
Int. on Investment[e]	573.38	743.11	954.79	1,966.41
Elevator Operating Cost	28.54	36.99	47.53	97.88
Total Grain Storage and Handling Cost	$ 1,375.10	$ 1,782.14	$ 2,289.80	$ 4,715.88

[a]Based on survey of grain bin dealers and Egge, Dennis, and Donald E. Anderson, An Analysis of the Profitability of Farm Storage of Grain, Bulletin No. 469, Department of Agricultural Economics, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, October, 1967.
[b]Sufficient capacity to store one year's harvest.
[c]At $.75 per bushel of storage capacity; includes all materials, fill, labor, and concrete floor.
[d]Assumes 20-year life for steel bins and no salvage value. Includes charge for unloading elevator.
[e](Purchase Price +Salvage Value) ÷ 2 x .09.

APPENDIX TABLE 12. SEASONAL MANAGEMENT TIME REQUIRED BY MODEL FARM OPERATORS, APPLE CREEK IRRIGATION UNIT[a]

Season	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
	(hours)			
Spring	158	170	178	266
Summer	110	123	141	255
Harvest	136	146	163	284
Fall	62	62	65	84
Winter	290	325	348	580
Total Management Hours	756	826	895	1,469

[a]Based on Hvinden, S. C., Use of Labor and Management Time on North Dakota Grain Farms, Unpublished M.S. Thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, January, 1977.

APPENDIX TABLE 13. MANAGEMENT AND OVERHEAD CHARGE BY MODEL FARM, APPLE CREEK IRRIGATION UNIT

Item	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Management Charge[a]	$2,835.00	$3,097.50	$3,356.25	$5,508.75
Overhead Charge[b]	2,138,26	2,336.25	2,531.41	4,154.90
Mgmt. and Overhead Charge	$4,973.26	$5,433.75	$5,887.66	$9,663.65

[a]Management hours (Appendix Table 12) x $3.75 per hour.
[b]Includes charge for farm share of electricity, general farm insurance, vehicle licenses, telephone, bookkeeping and office supplies, legal fees, etc.

APPENDIX TABLE 14. CROP BUDGETS FOR THE DRYLAND MODEL FARM DURING PROJECT CONSTRUCTION, APPLE CREEK IRRIGATION UNIT (1986)

Item	Wheat (CC)	Wheat (Fallow)	Oats	Sunfl.	Summer Fallow	Alfalfa	Corn Silage	Straw
Acres	130	78	134	117	78	95	43	218
Yield	20.4 bu.	25.8 bu.	40.7 bu.	9.5 cwt.	--	1.67 ton	6.1 ton	.53 ton/acre
Price	$3.70 bu.	$3.70 bu.	$1.25 bu.	$11.80 cwt.	--	--	--	--
Return Per Acre	$75.48	$95.46	$50.88	$112.10	--	--	--	--
	dollars/acre							
Cash Costs								
Seed	$ 6.00	$ 6.00	$ 5.40	$ 7.50	$ --	$ 3.99	$ 10.00	$ --
Fertilizer	2.55	2.72	4.64	2.17	--	5.10	3.40	--
Chemicals	5.21	5.21	.70	5.38	--	--	5.05	--
Fuel and Lube	4.04	3.66	4.34	4.92	2.69	2.86	2.96	.76
Repairs	3.87	3.29	3.92	3.93	1.88	10.70	8.66	5.08
Custom Operations	3.41	3.41	2.57	4.72	--	4.41	1.72	--
Hail Insurance	3.25	3.25	3.00	3.75	--	--	5.75	--
Total Cash Cost	$28.33	$27.54	$24.57	$30.25	$ 4.57	$ 27.05	$ 43.54	$ 5.84
Interest Cost								
Int. on Operating Capital	1.37	1.32	1.20	1.46	.15	.95	1.90	.13
Int. on Investment	5.90	6.99	5.96	8.83	3.37	5.70	15.82	1.62
Total Interest Cost	$ 7.27	$ 8.31	$ 7.16	$10.29	$ 3.52	$ 6.65	$ 17.72	$ 1.75
Depreciation and Insurance	6.30	6.86	6.38	9.36	3.46	7.44	17.76	2.18
Labor	5.29	5.18	5.53	6.86	3.41	4.44	12.41	1.04
Total Costs	$47.19	$47.89	$43.64	$56.76	$ 14.96	$ 45.59	$ 91.43	$ 10.81
Return to Land, Overhead Risk, and Management	$28.29	$47.57	$ 7.24	$55.34	$-14.96	$-45.59	$-91.43	$-10.81

APPENDIX TABLE 15. CROP BUDGETS FOR THE IRRIGATED MODEL FARM DURING PROJECT CONSTRUCTION, APPLE CREEK IRRIGATION UNIT (1986)

Item	Wheat (CC)	Wheat (Fallow)	Oats	Sunfl.	Summer Fallow	Alfalfa	Irr. Corn Silage	Irr. Sunfl.	Irr. Corn Grain	Straw
Acres	132	78	134	118	78	30	13	46	46	240
Yield	20.4 bu.	25.8 bu.	40.7 bu.	9.5 cwt.	--	5.7 tons	24 tons	24 cwt.	120 bu.	.56 tons
Price	$ 3.70 bu.	$ 3.70	$ 1.25 bu.	$ 11.80 cwt.	--	--	--	$ 11.80 cwt.	$ 2.55 bu.	--
Return Per Acre	$75.48	$95.46	$50.88	$112.10	--	--	--	$283.20	$306.00	--
	dollars/acre									
Cash Costs										
Seed	$ 6.00	$ 6.00	$ 5.40	$ 7.50	$ --	$ 5.32	$ 16.25	$ 7.50	$ 16.25	$ --
Fertilizer	2.55	2.72	4.64	--	--	13.09	20.21	10.40	15.50	--
Chemicals	5.21	5.21	.70	5.38	--	--	5.05	5.38	5.05	--
Fuel and Lube	4.00	3.62	4.26	4.92	2.69	4.06	21.29	5.37	5.54	.81
Repairs	3.95	3.36	3.99	4.15	1.93	15.75	22.27	4.26	2.59	5.02
Custom Operations	3.41	3.41	2.57	.91	--	10.90	4.97	5.88	18.12	--
Hail Insurance	3.25	3.25	2.75	3.25	--	--	18.75	10.75	15.00	--
Custom Drying	--	--	--	2.09	--	--	--	5.28	24.00	--
Irrigation Power	--	--	--	--	--	20.86	25.33	25.33	25.33	--
Irrigation Repairs	--	--	--	--	--	5.60	6.80	6.80	6.80	--
Total Cash Cost	$28.37	$27.57	$24.31	$28.20	$ 4.62	$ 75.58	$ 140.92	$ 86.95	$134.18	$ 5.83
Interest Cost										
Int. on Operating Capital	1.38	1.32	1.19	1.26	.16	2.48	5.63	3.69	4.83	.13
Int. on Investment	5.83	7.17	5.89	7.54	3.18	9.53	32.52	7.82	6.42	1.87
Int. on Irr. Systems Inv.	--	--	--	--	--	18.06	18.02	18.02	18.02	--
Total Interest Cost	$ 7.21	$ 8.49	$ 7.08	$ 8.80	$ 3.34	$ 30.07	$ 59.17	$ 29.53	$ 29.27	$ 2.00
Depreciation and Ins.										
Depreciation and Ins.	6.27	7.06	6.35	7.86	3.27	12.46	39.62	8.13	7.01	2.54
Depreciation on Irr. System	--	--	--	--	--	22.96	23.12	23.12	23.12	--
Total Depreciation & Ins.	$ 6.27	$ 7.06	$ 6.35	$ 7.86	$ 3.27	$ 35.42	$ 62.74	$ 31.25	$ 30.13	$ 2.54
Labor										
Machinery Labor	5.24	5.14	5.44	6.86	3.41	6.26	28.48	7.35	7.47	1.11
Irrigation Labor	--	--	--	--	--	2.83	3.44	3.44	3.44	--
Total Labor Cost	$ 5.24	$ 5.14	$ 5.44	$ 6.86	$ 3.41	$ 9.09	$ 31.92	$ 10.79	$ 10.91	$ 1.11
Total Cost	$47.09	$48.26	$43.18	$51.72	$ 14.64	$ 150.16	$ 294.75	$158.52	$204.49	$ 11.48
Return to Land, Overhead Risk, and Management	$28.39	$47.20	$ 7.70	$60.38	$-14.64	$-150.16	$-294.75	$124.68	$101.51	$-11.48

APPENDIX TABLE 16. CROP BUDGETS FOR THE DRYLAND MODEL FARM AFTER PROJECT CONSTRUCTION, APPLE CREEK IRRIGATION UNIT (2004)

Item	Crop							
	Wheat (CC)	Wheat (Fallow)	Oats	Sunfl.	Summer Fallow	Alfalfa	Corn Silage	Straw
Acres	136	81	140	122	81	82	33	188
Yield Per Acre	24.9 bu.	29.40 bu.	49.90 bu.	12.75 cwt.	--	1.92 ton	7.9 ton	.67
Price	$ 3.70 bu.	$ 3.70 bu.	$ 1.25 bu.	$ 11.80 cwt.	--	--	--	--
Return Per Acre	$92.13	$108.78	$62.38	$150.45	--	--	--	--
	dollars/acre							
Cash Costs								
Seed	$ 6.00	$ 6.00	$ 5.40	$ 7.50	$ --	$ 3.99	$ 10.00	$ --
Fertilizer	4.45	3.23	9.10	4.36	--	5.10	3.40	--
Chemicals	5.21	5.21	.70	5.38	--	--	5.05	--
Fuel and Lube	4.04	3.66	4.34	4.92	2.69	2.86	8.96	.76
Repairs	3.87	3.29	3.92	3.98	1.88	10.70	8.66	5.08
Custom Operations	3.41	3.41	2.57	5.43	--	4.81	1.72	--
Hail Insurance	3.25	3.25	3.00	3.75	--	--	5.75	--
Total Cash Cost	$30.23	$28.05	$29.03	$35.32	$ 4.57	$ 27.46	$ 43.54	$ 5.84
Interest Cost								
Int. on Operating Capital	1.47	1.32	1.43	1.61	.15	.95	1.90	.13
Int. on Investment	5.90	6.99	5.96	8.83	3.37	5.70	15.82	1.62
Total Investment Cost	$ 7.37	$ 8.31	$ 7.39	$10.44	$ 3.52	$ 6.65	$ 17.72	$ 1.75
Depreciation and Insurance	6.30	6.86	6.38	9.36	3.46	7.44	17.76	2.18
Labor	5.29	5.18	5.53	6.86	3.41	4.44	12.41	1.04
Total Cost	$49.19	$48.50	$48.33	$61.98	$ 14.96	$ 45.99	$ 91.43	$ 10.81
Return to Land, Overhead, Risk and Management	$42.94	$60.38	$14.05	$88.47	$-14.96	$-45.99	$-91.43	$-10.81

APPENDIX TABLE 17. CROP BUDGETS FOR THE IRRIGATED MODEL FARM AFTER PROJECT CONSTUCTION, APPLE CREEK IRRIGATION UNIT (2008)

	Crop										
	Wheat (CC)	Wheat (Fallow)	Oats	Sunfl.	Summer Fallow	Irr. Alf.	Irr. Corn Silage	Irr. Sunfl.	Irr. Corn Grain	Irr. Pinto Beans	Straw
Acres	72	42	72	63	42	25	11	126	126	96	229
Yield	25.9 bu.	30.2 bu.	51.9 bu.	13.5 cwt.	--	8.0 ton	30.0 ton	30.0 ton	165.0 bu.	28.0 cwt.	.69 tons
Price	$ 3.70 bu.	$ 3.70 bu.	$ 1.25 bu.	$ 11.80 cwt.	--	--	--	$ 11.80 cwt.	$ 2.55 bu.	$ 17.10 cwt.	--
Return Per Acre	$95.83	$111.74	$64.88	$159.30	--	--	--	$354.00	$420.75	$478.80	--
	dollars/acre										
Cash Costs											
Seed	$ 6.00	$ 6.00	$ 5.40	$ 7.50	$. --	$ 5.32	$ 16.25	$ 7.50	$ 16.25	$ 21.00	$ --
Fertilizer	5.38	3.40	9.67	5.12	--	20.40	26.60	16.25	23.91	14.65	--
Chemicals	5.21	5.21	.70	5.38	--	--	5.05	5.38	5.05	5.38	--
Fuel and Lube	4.04	3.71	4.38	5.04	2.69	5.40	25.72	6.08	7.46	6.13	.88
Repairs	3.95	3.42	4.00	5.17	1.79	21.90	27.68	5.41	5.83	5.57	5.28
Custom Operations	3.41	3.41	2.57	2.63	--	14.60	4.97	5.88	4.97	1.72	--
Hail Insurance	3.50	3.50	3.25	4.00	--	--	19.25	10.75	16.75	22.25	--
Drying	--	--	--	2.97	--	--	--	6.60	33.00	--	--
Irrigation Power	--	--	--	--	--	20.86	25.33	25.33	25.33	20.86	--
Irrigation Repairs	--	--	--	--	--	5.60	6.80	6.80	6.80	5.60	--
Total Cash Costs	$31.49	$ 28.65	$29.97	$ 37.81	$ 4.48	$. 94.08	$ 157.65	$ 95.98	$145.35	$103.16	$ 6.16
Interest Cost											
Int. on Operating Capital	1.52	1.36	1.48	1.70	.15	2.78	6.21	4.05	5.38	4.98	.14
Int. on Investment	6.83	9.52	6.94	7.23	3.82	15.58	41.00	7.85	8.62	9.29	2.12
Int. on Irr. System Inv.	--	--	--	--	--	18.06	18.02	18.02	18.02	18.06	--
Total Interest Cost	$ 8.35	$ 10.88	$ 8.42	$ 8.93	$ 3.97	$ 36.42	$ 65.23	$ 29.92	$ 32.02	$ 32.33	$ 2.26
Depreciation and Insurance											
Depreciation and Insurance	7.57	9.41	7.71	7.51	3.93	20.28	45.41	8.13	8.88	9.74	2.89
Depreciation on Irr. System	--	--	--	--	--	22.96	23.12	23.12	23.12	22.96	--
Total Depreciation & Ins.	$ 7.57	$ 9.41	$ 7.71	$ 7.51	$ 3.93	$ 43.23	$ 68.53	$ 31.25	$ 32.00	$ 32.70	$ 2.89
Labor											
Machinery Labor	5.29	5.23	5.58	6.99	3.41	8.27	34.23	8.12	9.62	9.29	1.21
Irrigation Labor	--	--	--	--	--	2.83	3.44	3.44	3.44	2.83	--
Total Labor Cost	$ 5.29	$ 5.23	$ 5.58	$ 6.99	$ 3.41	$ 11.10	$ 37.67	$ 11.56	$ 13.06	$ 12.12	$ 1.21
Total Cost	$52.70	$ 54.17	$51.68	$ 61.24	15.79	$ 184.84	$ 329.08	$168.71	$222.43	$180.31	$ 12.52
Return to Land, Overhead, Risk, and Management	$43.13	$ 57.57	$13.20	$ 98.06	$-15.79	$-184.84	$-329.08	$185.29	$198.32	$298.49	$-12.52

APPENDIX TABLE 18. BEEF BUDGETS FOR DRYLAND AND IRRIGATED MODEL FARMS, APPLE CREEK IRRIGATION UNIT

Item	Dryland Farm		Irrigated Farm	
	During Construction (1986)	After Construction (2004)	During Construction (1986)	After Construction (2008)
Number of Cows	135	135	148	170
Steer Calves Sold at $60.00/cwt.	60.75	60.75	66.6	76.5
Heifer Calves Sold at $52.50/cwt.	36.75	36.75	35.6	45.5
Cull Cow Sold at $33.50/cwt.	23	23	25	29
Weaning Weight, Steer Calves	480 lb.	540 lb.	480 lb.	550 lb.
Weaning Weight, Heifer Calves	460 lb.	520 lb.	460 lb.	530 lb.
Weight of Cull Cows Sold	1,100 lb.	1,100 lb.	1,100 lb.	1,100 lb.
Gross Income	$34,846.63	$38,191.25	$36,990.70	$48,591.88
Gross Income Per Cow	$ 258.12	$ 282.90	$ 249.94	$ 285.83
	dollars/cow			
Cash Costs				
Salt and Minerals	$ 1.92	$ 1.92	$ 1.92	$ 1.92
Vet. and Medicine	5.50	5.50	5.50	5.50
Repairs and Fuel	8.86	8.86	8.86	8.86
Misc. Expense	4.60	4.60	4.60	4.60
Hauling and Marketing	6.30	6.30	6.30	6.30
Total Cash Cost	$ 27.18	$ 27.18	$ 27.18	$ 27.18
Feed Costs				
Alfalfa	32.08	27.93	30.44	27.18
Corn Silage	29.12	22.35	25.89	21.29
Oats	4.85	4.30	4.96	4.26
Straw and Chaff	17.46	15.05	18.62	16.87
Total Feed Cost	$ 83.51	$ 69.53	$ 79.91	$ 69.60
Interest Cost				
Int. on Operating Capital	.94	.94	.94	.94
Int. on Investment	8.37	8.37	7.64	6.65
Int. on Breeding Stock	41.46	41.46	41.46	41.46
Total Interest Cost	$ 50.77	$ 50.77	$ 50.04	$ 49.05
Depreciation and Insurance				
Depreciation on Bull	7.00	7.00	7.00	7.00
Depreciation and Ins.	10.65	10.65	9.72	8.46
Total Depreciation and Ins.	$ 17.65	$ 17.65	$ 16.72	$ 15.46
Labor	33.00	33.00	31.88	30.38
Total Cost	$212.11	$198.23	$205.73	$191.67
Return to Pasture, Overhead, Risk and Management	$ 46.01	$ 84.67	$ 44.21	$ 94.16

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