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A REEVALUATION OF GDU IRRIGATION

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Project report to
Garrison Diversion Conservancy District
Carrington, North Dakota

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A REEVALUATION OF GDU IRRIGATION

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Background

Changes in production agriculture necessitate periodic reevaluations of economic analyses concerning the production process. Crop rotations change over time in response to input costs, output prices, technologies, and government programs. Input costs and output prices are each influenced by a number of market and government related variables. Technology changes as a result of directed research or chance discovery.

The purpose of this report is to estimate the anticipated on-farm net returns to irrigation in three Garrison Diversion Unit¹ (GDU) areas in North Dakota. Changes in farm-level net returns are used to project irrigation impacts on economic activity in the state. Over 75,000 additional acres, in three general areas, are expected to be irrigated because of GDU water (Table 1).

Method

Our method was straightforward: to compare a projected irrigation scenario with a projected dryland situation. To do this required estimation of expected dryland and irrigated crop rotations, prices, costs, and yields. Estimation of the values of these variables involved the use of published statistics, conversations with producers and other knowledgeable persons, and settling on some underlying assumptions.

At least two approaches have been used to first, estimate change, and second, estimate the aggregate impact of change. Others have taken a whole-farm approach to estimate the impacts of irrigation. Under this approach it is necessary to construct a model farm and follow the changes induced by irrigation through the farm and then through the

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¹See Appendix A for a brief history of the Garrison Diversion Project.

**TABLE 1. ADDITIONAL IRRIGABLE GDU ACRES,
TURTLE LAKE, NEW ROCKFORD, AND OAKES
AREAS**

Location	Acres
Turtle Lake	
Southeast of Harvey	2,000
North end of McClusky Canal	6,515
Northwest of Turtle Lake	13,700
Along McClusky Canal	4,000
Less current irrigation ^a	<u>(1,382)</u>
TOTAL	24,833
New Rockford	
Northeast of New Rockford	20,935
West of New Rockford	1,200
Less current irrigation ^a	<u>(132)</u>
TOTAL	22,003
Oakes	
Near Oakes	23,660
James River	13,350
Less current irrigation ^a	<u>(8,614)</u>
TOTAL	28,396
TOTAL^b	<u>75,232</u>

^aCurrent Irrigators in these areas are expected to switch from present water sources to GDU water.

^bThe total does not include 13,000 acres on Indian land and 28,000 acres whose exact location in the state is unspecified.

economy. A whole-farm approach greatly increases the number of assumptions, increases the ranges of uncertainty, and generally confuses more than clarifies the analysis.

We have chosen the composite acre approach. It is a more appropriate model for assessing the impacts of irrigation, as it makes the direct activity as well as the induced activities more apparent. Direct benefits to irrigation are the net gains brought about as a result of the switch from dryland cropping. These can be estimated by comparing a composite acre with and without irrigation. A composite acre approach minimizes the number of assumptions (e.g., farm size, farm equity position, livestock markets), thereby making the result less sensitive to assumptions. The induced benefits of irrigation are mostly

"value added," captured by the regional impact assessment. The per acre direct benefits are all captured by increased expenditures and net returns due to irrigation on a composite acre, with total benefits dependent on the number of acres irrigated. Output prices capture the values of such commodities as alfalfa and corn silage as inputs into livestock enterprises.

Three estimates of economic impacts are made for each of the irrigation areas—dryland baseline condition, irrigation with some surplus crops, and irrigation without surplus crops. Irrigation that includes surplus crops is further divided into one with and one without a surcharge.²

"With Surplus Crops" irrigation represents a projection of existing situations and technology into the future. Only minor improvements in disease control and limited introductions of higher-valued alternative crops are assumed. Two scenarios were included—one with and one without a surcharge—to account for changes in set-aside requirements from year to year. The surcharge will be equal to 10 percent of the full cost of the delivery of project water. We have assumed a surcharge of \$55 per acre of surplus crop produced.

"Without Surplus Crops" irrigation represents a future with improvements in crop disease control and with more higher-valued specialty and disease prone crops, thereby increasing their percentages in the composite acre. The introduction and/or development of higher-valued alternative crops is incorporated in the analysis by increasing the percentages of currently grown high-valued crops, such as potatoes and dry edible beans, to serve as examples for future cropping innovations. For example, the percentage of potatoes grown in the Oakes area "without surplus crops" includes not only potatoes, but also acreages of some other high value crops. Potatoes serve as the proxy (similar revenues and costs) for high

²Surplus crops are those that the Secretary of Agriculture determines to be in excess supply in accordance with general agricultural statutes (1990 Farm Bill that refers back to the 1985 Farm Bill). Definition of a surplus crop is any program crop which requires set-aside or idle acres for participation in the farm program. One exception is corn silage. In accordance with the GDU Reformulation Act of 1986 (P.L. 99-525), if producers grow basic agricultural commodities that are in surplus supply, the Garrison Diversion Conservancy District will be assessed a surplus crop production charge.

value specialty crops such as sweet corn, carrots, onions, and sugarbeets. This rotation also represents an expansion in livestock production in these areas.

Composite Acres

A composite acre represents the mix of crops grown both across the area as well as over the time horizon being analyzed. A composite acre will not likely be what any one producer does in any one year but instead will represent what all producers in the aggregate do over time. Three composite acres were developed for each of the areas: one for the baseline dryland (Table 2), one for irrigation "with surplus crops" (Table 3), and another for irrigation "without surplus crops" (Table 3).

TABLE 2. DISTRIBUTION OF CROPS FOR DRY CROPLAND COMPOSITE ACRES

Crop ^a	Area		
	Turtle Lake	New Rockford	Oakes
	-----% of dry cropland-----		
Spring wheat	44	38	23
Barley	10	9	11
Sunflower	15	19	13
Oats	6	7	4
Corn	--	--	25
Alfalfa	2	11	6
Soybeans	--	--	2
Summerfallow	<u>23</u>	<u>16</u>	<u>16</u>
TOTAL	100	100	100

^aCrops grown and the percentage of crops on each composite acre are based on a 6-year simple average (1984-1989) of crop acreages in these regions (North Dakota Agricultural Statistics 1990). The Turtle Lake region is represented by crop acreages in McLean, Sheridan, and Wells counties. The New Rockford region is represented by Eddy County while the Oakes region is represented by Dickey and LaMoure counties. Spring wheat and corn percentages in the Oakes area were adjusted to reflect cropping patterns on irrigatable soils. Although small amounts of other crops are grown in these areas, only major crops based on planted crop acreages were included.

TABLE 3. DISTRIBUTION OF CROPS FOR IRRIGATED CROPLAND COMPOSITE ACRES, WITH AND WITHOUT SURPLUS CROPS

Crop	Turtle Lake		New Rockford		Oakes	
	With Surplus Crops ^a	Without Surplus Crops ^b	With Surplus Crops	Without Surplus Crops	With Surplus Crops	Without Surplus Crops
	-----% of irrigated cropland-----					
Spring wheat	27	--	27	--	11	--
Corn grain	--	--	--	--	25	--
Corn silage	20	25	20	25	11	25
Soybeans	5	--	5	--	5	--
Edible beans	15	25	15	25	15	25
Alfalfa - new	4	5	4	5	4	5
Alfalfa - existing	16	20	16	20	16	20
Potatoes	13	25	13	25	13	25
TOTAL	100	100	100	100	100	100

^aAssumes surplus program crops are grown. Rotations are based on the assumption that 33 percent is the maximum amount of potato/bean production that can be produced with little or no disease problems. Up to 20 percent of the rotation was assumed to be alfalfa. The remaining percentage was allocated among crops (i.e., spring wheat and corn) based on current irrigation patterns and estimated future production levels.

^bAssumes only non-surplus crops are grown. Rotations are based on the assumption that 50 percent is the maximum amount of potato/bean production. Up to 25 percent of the rotation was assumed to be alfalfa. The remaining 25 percent was assumed to be planted to corn silage.

The dryland composite acre represents current crop production rotations in the three irrigation areas. The irrigation composite acre adds edible beans (i.e., navy and pinto beans) and potatoes to the rotation. North Dakota ranked second and eighth in the nation in edible bean and potato production, respectively, in 1990.

Prices

Commodity prices and government payments respond to both market forces and government programs. We assumed that a 10-year (1980-89) simple average of North Dakota marketing year prices (except for alfalfa, edible beans, and potatoes) (North Dakota Agricultural Statistics 1990) represent realistic commodity prices. Because alfalfa prices are sensitive to yields, prices are based on a weighted 10-year average. Edible bean and potato prices used in this analysis are based on perceived long-term estimates derived from

discussions with extension and industry personnel. Edible bean and potato ten-year average prices, which were not used, were considerably higher than those perceived in future years. Therefore, prices for edible beans and potatoes should reflect conservative estimates. Government payments were based on average rates over the last 10 years.

Commodity prices and government payment rates used in the analysis are shown in the crop budgets tables in the appendices (Appendix Tables B1, B3, C1, C3, D1, and D3). The procedure used to estimate government payments for program crops is presented in Appendix E.

Production Costs

Expenses (except for potatoes) were based on dryland and irrigated production costs reported in Estimated 1991 Crop Budgets (Haugen and Aakre 1991 and Haugen and Aakre 1991a) for each area. Crop production costs used in the analysis are shown in the crop budgets tables in the appendices.

Yields

Dryland yields are based on a 10-year simple average of yields as reported for counties within the three study areas (North Dakota Agricultural Statistics 1990) and verified by yields from the five-year agricultural practices inventory for the Oakes test area (Esser 1991). Irrigated yields³ for wheat, corn, soybeans, edible beans, and alfalfa are those which can be achieved through proper management practices and appropriate yield goals. Potato yields represent long-term estimates derived from discussions with extension and industry personnel. The irrigation budgeting process relied heavily upon research results from the Carrington and Oakes Experiment Stations. Yields used in the analysis are shown in the crop budget tables in the appendices.

³This study does not consider the economic benefits of less yield variability associated with irrigation.

Livestock Enterprises

The increase in forage production from irrigation implies either an accompanying increase in local livestock numbers and/or transportation and sale of forage in regional and/or in national markets. The second option is viable for alfalfa hay sales into dairy producing areas such as Minnesota or through the development of drying and pelleting facilities for sale into the processed feed ingredient market. However, local feeding is the only viable option for corn silage because of the high transportation cost.

The motivation for increasing livestock numbers to utilize the irrigated production would be the reliable availability of good quality forage. By valuing forage production at ten-year average prices, the model captures that part of livestock income directly attributable to irrigation. The procedure used conservatively accounts for the direct impact of increased irrigated forage production. The indirect effects are slightly underestimated because the livestock sales multiplier (4.4931) is higher than the crop sale multiplier (3.6851) (Coon et al., 1989). The increase in livestock needed to utilize all the increased forage produced is shown in Table 4.

TABLE 4. ANIMAL UNITS SUPPORTED BY INCREASED FORAGE PRODUCTION BY AREA WITH AND WITHOUT SURPLUS CROPS

Item	Turtle Lake Surplus Crops		New Rockford Surplus Crops		Oakes Surplus Crops		State Total Surplus Crops	
	With	Without	With	Without	With	Without	With	Without
Alfalfa hay (tons) ^a	21,675	27,439	16,177	21,178	59,839	76,947	97,691	125,564
Corn silage (tons)	<u>74,499</u>	<u>93,120</u>	<u>70,410</u>	<u>93,500</u>	<u>140,692</u>	<u>319,702</u>	<u>285,601</u>	<u>506,322</u>
Hay equivalent (tons) ^b	46,508	58,479	39,647	52,344	106,736	183,514	192,891	294,337
Animal units ^c	8,944	11,246	7,624	10,066	20,526	35,291	37,094	56,603

^aIrrigated production minus dryland production.

^bAlfalfa hay plus 1/3 times corn silage.

^cAnimal unit equals 1,000 lb cow or equivalent in other livestock. An animal unit requires 26 pounds of dry matter per day or 5.2 tons of hay equivalent per year at 91 percent dry matter.

Estimating Regional Impacts

Conversion from dryland to irrigated agriculture brings with it changes at the farm level as well as at the regional economy level. Farm level effects are captured in the per acre net returns, while changes in regional economic activity are captured using an input-output model. The intensification that comes with irrigation results in increased purchases of inputs and sales of outputs and presents additional opportunities for value-added activities in the state. These changes in business activity result in additional profits to the agribusiness sector and to other sectors serving agriculture and support additional jobs all across the regional and statewide economy.

The North Dakota Input-Output model was initially developed 25 years ago to estimate changes in the economy brought about by energy development. It has since been revised and remodeled to capture the value-added impacts of all types of development in North Dakota (Coon et al. 1989).

Critical Assumptions

Several assumptions—some with respect to specific numbers, others with respect to general activities—had to be made in order to estimate what might happen if irrigated cropland were to replace dryland cropland on 75,000 acres in the state. The results are highly sensitive to some assumptions, such as the choices of crops to include and the structure of future government farm programs. The results are less sensitive (at least with reasonable ranges of values) to others, such as estimates of the percentage of each crop within composite acres, individual crop prices, or individual crop yields.

Results

Two types of economic effects occur when cropland is converted from dry to irrigated. Per farm net returns change, affecting the well being of farm families. On-farm production activity

increases as a result of intensified cropping and widening range of possible enterprises. These changes generate additional off-farm business activity and jobs.

On-Farm Net Returns

Switching to irrigated agriculture would increase on-farm net per acre returns to unpaid labor and management on each of the three irrigation areas under each of the three irrigation cases. Increases in returns range from a low of \$35.29 in the Turtle Lake area under the "with surplus crops" and surcharge, to \$107.97 in the Oakes area under the "without surplus crops" (Table 5). Composite irrigated acre returns are positive in each area even with a \$55 per acre surcharge assessed for growing surplus crops.

Regional Economic Impacts

Added direct expenditures from irrigation of 75,000 acres range from \$6.5 million in the New Rockford area with surplus crops and surcharge to \$12.4 million in the Oakes area without

TABLE 5. NET RETURNS TO UNPAID LABOR AND MANAGEMENT PER COMPOSITE ACRE, DRYLAND AND THREE IRRIGATION SITUATIONS, 1991 DOLLARS

Cropping Scenario	Area		
	Turtle Lake	New Rockford	Oakes
	-----Net Returns Per Acre-----		
Dryland	-\$4.73	\$3.81	\$7.51
Irrigation			
Gain over dryland with surplus crops, without surcharge	45.41	63.68	68.89
Gain over dryland with surplus crops, with surcharge	35.29	48.83	49.09
Gain over dryland without surplus crops	79.25	96.52	107.97

surplus crops (Appendix Table F1). Total project added direct expenditures range from \$21.9 million with surplus crops and surcharge to \$33.0 million without surplus crops.

Added activities at the farm-level induce additional business activity in the region. Total business activity from irrigation (direct and indirect) increases \$48 to \$77 million above baseline dryland (Table 6 and Appendix Table F2). Approximately 1,200 additional jobs, spread across all business sectors, are supported by this increase in business activity.

Livestock Impacts

The potential increase in livestock numbers ranges from 37,000 to 56,600 animal units (Table 4). This represents a 2.3 to 3.5 percent increase from the 1,614,240 animal unit equivalent of cattle and sheep in the state in 1990 (North Dakota Agricultural Statistics Service, 1990).

Beef cows are the predominant class of livestock produced in the irrigation areas. The high cost of transporting corn silage would necessitate an expansion of cattle feeding in the irrigation areas. Currently, about 500,000 calves are shipped out of the state for finishing, so a supply of calves is readily available.

TABLE 6. INCREASES IN RETAIL TRADE, PERSONAL INCOME, TOTAL BUSINESS ACTIVITY, AND EMPLOYMENT, 75,232 ACRES

Sector	With Surplus Crops Without Surcharge	With Surplus Crops With Surcharge	Without Surplus Crops
	-----millions-----		
Retail trade	\$19.6	\$18.6	\$29.2
Personal income	14.8	12.8	22.8
Total business activity	52.1	48.2	77.2
Secondary employment	913	875	1,248

Alfalfa hay can be efficiently used in beef cattle rations to supplement low quality forages including crop residues. Alfalfa is the major source of high quality forage for dairy cattle. North Dakota currently has 88,000 milk cows. The increase in alfalfa production could assure the forage needs of from 15 to 18 percent of the dairy cows in the state. Sale out of state is also a feasible option for alfalfa hay.

Summary

Per acre increases in returns to unpaid labor and management as a result of irrigation were estimated for three areas of North Dakota. Two irrigated crop rotations were assumed, one that included surplus crops and another that did not. Net per acre returns were estimated to increase even when accounting for a \$55 per acre surcharge to grow surplus crops, ranging from \$35 to \$108 per acre. These improved net returns increased value-added business activity in the state by as much as \$77 million and supported up to 1,248 new jobs.

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**APPENDIX A:
History of the Garrison
Diversion Project**

History of the Garrison Diversion Project

The Corps of Engineers Pick Plan⁴ proposed a series of dams on the Missouri River that would alleviate flood problems in downstream states. The Bureau of Reclamation's Sloan Plan⁵ suggested diversion of water from Fort Peck Reservoir in Montana to North Dakota for irrigation. Political forces combined the two plans together into the Pick-Sloan Plan⁶ for development of the Missouri River Basin's water resources. Garrison Dam in North Dakota and the Oahe Dam in South Dakota were authorized for construction under this joint plan.

Originally, North Dakota was to receive irrigation water from the Missouri reservoir system for 1 million acres or more in return for land inundated by the reservoirs. North Dakota gave up over 550,000 acres of river bottom-land to protect residents of downstream states from flooding, to provide electrical power for a multi-state region, and to maintain water storage for down stream navigational needs. Economic losses to North Dakota included agricultural, mineral, forestry, and bank erosion.

The plan was re-authorized in 1965 with 250,000 acres of irrigation identified as the first stage of the 1 million acre project. Additional project features included municipal water delivery, recreation development, wildlife development, stream and lake stabilization, and power generation. Controversy involving wildlife habitat and interbasin transfer of biota surfaced shortly after construction began creating periodic delays and causing congressional appropriations to become sporadic.

A congressionally mandated commission that reviewed the Garrison Project and North Dakota's contemporary water needs proposed additional project modifications. The Garrison

⁴House document 475, 78th Congress, second session, March 2, 1944.

⁵Senate document 191, 78th Congress, second session, May 5, 1944.

⁶Flood Control Act of 1944 (57 Stat. 877).

Diversion Unit Reformulation Act of 1986 significantly altered the focus of the project from principally irrigation to municipal, rural, industrial water delivery, recreation, and fish and wildlife enhancement. Irrigation acres have been reduced to 130,940 acres including 17,580 acres within Indian reservations.

There are several laws that relate to the use of irrigation water in a manner that minimizes the potential for degradation of ground water and/or receiving streams from irrigation return flows. Of particular importance is the concept of "best management practices." Best management practices assumes the judicious use of irrigation water, fertilizer, and other agricultural chemicals on crops grown on lands to be developed for irrigation agriculture in the Garrison Diversion Unit (GDU). The International Garrison Diversion Study Board Report in 1976 to the International Joint Commission in part stated:

"The greatest incentive for farm operators and managers to employ best management practices is long-term economics. The objective is to obtain maximum net returns with minimum inputs. The utilization of best management practices allows the producer to approach optimum production and at the same time reduce the potential for adverse impacts on the environment."

The North Dakota Legislature, during the 1979 session, mandated that farmers using water from the Garrison Diversion Unit employ "best management practices" as outlined by the director of the North Dakota Agricultural Experiment Station.

**APPENDIX B:
Turtle Lake**

Table B1. Crop Budgets for an Acre of Dry Cropland, Turtle Lake Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Alfalfa	Summerfallow
Yield ^a	24 bu	37 bu	1,080 lbs	43 bu	1.66 tons	n/a
Price ^b	\$3.27/bu	\$1.98/bu	\$0.1013/lb	\$1.39/bu	\$56.42/ton ^c	n/a
Government Payment ^d	\$25.02	\$12.00	n/a	\$9.30	n/a	n/a
Gross Income	\$103.50	\$85.26	\$109.40	\$69.07	\$93.66	n/a
	dollars					
EXPENSES:^e						
Seed	5.63	5.25	13.20	5.00	10.06	1.20
Fertilizer and chemicals	8.76	8.73	12.85	4.96	6.15	0.00
Miscellaneous	3.75	5.25	8.74	5.95	3.00	0.20
Insurance and interest	5.02	6.14	7.16	5.94	1.09	0.58
Fuel and lubrication	5.58	5.58	7.19	5.58	5.29	5.69
Repairs	6.89	6.89	6.65	6.89	3.65	2.57
Machinery ownership	27.32	27.32	22.78	27.32	6.88	8.26
Land ownership	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>
TOTAL	89.49	91.70	105.11	88.18	62.66	45.04
Returns to unpaid labor and management	14.01	(6.44)	4.29	(19.11)	31.00	(45.04)

^aYields are based on a 10-year simple average of yields from McLean, Sheridan, and Wells counties (North Dakota Agricultural Statistics 1990) from 1980-1989.

^bPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-1990.

^cAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre was divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^dMethods used to estimate government payments are provided in Appendix E.

^eExpenses are those reported in Estimated 1991 Crop Budgets: North Central North Dakota (Haugen and Aakre 1991).

Table B2. Budget for a Composite Acre of Dry Cropland, Turtle Lake Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Alfalfa	Summerfallow	Total
Percent of acre	44	10	15	6	2	23	100
	dollars						
Gross income	45.54	8.53	16.41	4.14	1.87	n/a	76.49
EXPENSES:							
Seed	2.48	0.53	1.98	0.30	0.20	0.28	5.76
Fertilizer and chemicals	3.85	0.87	1.93	0.30	0.12	0.00	7.08
Miscellaneous	1.65	0.53	1.31	.036	0.06	0.05	3.95
Insurance and interest	2.21	0.61	1.07	0.36	0.02	0.13	4.41
Fuel and lubrication	2.46	0.56	1.08	0.33	0.11	1.31	5.84
Repairs	3.03	0.69	1.00	0.41	0.07	0.59	5.80
Machinery ownership	12.02	2.73	3.42	1.64	0.14	1.90	21.85
Land ownership	<u>11.68</u>	<u>2.65</u>	<u>3.98</u>	<u>1.59</u>	<u>0.53</u>	<u>6.10</u>	<u>26.54</u>
TOTAL	39.38	9.17	15.77	5.29	1.25	10.36	81.22
Returns to unpaid labor and management	6.16	(0.64)	0.64	(1.15)	0.62	(10.36)	(4.73)

Table B3. Crop Budgets for an Acre of Irrigated Cropland, Turtle Lake Area, 1991

	Spring Wheat	Corn Silage No Base	Corn Silage With Base	Soybeans	Dry Edible Beans	Alfalfa New ^a	Alfalfa Existing	Potatoes ^b
Yield ^c	60 bu	15 tons	15 tons	40 bu	2,200 lbs	1.75 tons	5.50 tons	325 cwt
Price ^d	\$3.27/bu	\$15.56/ton	\$15.56/ton	\$5.67/bu	\$0.15/lb	\$56.42/ton ^e	\$56.42/ton ^e	\$3.65/cwt
Government Payment ^f	\$25.02	\$0.00	\$20.76	n/a	n/a	n/a	n/a	n/a
Gross Income	\$221.50	\$233.40	\$254.16	\$226.80	\$330.00	\$98.74	\$310.31	\$1,186.25
	dollars							
EXPENSES:^g								
Electricity ^h	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Seed	6.38	19.50	19.50	10.64	27.00	41.25	0.00	257.40
Fertilizer and chemicals	22.05	64.44	64.44	33.59	41.66	22.13	30.63	287.85
Miscellaneous	7.00	1.05	1.05	5.70	5.60	3.85	6.60	148.51
Insurance and interest	7.66	16.63	16.63	13.55	17.52	6.77	4.49	75.11
Fuel and lubrication	5.76	15.87	15.87	5.00	9.72	12.11	7.83	23.11
Repairs	13.89	15.32	15.32	12.06	13.39	15.24	11.41	44.38
Hired labor ⁱ	2.22	4.71	4.71	2.58	3.03	3.33	3.33	11.20
Machinery ownership	27.32	18.66	18.66	24.44	23.36	19.11	6.88	41.33
Irrigation ownership	31.20	31.20	31.20	31.20	31.20	31.20	31.20	31.20
Irrigation O&M ^j	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Land ownership	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>	<u>26.54</u>
TOTAL	207.52	271.42	271.42	222.80	256.52	239.03	186.41	1,004.13
Returns to unpaid labor and management								
No surcharge	13.70	(38.02)	(17.26)	4.00	73.48	(140.29)	123.90	182.12
Surcharge ^k	(41.30)	(38.02)	(17.26)	4.00	73.48	(140.29)	123.90	182.12

^aNew alfalfa will be established on set-aside acres in accordance with ASCS guidelines. Yield assumes alfalfa is established on set-aside acres and one cutting is harvested.

^bYields, prices, and expenses for potatoes were provided by the North Dakota Potato Growers Association.

^cYields are provided in Estimated 1991 Irrigated Crop Budgets: Southwest North Dakota (Haugen and Aakre 1991a). Alfalfa new yield for without surplus crops assumes 25 percent of the new alfalfa acreage is planted on set-aside acres and one cutting of alfalfa producing 1.75 tons per acre is harvested in accordance with ASCS guidelines; 75 percent of the new alfalfa acreage produces two cuttings yielding 3.75 tons per acre.

^dPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-90.

^eAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre was divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^fMethods used to estimate government payments for wheat and corn are provided in Appendix E.

^gExpenses are those reported in Estimated 1991 Irrigated Crop Budgets: Southwest North Dakota (Haugen and Aakre 1991a).

^hElectricity charge represent a minimum REC rate for service delivery.

ⁱHired labor represents the additional labor requirement for irrigation cropland over and above dryland.

^jIrrigation operation and maintenance charge was provided by the Garrison Conservancy District.

^kAssumes a surcharge of \$55 per planted acre for growing surplus program crops.

Table B4. Budget for a Composite Acre of Irrigated Cropland, With Surplus Crops, Turtle Lake Area, 1991

	Spring Wheat	Weighted Corn Silage ^a	Soybeans	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector
Percent of acre	27	20	5	15	4	16	13	100		
	dollars									
Gross income	59.73	46.89	11.34	49.50	3.95	49.65	154.21	375.27	298.78	
Expenses:										
Electricity	2.03	1.50	0.38	1.13	0.30	1.20	0.98	7.50	7.50	Retail
Seed	1.72	3.90	0.53	4.05	1.65	0.00	33.46	45.32	39.56	Retail
Fertilizer and chemicals	5.95	12.89	1.68	6.25	0.89	4.90	37.42	69.98	62.90	Retail
Miscellaneous	1.89	0.21	0.29	0.84	0.15	1.06	19.31	23.74	19.79	B&P Service
Insurance and interest	2.07	3.33	0.68	2.63	0.27	0.72	9.76	19.45	15.04	FIRE
Fuel and lubrication	1.56	3.17	0.25	1.46	0.48	1.25	3.00	11.18	5.34	Retail
Repairs	3.75	3.06	0.60	2.01	0.61	1.83	5.77	17.63	11.83	B&P Service
Hired labor	0.60	0.94	0.13	0.45	0.13	0.53	1.46	4.25	4.25	Households
Machinery ownership	7.38	3.73	1.22	3.50	0.76	1.10	5.37	23.07	1.23	Retail
Irrigation ownership	8.42	6.24	1.56	4.68	1.25	4.99	4.06	31.20	31.20	Retail
Irrigation O&M	13.50	10.00	2.50	7.50	2.00	8.00	6.50	50.00	50.00	Government
Land ownership	<u>7.17</u>	<u>5.31</u>	<u>1.33</u>	<u>3.98</u>	<u>1.06</u>	<u>4.25</u>	<u>3.45</u>	<u>26.54</u>	<u>0.00</u>	FIRE
Total	56.03	54.28	11.14	38.48	9.56	29.83	130.54	329.86	248.64	
Returns to unpaid labor and management										
No surcharge	3.70	(7.39)	0.20	11.02	(5.61)	19.82	23.67	45.41	50.14	Households
Surcharge	(11.15)	(7.39)	0.20	11.02	(5.61)	19.82	23.67	30.56	35.29	

^aAssumes a corn base of 5 percent. Income, expenses, and returns based on 95 percent corn silage no base and 5 percent corn silage with base.

Table B5. Budget for a Composite Acre of Irrigated Cropland Without Surplus Crops, Turtle Lake Area, 1991

	Weighted Corn Silage ^a	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector
Percent of acre	25	25	5	20	25	100		
	dollars							
Gross income	58.61	82.50	7.05	62.06	296.56	506.78	430.29	
Expenses:								
Electricity	1.88	1.88	0.38	1.50	1.88	7.50	7.50	Retail
Seed	4.88	6.75	2.06	0.00	64.35	78.04	72.27	Retail
Fertilizer and chemicals	16.11	10.42	1.11	6.13	71.96	105.72	98.64	Retail
Miscellaneous	0.26	1.40	0.19	1.32	37.13	40.30	36.35	B&P Service
Insurance and investment	4.16	4.38	0.34	0.90	18.78	28.55	24.14	FIRE
Fuel and lubrication	3.97	2.43	0.61	1.57	5.78	14.35	8.51	Retail
Repairs	3.83	3.35	0.76	2.28	11.10	21.32	15.52	B&P Service
Hired Labor	1.18	0.76	0.17	0.67	2.80	5.57	5.57	Households
Machinery ownership	4.67	5.84	0.96	1.38	10.33	23.17	1.32	Retail
Irrigation ownership	7.80	7.80	1.56	6.24	7.80	31.20	31.20	Retail
Irrigation O&M	12.50	12.50	2.50	10.00	12.50	50.00	50.00	Government
Land ownership	<u>6.64</u>	<u>6.64</u>	<u>1.33</u>	<u>5.31</u>	<u>6.64</u>	<u>26.54</u>	<u>0.00</u>	FIRE
TOTAL	67.86	64.13	11.95	37.28	251.03	432.25	351.04	
Returns to unpaid labor and management	(9.25)	18.37	(4.90)	24.78	45.53	74.53	79.25	Households

^aAssumes a corn base of 5 percent. Income, expenses, and returns based on 95 percent market corn silage no base and 5 percent base corn silage with base.

**APPENDIX C:
New Rockford**

Table C1. Crop Budgets for an Acre of Dry Cropland, New Rockford Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Alfalfa	Summerfallow
Yield ^a	24 bu	39 bu	1,117 lbs	44 bu	1.59 tons	n/a
Price ^b	\$3.27/bu	\$1.98/bu	\$0.1013/lb	\$1.39/bu	\$56.42/ton ^c	n/a
Government Payment ^d	\$25.02	\$12.65	n/a	\$9.52	n/a	n/a
Gross Income	\$103.50	\$89.87	\$113.15	\$70.68	\$89.71	n/a
	-----dollars-----					
EXPENSES: ^e						
Seed	5.63	5.25	13.20	5.00	10.06	1.20
Fertilizer and chemicals	9.15	9.91	12.98	5.30	6.15	0.00
Miscellaneous	3.75	5.75	8.98	6.05	3.00	0.20
Insurance and interest	5.04	6.24	8.24	5.97	1.09	0.58
Fuel and lubrication	5.58	5.58	7.19	5.58	5.29	5.69
Repairs	6.89	6.89	6.65	6.89	3.65	2.57
Machinery ownership	27.32	27.32	22.78	27.32	6.88	8.26
Land ownership	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>
TOTAL	86.70	90.28	103.36	85.45	59.46	41.84
Returns to unpaid labor and management	16.80	(0.41)	9.79	(14.77)	30.25	(41.84)

^aYields are based on a 10-year simple average of yields from Eddy County (North Dakota Agricultural Statistics 1990) from 1980-1989.

^bPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-1990.

^cAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre was divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^dMethods used to estimate government payments are provided in Appendix E.

^eExpenses are those reported in Estimated 1991 Crop Budgets: South Central North Dakota (Haugen and Aakre 1991).

Table C2. Budget for a Composite Acre of Dry Cropland, New Rockford Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Alfalfa	Summerfallow	Total
Percent of acre	38	9	19	7	11	16	100
	----- dollars -----						
Gross income	39.33	8.09	21.50	4.95	9.87	n/a	83.74
EXPENSES:							
Seed	2.14	0.47	2.51	0.35	1.11	0.19	6.77
Fertilizer and chemicals	3.48	0.89	2.47	0.37	0.68	0.00	7.88
Miscellaneous	1.43	0.52	1.71	0.42	0.33	0.03	4.43
Insurance and interest	1.92	0.56	1.57	0.42	0.12	0.09	4.67
Fuel and lubrication	2.12	0.50	1.37	0.39	0.58	0.91	5.87
Repairs	2.62	0.62	1.26	0.48	0.40	0.41	5.80
Machinery ownership	10.38	2.46	4.33	1.91	0.76	1.32	21.16
Land ownership	8.87	2.10	4.43	1.63	2.57	3.73	23.34
TOTAL	<u>32.95</u>	<u>8.13</u>	<u>19.64</u>	<u>5.98</u>	<u>6.54</u>	<u>6.69</u>	<u>79.93</u>
Returns to unpaid labor and management	6.38	(0.04)	1.86	(1.03)	3.33	(6.69)	3.81

Table C3. Crop Budgets for an Acre of Irrigated Cropland, New Rockford Area, 1991

	Spring Wheat	Corn Silage No Base	Corn Silage With Base	Soybeans	Dry Edible Beans	Alfalfa New ^a	Alfalfa Existing	Potatoes ^b
Yield ^c	60 bu	16 tons	16 tons	42 bu	2,800 lbs	1.75 tons	5.50 tons	325 cwt
Price ^d	\$3.27/bu	\$15.56/ton	\$15.56/ton	\$5.67/bu	\$0.15/lb	\$56.42/ton ^e	\$56.42/ton ^e	\$3.65/cwt
Government Payment ^f	\$25.02	\$0.00	\$23.78	n/a	n/a	n/a	n/a	n/a
Gross Income	\$221.22	\$248.96	\$272.74	\$238.14	\$420.00	\$98.74	\$310.31	\$1,186.25
	dollars							
EXPENSES:^g								
Electricity ^h	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Seed	6.38	19.50	19.50	10.64	27.00	41.25	0.00	257.40
Fertilizer and chemicals	22.05	67.02	67.02	33.59	53.67	21.37	29.09	287.85
Miscellaneous	7.00	1.05	1.05	5.70	6.80	3.85	6.60	148.51
Insurance and interest	7.66	16.79	16.79	9.31	18.32	6.73	4.40	75.11
Fuel and lubrication	5.76	15.87	15.87	5.00	9.72	12.11	7.83	23.11
Repairs	13.89	15.32	15.32	12.06	13.39	15.24	11.41	44.38
Hired labor ⁱ	2.22	4.71	4.71	2.58	3.03	3.33	3.33	11.20
Machinery ownership	27.32	18.66	18.66	24.44	23.36	19.11	6.88	41.33
Irrigation ownership	31.20	31.20	31.20	31.20	31.20	31.20	31.20	31.20
Irrigation O&M ^j	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Land ownership	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>
TOTAL	204.32	270.96	270.96	215.36	267.33	235.03	181.58	1,000.93
Returns to unpaid labor and management								
No surcharge	16.90	(22.00)	1.78	22.78	152.67	(136.29)	128.73	185.32
Surcharge ^k	(38.10)	(22.00)	1.78	22.78	152.67	(136.29)	128.73	185.32

^aNew alfalfa will be established on set-aside acres in accordance with ASCS guidelines. Yield assumes alfalfa is established on set-aside acres and one cutting is harvested.

^bYields, prices, and expenses for potatoes were provided by the North Dakota Potato Growers Association.

^cYields are provided in Estimated 1991 Irrigated Crop Budgets: South Central North Dakota (Haugen and Aakre 1991a). Alfalfa new yield for without surplus crops assumes 25 percent of the new alfalfa acreage is planted on set-aside acres and one cutting of alfalfa producing 1.75 tons per acre is harvested in accordance with ASCS guidelines; 75 percent of the new alfalfa acreage produces two cuttings yielding 3.75 tons per acre.

^dPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-90.

^eAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre was divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^fMethods used to estimate government payments for wheat and corn are provided in Appendix E.

^gExpenses are those reported in Estimated 1991 Irrigated Crop Budgets: South Central North Dakota (Haugen and Aakre 1991a).

^hElectricity charge represent a minimum REC rate for service delivery.

ⁱHired labor represents the additional labor requirement for irrigation cropland over and above dryland.

^jIrrigation operation and maintenance charge was provided by the Garrison Conservancy District.

^kAssumes a surcharge of \$55 per planted acre for growing surplus program crops.

Table C4. Budget for a Composite Acre of Irrigated Cropland, With Surplus Crops, New Rockford Area, 1991

	Spring Wheat	Weighted Corn Silage ^a	Soybeans	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector
Percent of acre	27	20	5	15	4	16	13	100		
	dollars									
Gross income	59.73	50.03	11.91	63.00	3.95	49.65	154.21	392.48	308.74	
Expenses:										
Electricity	2.03	1.50	0.38	1.13	0.30	1.20	0.98	7.50	7.50	Retail
Seed	1.72	3.90	0.53	4.05	1.65	0.00	33.46	45.32	38.55	Retail
Fertilizer and Chemicals	5.95	13.40	1.68	8.05	0.85	4.65	37.42	72.02	64.13	Retail
Miscellaneous	1.89	0.21	0.29	1.02	0.15	1.06	19.31	23.92	19.49	B&P Service
Insurance and interest	2.07	3.36	0.47	2.75	0.27	0.70	9.76	19.38	14.70	FIRE
Fuel and lubrication	1.56	3.17	0.25	1.46	0.48	1.25	3.00	11.18	5.31	Retail
Repairs	3.75	3.06	0.60	2.01	0.61	1.83	5.77	17.63	11.83	B&P Service
Hired labor	0.60	0.94	0.13	0.45	0.13	0.53	1.46	4.25	4.25	Households
Machinery ownership	7.38	3.73	1.22	3.50	0.76	1.10	5.37	23.07	1.91	Retail
Irrigation ownership	8.42	6.24	1.56	4.68	1.25	4.99	4.06	31.20	31.20	Retail
Irrigation O&M	13.50	10.00	2.50	7.50	2.00	8.00	6.50	50.00	50.00	Government
Land ownership	<u>6.30</u>	<u>4.67</u>	<u>1.17</u>	<u>3.50</u>	<u>0.93</u>	<u>3.73</u>	<u>3.03</u>	<u>23.34</u>	<u>0.00</u>	FIRE
Total	55.17	54.19	10.77	40.10	9.40	29.05	130.12	328.80	248.87	
Returns to unpaid labor and management										
No surcharge	4.56	(4.16)	1.14	22.90	(5.45)	20.60	24.09	63.68	59.87	Households
Surcharge	(10.29)	(4.16)	1.14	22.90	(5.45)	20.60	24.09	48.83	45.02	

^aAssumes a corn base of 5 percent. Incomes, expenses, and returns based on 95 percent corn silage no base and 5 percent corn silage with base.

Table C5. Budget for a Composite Acre of Irrigated Cropland Without Surplus Crops, New Rockford Area, 1991

	Weighted Corn Silage ^a	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector
Percent of acre	25	25	5	20	25	100		
	dollars							
Gross income	62.54	105.00	7.05	62.06	296.56	533.21	449.47	
Expenses:								
Electricity	1.88	1.88	0.38	1.50	1.88	7.50	7.50	Retail
Seed	4.88	6.75	2.06	0.00	64.35	78.04	71.27	Retail
Fertilizer and chemicals	16.76	13.42	1.07	5.82	71.96	109.02	101.14	Retail
Miscellaneous	0.26	1.70	0.19	1.32	37.13	40.60	36.17	B&P Service
Insurance and investment	4.20	4.58	0.34	0.88	18.78	28.77	24.10	FIRE
Fuel and lubrication	3.97	2.43	0.61	1.57	5.78	14.35	8.47	Retail
Repairs	3.83	3.35	0.76	2.28	11.10	21.32	15.52	B&P Service
Hired Labor	1.18	0.76	0.17	0.67	2.80	5.57	5.57	Households
Machinery ownership	4.67	5.84	0.96	1.38	10.33	23.17	2.01	Retail
Irrigation ownership	7.80	7.80	1.56	6.24	7.80	31.20	31.20	Retail
Irrigation O&M	12.50	12.50	2.50	10.00	12.50	50.00	50.00	Government
Land ownership	<u>5.84</u>	<u>5.84</u>	<u>1.17</u>	<u>4.67</u>	<u>5.84</u>	<u>23.34</u>	<u>0.00</u>	FIRE
TOTAL	67.74	66.83	11.75	36.32	250.23	432.87	352.95	
Returns to unpaid labor and management	(5.20)	38.17	(4.70)	25.74	46.33	100.34	96.52	Households

^aAssumes a corn base of 5 percent. Income, expenses, and returns based on 95 percent corn silage no base and 5 percent corn silage with base.

**APPENDIX D:
Oakes**

Table D1. Crop Budgets for an Acre of Dry Cropland, Oakes Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Corn	Soybeans	Alfalfa	Summerfallow
Yield ^a	24 bu	41 bu	1,170 lbs	44 bu	65.00 bu	19.00 bu	1.91 tons	n/a
Price ^b	\$3.27/bu	\$1.98/bu	\$0.1013/lbs	\$1.39/bu	\$2.26/bu	\$5.67/bu	\$56.42/ton ^c	n/a
Government Payment ^d	\$25.02	\$13.30	n/a	\$9.52	\$24.61	n/a	n/a	n/a
Gross Income	\$103.50	\$94.48	\$118.52	\$70.68	\$171.51	\$107.73	\$107.76	n/a
	-----dollars-----							
EXPENSES: ^e								
Seed	5.63	5.25	13.20	5.00	18.05	10.64	10.06	1.20
Fertilizer and chemicals	9.15	9.91	12.98	5.30	28.59	25.87	6.15	0.00
Miscellaneous	3.75	5.75	8.98	6.05	14.05	3.40	3.00	0.20
Insurance and interest	5.04	6.24	8.24	5.97	13.20	7.33	1.09	0.58
Fuel and lubrication	5.58	5.58	7.19	5.58	8.51	5.24	5.29	5.69
Repairs	6.89	6.89	6.65	6.89	9.52	6.32	3.65	2.57
Machinery ownership	27.32	27.32	22.78	27.32	26.20	25.29	6.88	8.26
Land ownership	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>	<u>23.34</u>
TOTAL	<u>86.70</u>	<u>90.28</u>	<u>103.36</u>	<u>85.45</u>	<u>141.46</u>	<u>107.43</u>	<u>59.46</u>	<u>41.84</u>
Returns to unpaid labor and management	16.80	4.20	15.16	(14.77)	30.05	0.30	48.30	(41.84)

^aYields are based on a 10-year simple average of yields from Dickey and LaMoure counties (North Dakota Agricultural Statistics 1990) from 1980-1989.

^bPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-1990.

^cAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre was estimated and then divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^dMethods used to estimate government payments are provided in Appendix E.

^eExpenses are those reported in Estimated 1991 Crop Budgets: South Central North Dakota (Haugen and Aakre 1991).

Table D2. Budget for a Composite Acre of Dry Cropland, Oakes Area, 1991

	Spring Wheat	Barley	Sunflower	Oat	Corn	Soybeans	Alfalfa	Summerfallow	Total
Percent of acre	23	11	13	4	25	6	2	16	100
	-----dollars-----								
Gross income	23.81	10.39	15.41	2.83	42.88	6.46	2.16	n/a	103.94
EXPENSES:									
Seed	1.29	0.58	1.72	0.20	4.51	0.64	0.20	0.19	9.33
Fertilizer and chemicals	2.10	1.09	1.69	0.21	7.15	1.55	0.12	0.00	13.92
Miscellaneous	0.86	0.63	1.17	0.24	3.51	0.20	0.06	0.03	6.71
Insurance and interest	1.16	0.69	1.07	0.24	3.30	0.44	0.02	0.09	7.01
Fuel and lubrication	1.28	0.61	0.93	0.22	2.13	0.31	0.11	0.91	6.51
Repairs	1.58	0.76	0.86	0.28	2.38	0.38	0.07	0.41	6.73
Machinery ownership	6.28	3.01	2.96	1.09	6.55	1.52	0.14	1.32	22.87
Land ownership	5.37	2.57	3.03	0.93	5.84	1.40	0.47	3.73	23.34
TOTAL	<u>19.94</u>	<u>9.93</u>	<u>13.44</u>	<u>3.42</u>	<u>35.37</u>	<u>6.45</u>	<u>1.19</u>	<u>6.69</u>	<u>96.43</u>
Returns to unpaid labor and management	3.87	0.46	1.97	(0.59)	7.51	0.01	0.97	(6.69)	7.51

Table D3. Crop Budgets for an Acre of Irrigated Cropland, Oakes Area, 1991

	Spring Wheat	Corn Grain With Base	Corn Silage No Base	Corn Silage With Base	Soybeans	Dry Edible Beans	Alfalfa New ^a	Alfalfa Existing	Potatoes ^b
Yield ^c	60 bu	135 bu	17 tons	17 tons	42 bu	2,800 lbs	1.75 tons	5.50 tons	325 cwt
Price ^d	\$3.27/bu	\$2.26/bu	\$15.56/ton	\$15.56/ton	\$5.67/bu	\$0.15/lb	\$56.42/ton ^e	\$56.42/ton ^e	\$3.65/cwt
Government Payment ^f	\$25.02	\$24.61	\$0.00	\$24.61	n/a	n/a	n/a	n/a	n/a
Gross Income	\$221.22	\$329.71	\$264.52	\$289.13	\$238.14	\$420.00	\$155.16	\$310.31	\$1,186.25
dollars									
EXPENSES: ^g									
Electricity ^h	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Seed	6.38	28.00	19.50	19.50	10.64	27.00	41.25	0.00	257.40
Fertilizer and chemicals	22.05	74.85	67.02	67.02	33.59	53.67	22.37	29.09	287.85
Miscellaneous	7.00	28.05	1.05	1.05	5.70	6.80	3.85	6.60	148.51
Insurance and interest	7.66	18.72	16.79	16.79	9.31	18.32	6.73	4.40	75.11
Fuel and lubrication	5.76	7.11	15.87	15.87	5.00	9.72	12.11	7.83	23.11
Repairs	13.89	14.06	15.32	15.32	12.06	13.39	15.24	11.41	44.38
Hired labor ⁱ	2.22	3.65	4.71	4.71	2.58	3.03	3.33	3.33	11.20
Machinery ownership	27.32	25.35	18.66	18.66	24.44	23.36	19.11	6.88	41.33
Irrigation ownership	31.20	31.20	31.20	31.20	31.20	31.20	31.20	31.20	31.20
Irrigation O&M ^j	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Land ownership	23.34	23.34	23.34	23.34	23.34	23.34	23.34	23.34	23.34
TOTAL	204.32	311.83	270.96	270.96	215.36	267.33	235.03	181.58	1,000.93
Returns to unpaid labor and management									
No surcharge	16.90	17.88	(6.44)	18.17	22.78	152.67	(136.29)	128.73	185.32
Surcharge ^k	(38.10)	(37.12)	(6.44)	18.17	22.78	152.67	(136.29)	128.73	185.32

^aNew alfalfa will be established on set-aside acres in accordance with ASCS guidelines. Yield assumes alfalfa is established on set-aside acres and one cutting is harvested.

^bYields, prices, and expenses for potatoes were provided by the North Dakota Potato Growers Association.

^cYields are provided in *Estimated 1991 Irrigated Crop Budgets: Southwest North Dakota* (Haugen and Aakre 1991a). Alfalfa new yield for without surplus crops assumes 25 percent of the new alfalfa acreage is planted on set-aside acres and one cutting of alfalfa producing 1.75 tons per acre is harvested in accordance with ASCS guidelines; 75 percent of the new alfalfa acreage is planted on nonset-aside acres and produces two cuttings yielding 2.75 tons per acre.

^dPrices are based on a 10-year simple average of North Dakota marketing year prices (North Dakota Agricultural Statistics 1990) from 1981-90.

^eAlfalfa price is a weighted average determined by multiplying annual state average production per acre (tons per acre) times state average price (dollars per ton) for years 1980-89. This represents annual gross income per acre. The 10-year average gross income per acre divided by the 10-year state average alfalfa yield to determine a 10-year weighted average alfalfa price per ton.

^fMethods used to estimate government payments for wheat and corn are provided in Appendix E. It was assumed that government payments would be provided for corn acreage up to 25 percent of the cropland base. Any corn grown in excess of 25 percent of the cropland base would not be eligible for government payments. It was assumed that the 25 percent would be applied to corn grain first with the remainder applied to corn silage acreage.

^gExpenses are those reported in *Estimated 1991 Irrigated Crop Budgets: South Central North Dakota* (Haugen and Aakre 1991a).

^hElectricity charge represent a minimum REC rate for service delivery.

ⁱHired labor represents the additional labor requirement for irrigation cropland over and above dryland.

^jIrrigation operation and maintenance charge was provided by the Garrison Conservancy District.

^kAssumes a surcharge of \$55 per planted acre for growing surplus program crops.

Table D4. Budget for a Composite Acre of Irrigated Cropland, With Surplus Crops, Oakes Area, 1991

	Spring Wheat	Corn Grain With Base ^a	Corn Silage No Base	Soybeans	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector
Percent of acre	11	25	11	5	15	4	16	13	100		
	dollars										
Gross income	24.33	82.43	29.10	11.91	63.00	3.95	49.65	154.21	418.58	314.64	
Expenses:											
Electricity	0.83	1.88	0.83	0.38	1.13	0.30	1.20	0.98	7.50	7.50	Retail
Seed	0.70	7.00	2.15	0.53	4.05	1.65	0.00	33.46	49.54	40.21	Retail
Fertilizer and chemicals	2.43	18.71	7.37	1.68	8.05	0.85	4.65	37.42	81.17	67.25	Retail
Miscellaneous	0.77	7.01	0.12	0.29	1.02	0.15	1.06	19.31	29.72	23.01	B&P Service
Insurance and interest	0.84	4.68	1.85	0.47	2.75	0.27	0.70	9.76	21.32	14.31	FIRE
Fuel and lubrication	0.63	1.78	1.75	0.25	1.46	0.48	1.25	3.00	10.61	4.09	Retail
Repairs	1.53	3.52	1.69	0.60	2.01	0.61	1.83	5.77	17.54	10.82	B&P Service
Hired labor	0.24	0.91	0.52	0.13	0.45	0.13	0.53	1.46	4.38	4.38	Households
Machinery ownership	3.01	6.34	2.05	1.22	3.50	0.76	1.10	5.37	23.36	0.49	Retail
Irrigation ownership	3.43	7.80	3.43	1.56	4.68	1.25	4.99	4.06	31.20	31.20	Retail
Irrigation O&M	5.50	12.50	5.50	2.50	7.50	2.00	8.00	6.50	50.00	50.00	Government
Land ownership	<u>2.57</u>	<u>5.84</u>	<u>2.57</u>	<u>1.17</u>	<u>3.50</u>	<u>0.93</u>	<u>3.73</u>	<u>3.03</u>	<u>23.34</u>	<u>0.00</u>	FIRE
Total	22.48	77.96	29.81	10.77	40.10	9.40	29.05	130.12	349.68	253.26	
Returns to unpaid labor and management											
No surcharge	1.85	4.47	(0.71)	1.14	22.90	(5.45)	20.60	24.09	68.89	61.38	Households
Surcharge	(4.20)	(9.28)	(0.71)	1.14	22.90	(5.45)	20.60	24.09	49.09	41.58	

Table D5. Budget for a Composite Acre of Irrigated Cropland Without Surplus Crops, Oakes Area, 1991

	Corn Silage Base ^a	Dry Edible Beans	Alfalfa- New	Alfalfa- Existing	Potatoes	Total	Added Dollar Flows	Input-Output Sector	
Percent of acre	25	25	5	20	25	100			
	dollars								
Gross income	72.28	105.00	4.94	62.06	296.56	540.84	436.90		
Expenses:									
Electricity	1.88	1.88	0.38	1.50	1.88	7.50	7.50	Retail	
Seed	4.88	6.75	2.06	0.00	64.35	78.04	68.71	Retail	
Fertilizer and chemicals	16.76	13.42	1.07	5.82	71.96	109.02	95.10	Retail	
Miscellaneous	0.26	1.70	0.19	1.32	37.13	40.60	33.89	B&P Service	
Insurance and investment	4.20	4.58	0.34	0.88	18.78	28.77	21.76	FIRE	
Fuel and lubrication	3.97	2.43	0.61	1.57	5.78	14.35	7.83	Retail	
Repairs	3.83	3.35	0.76	2.28	11.10	21.32	14.59	B&P Service	
Hired Labor	1.18	0.76	0.17	0.67	2.80	5.57	5.57	Households	
Machinery ownership	4.67	5.84	0.96	1.38	10.33	23.17	0.30	Retail	
Irrigation ownership	7.80	7.80	1.56	6.24	7.80	31.20	31.20	Retail	
Irrigation O&M	12.50	12.50	2.50	10.00	12.50	50.00	50.00	Government	
Land ownership	<u>5.84</u>	<u>5.84</u>	<u>1.17</u>	<u>4.67</u>	<u>5.84</u>	<u>23.34</u>	<u>0.00</u>	FIRE	
TOTAL	67.74	66.83	11.75	36.32	250.23	432.87	336.45		
Returns to unpaid labor and management	4.54	38.17	(6.81)	25.74	46.33	107.97	100.45	Households	

^aAssumes a corn base of 25 percent.

**APPENDIX E:
Government Payments**

Government payments were estimated for both wheat and feed grain programs. The average North Dakota wheat payment per acre was estimated by dividing the 10-year average (1980-89) of wheat program government payments received by North Dakota farmers by the 10-year average (1980-89) of planted wheat acres in the state. The 10-year average wheat payment was \$284,150,790 with an average of 9,859,500 planted wheat acres for an average government wheat program payment per planted wheat acre of \$28.82. Payments were adjusted for each area based on the pounds of wheat produced per acre. Average pounds produced per acre were based on average wheat yields. Average wheat payments for each area were:

	<u>Turtle Lake</u>	<u>New Rockford</u>	<u>Oakes</u>
WHEAT			
Average yield (bu)	24	24	24
Pounds per bushel	60	60	60
Pounds per acre	1,440	1,440	1,440
Percentage of State Average (state average = 1,655)	0.87	0.87	0.87
Average government wheat program payment	\$25.02	\$25.02	\$25.02

The average feed grain payments were divided into payments for oat, barley, and corn. State average payments for each were determined by:

$$(P_o * A_o) + (P_b * A_b) + (P_c * A_c) = P_t \quad (1)$$

where:

P_o = oat payment per acre
 A_o = oat planted acres

P_b = barley payment per acre
 A_b = barley planted acres

P_c = corn payment per acre
 A_c = corn planted acres, and

P_t = total North Dakota government feed grain payment.

It is assumed that the government feed grain payment rate for each crop is based on oat, barley, and corn yields in pounds per acre assuming 10-year state average yields. State

average pounds per acre (with 10-year average yields) are: Oat = 1,406.4, Barley = 2,128.8, and corn = 4,093.6. This implies

$$P_b = 1.5136 * P_o, \quad (2)$$

where the 1.5136 was determined by dividing the pounds of barley produced (2,128.8) per acre by the pounds of oat produced (1,406.4) per acre.

Likewise,

$$P_c = 2.9107 * P_o, \quad (3)$$

where the 2.9107 was determined by dividing the pounds of corn produced (4,093.6) per acre by the pounds of oat produced (1,406.4) per acre.

Substituting these values into equation 1 produces

$$(P_o * 1,162,500) + (1.5136P_o * 2,733,000) + (2.9107P_o * 848,000) = \$73,856,295.$$

Solving for P_o reveals that the 10-year state average payment for oat is \$9.51. Substituting this value into equation 2 and 3 shows that the state 10-year average government payments for barley and corn are \$14.39 and \$27.68 per planted acre.

State average feed grain payments were adjusted to reflect specific areas of the state based on the number of pounds of each crop produced per planted acre. Average yields, pounds produced per acre, percentage of state average, and 10-year average payment by crop and area were:

	Turtle Lake			New Rockford			Oakes		
	Oat	Barley	Corn	Oat	Barley	Corn	Oat	Barley	Corn
Average Yield (bu)	43	37	55	44	39	63	44	41	65
Pounds per acre	1,376	1,776	3,070	1,408	1,872	3,517	1,408	1,968	3,640
Percentage of State	0.978	0.834	0.750	1.001	0.879	0.859	1.001	0.924	0.889
Average Payment (\$/acre)	9.30	12.00	20.76	9.52	12.65	23.78	9.52	13.30	24.61

**APPENDIX F:
Regional Economic Activity**

Table F1. Added Dollar Flows Per Acre and Added Basic Economic Activity from Irrigation

Sector	Added Dollar Flows Per Acre		Acres	Added Basic Economic Activity	
	With Surplus Crops	no surcharge		Without Surplus Crops	no surcharge
Retail	147.73	147.73	24,883	3,668,579	3,668,579
FIRE	15.04	15.04	24,883	373,488	373,488
B&P Service	31.62	31.62	24,833	785,220	785,220
Households	54.39	39.54 ^a	24,833	1,350,670	981,897
Government	50.00	50.00	24,833	1,241,650	1,241,650
Total	298.78	283.93	430.28	7,419,604	7,419,604

Retail	148.60	148.60	22,033	3,269,646	3,269,646
FIRE	14.70	14.70	22,033	323,444	323,444
B&P Service	31.32	31.32	22,033	689,134	689,134
Households	64.12	49.27 ^a	22,033	1,410,832	1,084,088
Government	50.00	50.00	22,033	1,100,150	1,100,150
Total	308.74	293.89	449.47	6,793,206	6,466,462

Retail	150.74	150.74	28,996	4,280,413	4,280,413
FIRE	14.31	14.31	28,996	406,347	406,347
B&P Service	33.83	33.83	28,996	960,637	960,637
Households	65.76	45.96 ^a	28,996	1,867,321	1,305,080
Government	50.00	50.00	28,996	1,419,800	1,419,800
Total	314.64	294.84	436.90	8,934,518	8,372,277

Retail	149.12	149.12	75,232	11,218,638	11,218,638
FIRE	14.67	14.67	75,232	1,103,279	1,103,279
B&P Service	32.37	32.37	75,232	2,434,990	2,434,990
Households	61.53	44.81 ^a	75,232	4,628,820	3,371,065
Government	50.00	50.00	75,232	3,761,600	3,761,600
Total	307.68	290.96	438.39	23,147,327	21,889,572

Retail	149.12	149.12	75,232	11,218,638	11,218,638
FIRE	14.67	14.67	75,232	1,103,279	1,103,279
B&P Service	32.37	32.37	75,232	2,434,990	2,434,990
Households	61.53	44.81 ^a	75,232	4,628,820	3,371,065
Government	50.00	50.00	75,232	3,761,600	3,761,600
Total	307.68	290.96	438.39	23,147,327	21,889,572

NEW ROCKFORD AREA					
Retail	148.60	148.60	22,033	3,269,646	3,269,646
FIRE	14.70	14.70	22,033	323,444	323,444
B&P Service	31.32	31.32	22,033	689,134	689,134
Households	64.12	49.27 ^a	22,033	1,410,832	1,084,088
Government	50.00	50.00	22,033	1,100,150	1,100,150
Total	308.74	293.89	449.47	6,793,206	6,466,462

OAKES AREA					
Retail	150.74	150.74	28,996	4,280,413	4,280,413
FIRE	14.31	14.31	28,996	406,347	406,347
B&P Service	33.83	33.83	28,996	960,637	960,637
Households	65.76	45.96 ^a	28,996	1,867,321	1,305,080
Government	50.00	50.00	28,996	1,419,800	1,419,800
Total	314.64	294.84	436.90	8,934,518	8,372,277

PROJECT TOTAL					
Retail	149.12	149.12	75,232	11,218,638	11,218,638
FIRE	14.67	14.67	75,232	1,103,279	1,103,279
B&P Service	32.37	32.37	75,232	2,434,990	2,434,990
Households	61.53	44.81 ^a	75,232	4,628,820	3,371,065
Government	50.00	50.00	75,232	3,761,600	3,761,600
Total	307.68	290.96	438.39	23,147,327	21,889,572

^a Assumes a surcharge of \$55 per planted acre for growing surplus program crops (i.e., wheat and corn grain).

Table F2. Increased Retail Trade, Personal Income, Total Business Activity, and Secondary Employment From Irrigation in the Turtle Lake, New Rockford, and Oakes Areas, North Dakota

Area	Retail Trade	Personal Income	Total Business Activity	Secondary Employment
	\$1,000,000			
<u>Turtle Lake</u>				
With Surplus Crops				
No surcharge	6.3	4.6	16.6	291
Surcharge	6.0	4.0	15.4	279
Without Surplus Crops	9.5	7.1	23.8	403
<u>New Rockford</u>				
With Surplus Crops				
No surcharge	5.7	4.4	15.3	265
Surcharge	5.5	3.9	14.3	253
Without Surplus Crops	8.8	6.9	23.2	369
<u>Oakes</u>				
With Surplus Crops				
No surcharge	7.6	5.8	20.2	351
Surcharge	7.1	4.9	18.5	334
Without Surplus Crops	10.9	8.8	29.2	464