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# ECONOMIC IMPACT OF EXPANDED IRRIGATION DEVELOPMENT IN McKENZIE COUNTY, NORTH DAKOTA

By

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F. Larry Leistritz, and Jay A. Leitch

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## *Highlights*

*Irrigated cropland and dry cropland were compared to estimate the economic impact resulting from irrigation development. A composite acre approach was used to assess the impacts of a switch from dryland to irrigated farming. The composite dryland mix was composed of wheat (38%), summer fallow (35%), alfalfa (17%), oats (5%), and barley (5%) and represents the current mix of crops produced in the county. One composite irrigated mix was corn-grain (23%), wheat (23%), dry beans (21%), alfalfa (12.5%), safflower (12.5%), and sunflowers (8%). A second composit irrigated mix including potatoes was potatoes (41%), alfalfa (23%), corn-grain (18%), and wheat (18%). The irrigated crop mixes represent a reasonable approximation of what producers, in aggregate, might produce. Approximately 155,000 potentially irrigable acres were assumed available in the project area. It was assumed that 31,000 acres (20 percent of the potential 155,000 acres) were developed in the first phase of the project.* ***Charges for water or delivery of water to the farm were not included in this analysis.***

*Returns to unpaid labor, management, and equity were about $8 for a dryland composite acre, $24 for an irrigated composite acre without potatoes, and $165 when irrigated potatoes were included in the crop rotation. Total direct impacts (net change in on-farm returns plus change in input expenditures) per composite acre were $185 (without potatoes) and $636 (with potatoes).*

*Increase in regional economic activity with 155,000 irrigated acres with potatoes was $252 million, which was enough economic activity to support 2,700 secondary jobs. Without potatoes in the crop mix (155,000 acres), regional economic activity was about $69 million with only 140 secondary jobs supported.*

*Another potential economic impact of expanded irrigation was the potential to increase calf-backgrounding activities. Backgrounding additional feeder calves could stimulate local and regional economies through additional expenditures for feed and other inputs and from increased producer returns. Neither calves for backgrounding operations nor feed production appear to be limiting factors. At either level (31,000 or 155,000 acres), feed production would not be a limiting factor to expanded backgrounding.*

*If McKenzie County or the nearby area backgrounded about 10,000 calves from the additional feed generated by expanded irrigation, an estimated $3.0 million to $4.8 million in total economic activity could result.*

*In general, the economic development impact of irrigated crop production would be modest unless accompanied by the production of high-value crops. Potatoes are the irrigated crop with greatest economic potential for expansion. Including potatoes in the crop mix likely would require construction of a potato processing plant or access to a similar market. A model plant would require approximately 53,000 total annual irrigated acres or 21,000 acres of potato production (40 percent rotation schedule). Sufficient irrigated acres would exist in the region to supply a model processing plant. The estimated potato acreage (40 percent crop rotation schedule) includes 26,000 acres from existing irrigated land in northeast Montana; 12,000 acres from first-phase development in McKenzie County; and 2,200 existing irrigated acres from counties surrounding McKenzie and Williams counties. However, these estimates do not account for physical factors or producer decisions which might prevent or reduce potential potato production on existing or proposed irrigated acres.*

# ECONOMIC IMPACT OF EXPANDED IRRIGATION DEVELOPMENT IN McKENZIE COUNTY, NORTH DAKOTA

by
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The purposes of this report are to estimate the economic impact of irrigation development and to provide a preliminary assessment of the potential for value-added processing resulting from expanded irrigation. Approximately 155,000 potentially irrigable acres would be available in the project area (Naze 1994). For analysis, an assumed 31,000 acres or 20 percent would be supplied in first-phase development.

A switch to irrigation from dry cropland production implies changes in production inputs, crop yields, and on-farm net returns. Changes in economic activity at the production level lead to secondary impacts on regional and state economies, such as changes in retail sales, personal income, total business activity, and secondary employment.

This study estimated the changes in production-level impacts, on-farm net returns, state economic activity, and secondary employment given a hypothetical switch from dryland to irrigated farming in McKenzie County, North Dakota (Figure 1). The potential for value-added agriculture from adding 155,000 acres of irrigation development in McKenzie County was also discussed.

## Method

Irrigated cropland and dry cropland were compared to estimate the differences that result from a shift to irrigation. This required estimating irrigated and dryland cropping patterns, crop yields, prices, and production costs. These values were determined using crop statistics, published and unpublished crop budgets, and interviews of North Dakota State University Extension Service staff.

A composite acre approach was used to assess the impacts of a switch from dryland to irrigated farming. This approach has been applied in past studies quantifying potential irrigation impacts (Baltezore et al. 1991, Leitch and Anderson 1978, Leitch and Schaffner 1984, Leitch et al. 1991). A composite acre approach minimizes the number of assumptions compared to a whole-farm approach and allows subsequent changes in development scenarios to be assessed.

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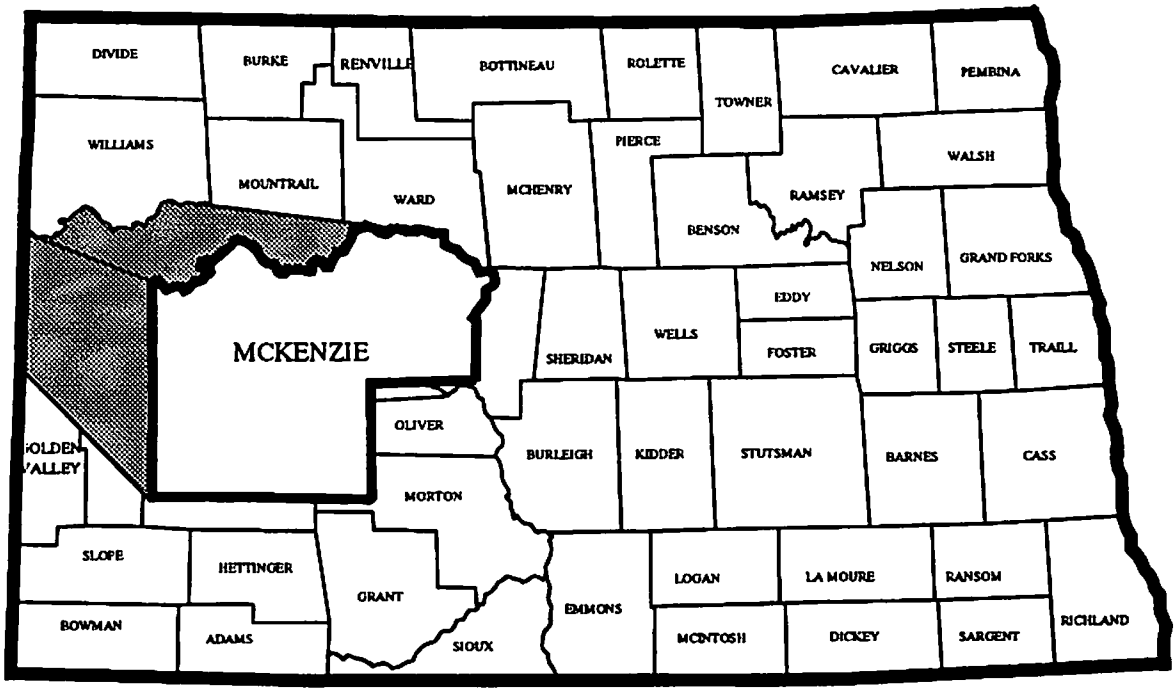


Figure 1. Location Map.

The North Dakota Input-Output Model (Coon et al. 1989) was used to estimate gross business volume and personal income resulting from changes in economic activity. Irrigation development was assumed to be staged, with 20 percent of the irrigable acres supplied the first five years. The remaining irrigable land was assumed to be completed in 20 percent increments.

## Composite Acres

A composite acre represents the mix of crops grown in an area. A composite acre is not necessarily what any one producer raises, but instead represents what producers raise in the aggregate. Three composite acres were developed for McKenzie County: (1) dryland crops, (2) irrigated crops (without potatoes), and (3) irrigated crops (with potatoes). The dryland composite acre was based on an average of actual planted crop acres in McKenzie County from 1990-1992 (North Dakota Agricultural Statistics Service 1991, 1992, 1993). The irrigated composite acres represent the mix of crops farmers likely would plant in this area, one without and one with potatoes (Aakre 1994).

## Crop Budgets

Dryland crop budgets (Table 1) were based on average yields for 1990-1992 (North Dakota Agricultural Statistics Service 1991,

1992, 1993). Market prices were the North Dakota market year averages for 1992 (North Dakota Agricultural Statistics Service 1992). Government program payments and production expenses were taken from Bangsund and Olson (1993). Appendix A contains detailed crop budgets. **NOT INCLUDED IN ON-FARM EXPENSES ARE ANY CHARGES FOR WATER OR DELIVERY OF WATER TO THE FARM.**

TABLE 1. COMPOSITE DRYLAND ACRE BUDGET, McKENZIE COUNTY, NORTH DAKOTA, 1994

| | All Wheat | Summer Fallow | Alfalfa | Oats | Barley | Composite Acre |
|---|---|---|---|---|---|---|
| Crop mix | 38% | 35% | 17% | 5% | 5% | 100% |
| | $[a] | | | | | |
| Total revenue | 110.82 | 0 | 44.64 | 71.04 | 86.16 | 57.52 |
| Variable costs | 28.44 | 7.61 | 19.31 | 33.59 | 35.48 | 20.28 |
| Fixed costs | 37.43 | 21.24 | 19.59 | 38.08 | 37.99 | 28.86 |
| Total expenses | 65.87 | 28.85 | 38.90 | 71.67 | 73.47 | 49.14 |
| Return to unpaid labor, management, and equity | 44.95 | (28.85)[b] | 5.74 | (0.63) | 12.69 | 8.39 |

[a]1992 dollars.
[b]Numbers in parentheses are negative.

Budgets for irrigated acres (Tables 2 and 3), with and without potatoes, were based on historical yields. Potato expenses were taken from several sources (Appendix A). Market prices were the North Dakota market-year averages for 1992 (North Dakota Agricultural Statistics Service 1993). Farm program payments for irrigated crops were not included in irrigated crop budgets. The Food, Agriculture, Conservation, and Trade Act of 1990 states that program payment yields shall not reflect any acres not irrigated before 1990 (Olschlager 1994). Expenses were estimated from several sources and represent 1992 dollars (Appendix A).

Composite acre budgets were estimated by multiplying individual crop budgets (gross income and production expenses) by the percentage of the crop in the composite acre. This procedure condenses individual crop budget information into a composite acre representative of aggregate farm production.

TABLE 2. COMPOSITE IRRIGATED ACRE BUDGET, WITHOUT POTATOES, McKENZIE COUNTY, NORTH DAKOTA, 1994

| | Corn-Grain | Wheat | Dry Beans | Alfalfa | Safflower | Sunflower | Composite Acre |
|---|---|---|---|---|---|---|---|
| Crop mix | 23% | 23% | 21% | 12.5% | 12.5% | 8% | 100% |
| | $[a] | | | | | | |
| Total revenue | 220.00 | 228.24 | 287.79 | 269.36 | 243.75 | 186.00 | 242.32 |
| Variable costs | 161.52 | 101.69 | 116.34 | 119.96 | 88.94 | 107.71 | 119.65 |
| Fixed costs | 104.94 | 94.87 | 98.77 | 105.54 | 90.82 | 96.03 | 98.90 |
| Total expenses | 266.46 | 196.56 | 215.11 | 225.39 | 179.76 | 203.74 | 218.55 |
| Returns to unpaid labor, management, and equity | (46.46) | 31.68 | 72.68 | 43.97 | 63.99 | (17.74) | 23.77 |

[a]1992 dollars.

TABLE 3. COMPOSITE IRRIGATED ACRE BUDGET, WITH POTATOES, McKENZIE COUNTY, NORTH DAKOTA, 1994

| | Potatoes | Alfalfa | Corn-Grain | Wheat | Composite Acre |
|---|---|---|---|---|---|
| Crop mix | 41% | 23% | 18% | 18% | 100% |
| | $[a] | | | | |
| Total revenue | 1,350.00 | 269.36 | 220.00 | 228.24 | 694.03 |
| Variable costs | 719.84 | 119.96 | 161.52 | 101.69 | 369.18 |
| Fixed costs | 243.26 | 105.43 | 104.94 | 94.87 | 159.68 |
| Total expenses | 963.10 | 225.39 | 266.46 | 196.56 | 528.87 |
| Returns to unpaid labor, management, and equity | 386.90 | 43.97 | (46.46) | 31.68 | 165.17 |

[a]1992 dollars.

## Regional Impacts

Conversion from dryland to irrigated crop production leads to changes at both the farm level and at the regional level. Production-level effects were captured by changes in per acre returns to unpaid labor, management, and equity and outlays for

production inputs, while changes in regional activity were estimated using the North Dakota Input-Output Model (Coon et al. 1989). The increase in economic activity that comes with converting dry cropland to irrigated cropland includes increased purchases of inputs and sales of outputs and presents opportunities for local or regional value-added activities. These changes in business activity result in increased returns to the agribusiness sector and to other sectors serving agriculture and lead to an increase in jobs across the regional and statewide economies.

Production-level changes in expenses and returns were aggregated into economic sectors and applied to the North Dakota Input-Output Model. The North Dakota Input-Output Model (Coon et al. 1989) was used to estimate retail sales, personal income, total business activity, and secondary employment resulting from a conversion of dry cropland to irrigated cropland in McKenzie County. Estimates were made for each of three scenarios (dryland, irrigated without potatoes, and irrigated with potatoes) and the results compared.

## Results

Converting dry cropland to irrigated agriculture affects on-farm returns, production inputs and expenses, and regional economic activity. Changes in production-level activities have secondary impacts on off-farm business activity and employment.

### Changes in Production-level Impacts

Returns to unpaid labor, management, and equity are the difference between total revenue and total expenses (subsequently called net return). Net returns were $8.39 for a dryland composite acre, $23.77 for an irrigated composite acre without potatoes, and $165.17 when irrigated potatoes are included in the rotation (Table 4). Total production-level impacts per composite acre are $57.53 for dryland, $242.32 for irrigated without potatoes, and $694.03 for irrigated with potatoes. The per acre net impact from conversion to irrigation is $184.79 without potatoes and $636.50 with potatoes.

### Regional Economic Impacts

At the fully developed level of 155,000 acres, total direct and secondary business activity resulting from irrigation, with potatoes in the crop mix, is over $252 million yearly and supports nearly 2,700 jobs (Table 5). At the 20 percent development level of 31,000 acres with potatoes, total business activity is an estimated $50 million and supports over 500 jobs. Removing potatoes from the crop mix markedly reduces total business activity and job creation. These results do not include

TABLE 4. TOTAL PRODUCTION-LEVEL ECONOMIC ACTIVITY FOR IRRIGATED AND DRYLAND, PER ACRE, McKENZIE COUNTY, NORTH DAKOTA, 1994

| | Dryland Crops | Irrigated Crops | | Net Impact[a] | |
|---|---|---|---|---|---|
| | | Without Potatoes | With Potatoes | Without Potatoes | With Potatoes |
| | $[b] | | | | |
| Variable costs | 20.28 | 119.65 | 369.18 | 99.37 | 348.90 |
| Fixed costs | 28.86 | 98.90 | 159.68 | 70.04 | 130.82 |
| Returns to unpaid labor, management, and equity | 8.39 | 23.77 | 165.17 | 15.38 | 156.78 |
| Direct economic impact[c] | 57.53 | 242.32 | 694.03 | 184.79 | 636.50 |

[a]Net impact figures were estimated by subtracting dryland economic activity from irrigated cropland activity. These dollars represent the net effect of a change from dryland to irrigated crop production.
[b]1992 dollars.
[c]Farmers and producers generate direct economic impacts to the economy through expenditures for production outlays and from returns to unpaid labor, management, and equity. From an economic perspective, direct impacts are those changes in output, employment, or income that result from the initial or direct effects of the activity.

TABLE 5. DIRECT AND SECONDARY IMPACTS OF IRRIGATION, McKENZIE COUNTY, NORTH DAKOTA, 1994

| Economic Sector/ Activity | Acres[a] | Irrigation | | | |
|---|---|---|---|---|---|
| | | Without Potatoes | | With Potatoes | |
| | | Direct | Total | Direct | Total |
| | | 000s $[b] | | | |
| Retail trade | 31,000 | 3,868 | 6,015 | 11,049 | 19,956 |
| | 155,000 | 19,340 | 30,077 | 55,245 | 99,782 |
| Households | 31,000 | 477 | 3,616 | 5,199 | 16,062 |
| | 155,000 | 2,384 | 18,080 | 25,996 | 80,314 |
| Total business activity | 31,000 | 5,728 | 13,875 | 19,731 | 95,659 |
| | 155,000 | 28,643 | 69,383 | 50,516 | 252,597 |
| Secondary employment | 31,000 | --- | 142 | --- | 534 |
| | 155,000 | --- | 729 | --- | 2,691 |

[a]Represents acres converted from dryland to irrigated crop production. The 31,000-acre development is a potential first phase, while 155,000 acres represent all potentially irrigable acres in the study area.
[b]1992 dollars.

any economic activity that would result from the development and operation of a potato processing facility. The increase in direct economic activity results from potato production at the farm level (Appendix B).

## Tax Revenue

Tax collections are another potential measure of the economic impact of an industry or a project on an economy. Tax implications have become an increasingly important measure of local and state-level impacts.

Tax revenue (sales and use, individual income, and corporate income taxes) generated by converting from dryland to irrigated cropland increases by about $11 per composite acre without potatoes and by nearly $40 per composite acre with potatoes. Total tax revenue generated by adding 31,000 irrigated acres was $354,000 without potatoes and nearly $1.3 million with potatoes. If 155,000 acres were irrigated, total tax revenues would be $1.7 million without potatoes and $6.1 million with potatoes (Table 6). Property taxes are a local issue, and irrigation development results in a shift in local property taxes, not a net increase.

TABLE 6. ESTIMATED TAX REVENUES FROM IRRIGATION DEVELOPMENT, McKENZIE COUNTY, NORTH DAKOTA, 1994

| Scenario/Size | Sales and Use | Individual Income | Corporate Income | Total |
|---|---|---|---|---|
| | $[a] | | | |
| Without potatoes | | | | |
| 31,000 acres | 278,000 | 47,000 | 29,000 | 354,000 |
| 155,000 acres | 1,393,000 | 235,000 | 144,000 | 1,772,000 |
| With potatoes | | | | |
| 31,000 acres | 924,000 | 209,000 | 96,000 | 1,229,000 |
| 155,000 acres | 4,620,000 | 1,044,000 | 480,000 | 6,144,000 |

[a] 1992 dollars

## Value-added Agriculture

A likely value-added activity is processing irrigated crops. In general, the economic development impact of irrigated crop production would be modest unless accompanied by value-added processing or a market for crops suited to value-added processing. Similarly, profitable value-added processing is unlikely unless production of the raw material is increased. Thus, any development plan must address this condition. This report assumes that markets for value-added crops and value-added processing exist.

Staging of irrigation is expected, so all potentially irrigable land would not be brought into production in the early years of the project. Construction of processing facilities and growth of markets are likely to be staged over a period of time. Thus, local impact might be expected to follow a moderate rather than a rapid growth path.

## Potential Crops

Discussions with experts (Anderson 1994, Lee 1994, Radke 1994) confirm the potential for increased economic activity through increased high-value crop production. These crops generally produce higher yields and consistent quality and quantity when grown under properly irrigated conditions. Indeed, "substantial areas of the state are generally well-suited for vegetable production, especially if irrigation can be supplied" (Lee et al. 1993, page 9).

North Dakota State University research and extension staff identified potatoes and other vegetable crops in rotation with potatoes as having potential for market expansion in this region. Potatoes must be rotated with other crops. Vegetables such as onions, carrots, and cabbage are good rotation crops and grow well under irrigation (Lee et al. 1993). Processing frozen potatoes and carrots also requires substantial amounts of high quality water, assumed available concurrent with irrigation development.

The market for high-value vegetable crops, such as potatoes, continues to expand (USDA 1993). Much of the increase stems from export demand. The value of both exported and imported vegetables increased in 1993 about 5 percent over 1992 and remained positive for the third consecutive year (USDA 1993).

Production of fresh vegetable crops in North Dakota for North Dakota consumption could be expanded; currently only a small percentage of demand is supplied from crops grown in the state. Developing the fresh market industry could serve as a base or springboard to supplying vegetables for an expansion of the processing industry (Lee et al. 1993). However, these crops are not included in this report because the feasibility and marketing of vegetable table crops requires investigation beyond the scope of this project.

## Potato Processing

Potatoes appear to be the irrigated crop with the greatest economic potential for expansion in this region based on USDA market projections (Tables 2 and 3). To produce potatoes in western North Dakota would require construction of a processing facility or access to an equivalent market.

Wulff and Helgeson (1988) developed a model potato processing plant that captures economies of size and technology needed to be economically feasible. Output was sized to produce 60,000 pounds per hour (25,000 pounds per hour of high solids french fries; 25,000 pounds per hour of medium solids french fries; and 10,000 pounds per hour of formed by-products). Incoming raw product rate was 118,000 pounds per hour. Yearly plant output was 324 million pounds while operating 22.5 hours per day and 240 days per year. Yearly raw product usage would be approximately 318,000 tons of potatoes. Based on crop rotation patterns, approximately 53,000 irrigated acres (21,000 acres of potatoes per year) would be required to supply a model plant.

Given the scenario that 20 percent (31,000 acres) of the McKenzie County irrigation project would be developed initially, approximately 22,000 additional irrigated acres would be needed to support a potato processing plant. Additional irrigated cropland is available from land surrounding McKenzie County.

Northeast Montana, on average, irrigates about 150,475 acres (Montana Agricultural Statistics Service 1993). Removing sugar beet production with a one-in-four rotation schedule provides about 66,000 potential irrigated potato acres in northeast Montana. Similarly, in northwestern North Dakota, excluding Williams and McKenzie counties, 5,600 potential acres are available for potato production (Figure 2). Applying a 40 percent rotation schedule to the existing acres and proposed project development shows an annual potential for 41,000 acres in the region; 21,200 acres are needed for a model processing plant. These calculations do not account for physical factors or producer decisions which might prevent or reduce potential potato production on existing irrigated acres.

## Feeder Cattle Backgrounding

An additional benefit of expanded irrigation includes the ability to produce more and/or different feed stocks. Feeder calf production is a common livestock enterprise on North Dakota farms and ranches (Leistritz and Sell 1993, Bangsund and Olson 1993). Systems Research and Development, Ltd. (1992) estimated that about 669,000 feeder calves were produced in North Dakota in 1991 and that about 50 percent were sold outside the state at weaning. Bangsund and Olson (1993) estimated that about 490,000 calves were sold at weaning annually from 1989 to 1991.

An alternative to marketing at weaning would be to retain calves in a backgrounding operation. Typically, backgrounding involves feeding the calves after weaning to add 150 to 300 pounds per animal before transferring to commercial feedlots. Backgrounding additional calves in the state could stimulate local and regional economies through expenditures for feed, fuel, utilities, and other inputs and through additional income to producers.

**Acres of Potatoes Needed to Support a Processing Plant**

| | |
|---|---|
| 318,000 | tons of potatoes needed yearly to operate a processing plant |
| 300 | potato yield in cwts per acre |
| 21,200 | minimum acres of potatoes needed to support a processing plant |

**Assessment of Potential Irrigated Potato Acreage**

| | |
|---|---|
| 150,475 | average irrigated acres in NE Montana |
| 21,025 | average sugarbeet acreage in NE Montana |
| x 4 | acres needed for sugarbeet rotation |
| 84,100 | irrigated crop acres devoted to sugarbeet production |
| 66,375 | acres of potential irrigated cropland available for potato production |
| x 40% | average potato rotation |
| 26,550 | potential yearly potato acreage available in NE Montana |
| 5,650 | average acres of irrigated cropland in counties surounding Williams and McKenzie Counties |
| 5,650 | acres of potential irrigated cropland available for potato production |
| x 40% | average potato rotation |
| 2,260 | potential yearly potato acreage available in NW North Dakota |
| 31,000 | acres of potentially irrigated cropland in McKenzie County (first phase of development) |
| x 40% | average potato rotation |
| 12,400 | potential yearly potato acreage available in NW North Dakota |

**Comparison of Acres Required and Potentially Available Acres**

| | Processing Plant | Available in NE Montana and NW North Dakota |
|---|---|---|
| Total irrigated acres | 53,000 | 103,000 |
| Actual potato acres | 21,200 | 41,000 |

Figure 2. Acreage Estimation for a Potato Processing Plant.

Several factors must be addressed when determining the potential for additional backgrounding activities in a region. These factors include the availability of competitively priced feeds and the number of animals for backgrounding. In the case of irrigation development in McKenzie County, additional concerns may include whether or not those producing irrigated crops choose to produce feed crops and whether or not those irrigating also produce livestock. In the latter case, the production of feed could be a decision contingent upon producers' needs for additional feed. Availability of feed is represented by the mix of crops produced on the irrigated land.

The potential for irrigation development to support additional backgrounding activity was based on examining the net change in feed production when converting dryland to irrigated crop production. The disposition of current feed (oats, barley, and hay) is unknown. Some is likely used in existing livestock enterprises and some sold as cash crops.

The net change in feed production does not appear to be a limiting factor to expanded backgrounding. With 31,000 irrigated acres and no potato production, about 33.5 million pounds of additional grain and about 13,200 tons of additional alfalfa would be produced (Table 7). With 31,000 irrigated acres and potato production, additional grain and hay production changes to about 25.6 million pounds and 28,000 tons, respectively. Based on the crop mix with potatoes, hay production actually increases over the irrigated crop mix without potatoes. Relatively large amounts of additional feed are produced with 155,000 irrigated acres, regardless of the crop mix.

TABLE 7. ESTIMATED INCREASE IN LIVESTOCK FEED PRODUCTION AND SUPPORT FOR BACKGROUNDING ACTIVITIES WITH EXPANDED IRRIGATION IN McKENZIE COUNTY, NORTH DAKOTA, 1994

| Crop Mix | Expanded Irrigation (acres) 31,000 | 155,000 |
|---|---|---|
| Without potatoes | | |
| Alfalfa (tons) | 13,000 | 66,000 |
| Calves supported[a] | 22,000 | 110,000 |
| Corn-grain (lbs) | 33,500,000 | 167,800,000 |
| Calves supported[a] | 22,300 | 111,800 |
| With potatoes | | |
| Alfalfa (tons) | 28,000 | 140,000 |
| Calves supported | 46,800 | 234,000 |
| Corn-grain (lbs) | 25,600,000 | 128,000,000 |
| Calves supported | 17,000 | 85,000 |

[a]Calves supported based on adding 250 pounds over 150 days on feed. Grain requirements estimated at 10 pounds and roughage at 8 pounds per day (dry matter basis).

Some corn silage likely would be produced, but was not included in the availability of potential feed. Because corn silage is bulky, highly perishable without expensive storage facilities, and expensive to transport, secondary markets for the crop are almost nonexistent. Thus, the production of corn silage generally requires an existing nearby market (i.e., some livestock operation to use the feed). In order to include corn silage in the crop mix, the number of animals and rations fed would need to be known. Corn silage acres could potentially offset the number of acres of corn grain.

Availability of calves for backgrounding operations does not appear to be a limiting factor. About 35,000 calves were sold at weaning yearly from 1989 through 1992 in State Planning Region 1, which is comprised of Divide, Williams, and McKenzie counties (Figure 3; Bangsund and Olson 1993). Surrounding regions also had a considerable number of calves sold at weaning. For example, Region 2 was estimated to sell about 58,000 calves at weaning, Region 7 about 151,000 calves, and Region 8 about 96,000 calves.

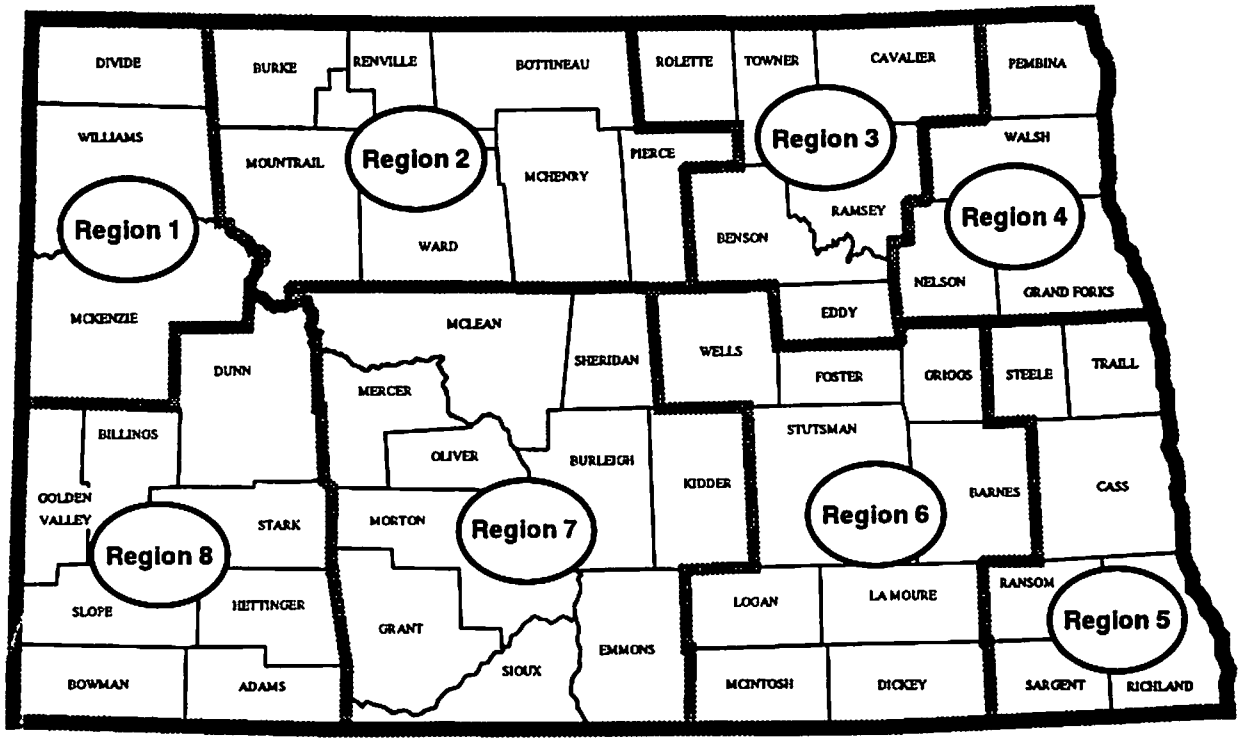


Figure 3. State Planning Regions, North Dakota.

Bangsund and Olson (1993) developed backgrounding rations assuming 250 pounds of gain (starting weight of 500 pounds per calf). Ration requirements included about 10 pounds of grain and about 8 pounds of roughage per day (dry matter basis). The additional grain and hay produced on 155,000 irrigated acres, with a strong emphasis on potatoes, would support 85,000 and 234,000 calves, respectively (Table 7). With the same acreage without potatoes, the additional grain and hay produced would support 111,800 and 110,000 calves, respectively. Grain does not appear to be a limiting factor in supporting additional backgrounding activities with only 31,000 irrigated acres (Table 7). For example, with only 31,000 irrigated acres including potato production, additional grain and hay production would support about 17,000 and 46,800 calves, respectively. Thus, initial estimates suggest enough additional feed stocks could be produced with only 31,000 irrigated acres.

Leistritz and Sell (1993) estimated the economic contribution of backgrounding about 161,000 calves statewide. Calves were assumed to be on feed for 150 days and to gain 250 pounds. Direct and secondary economic impacts were estimated at about $154 and $318 per calf, respectively. Total economic impacts were estimated to be about $482 per calf.

Bangsund and Leistritz (1993) estimated the potential of backgrounding about 95,000 calves in Region 7 of the state. Economic impacts were estimated using the North Dakota Impact Assessment Model (IAM; Bangsund and Leistritz 1993). The IAM was used with information compiled by Bangsund and Olson (1993). Calves were assumed to be on feed about 150 days and gain about 250 pounds. Direct and secondary economic impacts were estimated at about $100 and $217 per calf, respectively. Total economic impacts were estimated to be about $317 per calf.

The northwest corner of North Dakota could expect from $300 to $480 of economic activity per backgrounded calf, depending upon production costs, feed costs, and producer returns. If McKenzie County or the nearby area backgrounded about 10,000 calves from the additional feed generated by expanded irrigation, an estimated $3.0 million to $4.8 million in total economic activity could result.

## Livestock and Poultry Processing Facilities

Other possible ways to stimulate economic development are more problematic. Livestock slaughter plants use large amounts of water and would tend to employ more workers than frozen potato or vegetable processing plants. However, livestock numbers in North Dakota are not sufficient to support large-scale livestock slaughter plants (Petry 1994). On the positive side, livestock numbers in North Dakota may increase as farmers look for ways to obtain more value from their production and to diversify farm income as USDA commodity support programs are reduced. Furthermore, irrigated feed production could encourage more livestock production, but the profitability of irrigated feed production is less than for irrigated potatoes (Radke 1994).

The potential annual domestic broiler market available to North Dakota is an estimated 935 million pounds (Golz et al. 1990). The industry standard for a new facility is considered to be over 155 million pounds annually (about 48 million birds or broilers) of ready-to-cook broiler meat. An operation of that size would require a plant investment of about $83 million.

Poultry processing facilities, like livestock slaughter plants, require large amounts of water and tend to provide more employment per dollar of output than frozen potato or vegetable processing plants. However, poultry production was not considered in the economic analysis of this report. The scale of the plant relative to current bird production in North Dakota

differs by several orders of magnitude. The model plant requires approximately one million birds per week (Golz et al. 1990) while North Dakota produces about 45,000 birds per year (North Dakota Agricultural Statistics Service 1993). Development at this scale is clearly beyond the scope of any project based solely in McKenzie County. Additional feed represented by increased irrigation is not a sufficient condition to warrant construction of a major poultry industry.

## Summary

Four major scenarios were examined for expanded irrigation in McKenzie County: 31,000 and 155,000 acres with and without potato production. As acreage increases and potatoes are added, total direct impacts, total economic impacts, tax revenues, and secondary employment increase (Table 8). The production-level net economic impact of converting dryland to irrigated cropland would be from about $185 per irrigated composite acre without potatoes to $636 per irrigated composite acre with potatoes (Table 4). At the fully developed level of 155,000 acres, additional regional business activity with potato production would be about $252 million, which is enough economic activity to support 2,700 secondary jobs. Potatoes are the irrigated crop

TABLE 8. SUMMARY OF ECONOMIC IMPACTS FROM EXPANDED IRRIGATION, McKENZIE COUNTY, NORTH DAKOTA, 1994

| Crop Mix/Impact Category | Expanded Irrigation (acres) 31,000 | 155,000 |
|---|---|---|
| Without potatoes | | |
| Net returns ($/acre)[a] | 24 | 24 |
| Gross receipts ($/acre) | 242 | 242 |
| Total direct impacts (000s $) | 5,728 | 28,643 |
| Total economic impacts (000 $) | 13,875 | 69,383 |
| Tax revenue (000s $)[b] | 354 | 1,772 |
| Secondary employment | 142 | 729 |
| Additional backgrounding (hd)[c] | 23,300 | 111,800 |
| With potatoes | | |
| Net returns ($/acre)[a] | 165 | 165 |
| Gross receipts ($/acre) | 694 | 694 |
| Total direct impacts (000s $) | 19,731 | 98,659 |
| Total economic impacts (000 $) | 50,516 | 252,597 |
| Tax revenue (000s $)[b] | 1,229 | 6,144 |
| Secondary employment | 534 | 2,691 |
| Additional backgrounding (hd)[c] | 17,000 | 85,000 |

[a]Returns to unpaid labor, management, and equity.
[b]Only includes sales and use, corporate income, and personal income taxes.
[c]Calves supported based on adding 250 pounds over 150 days on feed. Grain requirements estimated at 10 pounds and roughage at 8 pounds per day (dry matter basis).

with the most economic potential for expansion. Eliminating potato production (155,000 acre scenario) reduces regional economic activity to about $69 million with 140 secondary jobs supported.

Backgrounding additional feeder calves could stimulate local and regional economies. Availability of calves for backgrounding operations does not appear to be a limiting factor. The net change in feed production does not appear to be a limiting factor in increased backgrounding activities. For example, 31,000 irrigated acres with potatoes could support at least 17,000 calves from the additional grain included in the crop mix (Table 8).

If McKenzie County or the nearby area backgrounded about 10,000 calves from the additional feed generated by expanded irrigation, an estimated $3.0 million to $4.8 million in total economic activity could result.

Farmers would require contracts before making the necessary commitments to potato production. Therefore, including potatoes in the crop mix would require construction of a potato processing plant or access to a similar market. A model plant would require approximately 53,000 irrigated acres with 21,200 acres of potatoes in rotation. Sufficient irrigated acres would exist in the region to supply a model processing plant. The estimated potato acreage (40 percent crop rotation schedule) includes 26,000 acres from existing irrigated land in northeast Montana; 12,000 acres from first-phase development in McKenzie County; and 2,200 existing irrigated acres from counties surrounding McKenzie and Williams counties. However, these estimates do not account for physical factors or producer decisions which might prevent or reduce potential potato production on existing or proposed irrigated acres.

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# APPENDIX A

## Crop Production Budgets

APPENDIX TABLE A1. DRYLAND CROP BUDGETS, McKENZIE COUNTY, NORTH DAKOTA, 1994

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| McKenzie County Dryland Crop Mix[a] | 37.59% | 35.04% | 16.62% | 5.40% | 5.36% | | |
| | All Wheat | Summer-fallow | All Hay | Oats | Barley | Composite Acre | |
| REVENUE | | | | | | | |
| Yield | 31.44 | 0.0 | 1.05 | 54.22 | 41.62 | | |
| Price[b] | $3.11 | $0.0 | $42.32 | $1.18 | $1.69 | | |
| Farm Program Payments[c] | $12.99 | $0.0 | $0.00 | $7.06 | $15.82 | | |
| Total Revenue | $110.82 | $0.0 | $44.64 | $71.04 | $86.16 | $57.52 | |
| VARIABLE COSTS[d] | $ | | | | | | Economic Sector |
| Seed | 4.74 | 0.00 | 1.90 | 5.50 | 4.38 | 2.63 | Retail Trade |
| Herbicides | 1.22 | 0.00 | 0.81 | 1.67 | 4.62 | 0.93 | Retail Trade |
| Fungicides | 0.96 | 0.00 | 0.00 | 0.95 | 0.95 | 0.46 | Retail Trade |
| Insecticides | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Retail Trade |
| Fertilizer | 3.53 | 0.00 | 0.85 | 2.45 | 4.45 | 1.84 | Retail Trade |
| Crop Insurance | 2.00 | 0.00 | 0.00 | 4.00 | 3.00 | 1.13 | FIRE |
| Fuel & Lubrication | 4.85 | 4.73 | 4.68 | 5.63 | 5.63 | 4.86 | Retail Trade |
| Repairs | 7.34 | 2.69 | 6.40 | 7.81 | 7.81 | 5.61 | Retail Trade |
| Hauling | 2.12 | 0.00 | 0.00 | 3.71 | 2.73 | 1.14 | Retail Trade |
| Other costs (custom hire, etc.) | 1.05 | 0.00 | 4.20 | 1.05 | 1.05 | 1.21 | Bus & Pers Service |
| Interest | 0.63 | 0.19 | 0.47 | 0.82 | 0.87 | 0.47 | FIRE |
| Total Variable Costs | 28.44 | 7.61 | 19.31 | 33.59 | 35.48 | 20.28 | |
| FIXED COSTS | | | | | | | |
| Land Taxes | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | Government |
| Machinery Depreciation | 17.60 | 6.20 | 5.79 | 17.60 | 17.60 | 11.64 | Retail Trade |
| Machinery Interest Payment | 5.39 | 1.90 | 1.33 | 5.39 | 5.39 | 3.49 | FIRE |
| Misc Overhead | 3.36 | 2.06 | 3.19 | 4.01 | 3.92 | 2.94 | FIRE/Comm & Pub Util |
| Land Interest Payment | 9.06 | 9.06 | 7.27 | 9.06 | 9.06 | 8.76 | FIRE |
| Total Fixed Costs | 37.43 | 21.24 | 19.59 | 38.08 | 37.99 | 28.86 | |
| Total Variable and Fixed Costs | 65.87 | 28.85 | 38.90 | 71.67 | 73.47 | 49.14 | |
| Return to Unpaid Labor, Management, and Equity | 44.95 | (28.85) | 5.74 | (0.63) | 12.69 | 8.39 | Households |

[a] Crop mixes and yields were based on a three year average (1990 through 1992) of crop production statistics for McKenzie County, North Dakota (North Dakota Agricultural Statistics Service 1991, 1992, 1993).
[b] Market year average price obtained from North Dakota Agricultural Statistics Service (1993).
[c] Represents an average farm program payment per acre for the county (Bangsund and Olson 1993).
[d] Variable and fixed costs were obtained from Bangsund and Olson (1993). All wheat expenses represent a weighted average of spring wheat--fallow and continuous, durum wheat--fallow and continuous, and winter wheat. Alfalfa was assumed to be raised for five years--one establishment year and four established years. Barley expenses represent a weighted average of fallow and continuous crops.

APPENDIX TABLE A2. IRRIGATED CROP BUDGETS, McKENZIE COUNTY, NORTH DAKOTA, 1994[a]

| | Corn-grain | Corn-silage | Potatoes | Dry Beans | Alfalfa | Wheat | Sun-flower | Saf-flower |
|---|---|---|---|---|---|---|---|---|
| REVENUE | | | | | | | | |
| Yield[b] | 100 | 16.5 | 300 | 1590 | 4.8 | 72 | 2000 | 1950 |
| Market Price[c] | $2.20 | $18.67 | $4.50 | $18.10 | $56.00 | $3.17 | $9.30 | $12.50 |
| Total Revenue | $220.00 | $308.00 | $1350.00 | $287.79 | $269.36 | $228.24 | $186.00 | $243.75 |
| VARIABLE COSTS | $ | | | | | | | |
| Seed | 25.21 | 26.13 | 111.60 | 22.96 | 9.90 | 8.75 | 13.58 | 13.13 |
| Herbicides | 19.18 | 19.87 | 67.00 | 16.52 | 2.25 | 5.41 | 14.12 | 10.92 |
| Fungicides | 0.00 | 0.00 | 35.00 | 0.00 | 0.00 | 1.25 | 0.00 | 0.13 |
| Insecticides | 13.62 | 14.12 | 15.00 | 0.00 | 0.00 | 0.00 | 10.29 | 0.00 |
| Fertilizer | 26.48 | 27.44 | 97.75 | 14.34 | 22.90 | 26.25 | 8.13 | 11.93 |
| Crop Insurance | 9.00 | 9.00 | 96.88 | 14.00 | 0.00 | 3.00 | 5.00 | 2.00 |
| Fuel and Lubrication | 7.98 | 8.27 | 23.77 | 6.03 | 14.88 | 8.23 | 6.83 | 6.72 |
| Repairs | 9.55 | 9.90 | 41.22 | 8.21 | 23.07 | 10.82 | 12.02 | 9.71 |
| Drying | 8.40 | 0.00 | 0.00 | 0.00 | 8.57 | 0.00 | 2.84 | 0.00 |
| Chopping and Hauling (silage) | 0.00 | 27.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hauling (grain) | 10.00 | 0.00 | 81.25 | 3.18 | 7.22 | 7.20 | 4.00 | 3.90 |
| Other Costs (custom hire, etc.) | 1.05 | 1.05 | 50.00 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| Misc Costs | 0.00 | 0.00 | 30.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hired Labor | 0.00 | 0.00 | 26.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Irrigation Electricity | 19.45 | 19.45 | 19.45 | 19.45 | 19.45 | 19.45 | 19.45 | 19.45 |
| Irrigation Repairs | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 |
| Interest[d] | 3.55 | 3.84 | 15.84 | 2.56 | 2.64 | 2.24 | 2.37 | 1.96 |
| Total Variable Costs | 161.52 | 174.60 | 719.84 | 116.34 | 119.96 | 101.69 | 107.71 | 88.94 |
| FIXED COSTS | | | | | | | | |
| Land Taxes[e] | 3.03 | 3.03 | 3.03 | 3.03 | 3.03 | 3.03 | 3.03 | 3.03 |
| Machinery Depreciation | 23.31 | 12.28 | 148.54 | 18.95 | 23.39 | 16.27 | 16.85 | 13.10 |
| Machinery Interest Payment | 7.80 | 4.05 | 20.89 | 5.99 | 8.21 | 4.77 | 5.35 | 3.89 |
| Irrigation Depreciation[f] | 47.96 | 47.96 | 47.96 | 47.96 | 47.96 | 47.96 | 47.96 | 47.96 |
| Irrigation Interest[g] | 7.93 | 7.93 | 7.93 | 7.93 | 7.93 | 7.93 | 7.93 | 7.93 |
| Land Interest Payment[h] | 9.06 | 9.06 | 9.06 | 9.06 | 9.06 | 9.06 | 9.06 | 9.06 |
| Misc Overhead | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 |
| Total Fixed Costs | 104.94 | 90.16 | 243.26 | 98.77 | 105.43 | 94.87 | 96.03 | 90.82 |
| Total Variable and Fixed Costs | 266.46 | 264.76 | 963.10 | 215.11 | 225.39 | 196.56 | 203.74 | 179.76 |
| Returns to Unpaid Labor, Management, and Equity | -46.46 | 43.24 | 386.90 | 72.68 | 43.97 | 31.68 | -17.74 | 63.99 |

- continued -

APPENDIX TABLE A2. (continued)

| | Corn-grain | Corn-silage | Potatoes | Dry Beans | Alfalfa | Wheat | Sun-flower | Saf-flower |
|---|---|---|---|---|---|---|---|---|
| Irrigated Crop Mix 1[1] | 18.3% | 0.0% | 40.8% | 0.0% | 22.5% | 18.3% | 0.0% | 0.0% |
| Irrigated Crop Mix 2[1] | 22.9% | 0.0% | 0.0% | 20.8% | 12.5% | 22.9% | 8.3% | 12.5% |

| Composite Acre | Crop Mix 1 | 2 | Economic Sector |
|---|---|---|---|
| | -------- $ | -------- | |
| TOTAL REVENUE | 694.03 | 242.32 | |
| VARIABLE COSTS | | | |
| Seed | 54.02 | 16.58 | Retail Trade |
| Herbicides | 32.37 | 11.90 | Retail Trade |
| Fungicides | 14.52 | 0.30 | Retail Trade |
| Insecticides | 8.62 | 3.98 | Retail Trade |
| Fertilizer | 54.73 | 20.10 | Retail Trade |
| Crop Insurance | 41.76 | 6.33 | FIRE |
| Fuel and Lubrication | 16.03 | 8.24 | Retail Trade |
| Repairs | 25.76 | 11.48 | Retail Trade |
| Drying | 3.47 | 3.23 | Bus & Pers Serv |
| Chopping and Hauling (silage) | 0.00 | 0.00 | Retail Trade/Bus & Pers Serv |
| Hauling (grain) | 37.95 | 6.33 | Retail Trade |
| Other Costs (custom hire, etc.) | 21.04 | 1.05 | Bus & Pers Serv |
| Misc Costs | 12.35 | 0.00 | Retail Trade |
| Hired Labor | 10.94 | 0.00 | Households |
| Irrigation Electricity | 19.45 | 19.45 | Comm & Pub Util |
| Irrigation Repairs | 8.04 | 8.04 | Retail Trade |
| Interest | 8.12 | 1.96 | FIRE |
| Total Variable Costs | 369.18 | 119.65 | |
| FIXED COSTS | | | |
| Land Taxes | 3.03 | 3.03 | Government |
| Machinery Depreciation | 73.17 | 18.98 | Retail Trade |
| Machinery Interest Payment | 12.68 | 6.09 | FIRE |
| Irrigation Depreciation | 47.96 | 47.96 | Retail Trade |
| Irrigation Interest | 7.93 | 7.93 | FIRE |
| Land Interest Payment | 9.06 | 9.06 | FIRE |
| Misc Overhead | 5.85 | 5.85 | FIRE/Comm & Pub Util |
| Total Fixed Costs | 159.68 | 98.90 | |
| Total Variable and Fixed Costs | 528.87 | 218.55 | |
| Returns to Unpaid Labor, Management, and Equity | 165.17 | 23.77 | Households |

[a] All expenses for corn-grain, corn-silage, dry beans, alfalfa, and wheat production were obtained from Aakre (1994), unless otherwise cited. Potato budget was from NDSU extension service (1994). Sunflower and safflower budgets were adopted from NDSU extension budgets (Swenson and Aakre 1992).

[b] Yields were an average of crop production years 1990 through 1992 (North Dakota Agricultural Statistics Service 1991, 1992, 1993). Yield for potatoes was estimated from NDSU extension service (1994). Alfalfa yield was based on a mix of 3-year and 4-year established stands (Aakre 1994). Sunflower yields were obtained from the North Central Experiment Station and represent an average irrigated yield from 1979 to 1986 (Weigel 1994). Safflower yields were provided by Naze (1994).

[c] Prices were obtained from North Dakota Agricultural Statistics Service (1993). Corn silage was valued at a third of the price of alfalfa hay. Safflower price was obtained from Swenson and Aakre (1993).

[d] Interest was based on borrowing half of the variable expenses for 6 months at 9.0 percent interest.

[e] Land taxes were based on 150 percent of dryland.

[f] Irrigation expenses were obtained from Selley and Bockstadter (1993). Costs were based on a 1,290 ft center pivot, pumping 850 gpm with electric power, and covering 130 acre plots.

[g] Irrigation interest payments were based on an average annual irrigation investment of $417.76 per acre, assuming 34 percent debt finance for 7 years at 9.0 percent interest.

[h] Land interest payments were obtained from Bangsund and Olson (1993), and based on average long-term debt in the region, average land prices, and typical loan terms.

[i] The overall crop mix represents a blending of several possible crop mixes. The overall crop mix reflects, in aggregate, what all producers raise, rather than what individual farmers may raise.

# APPENDIX B

## Direct and Secondary Economic Impacts of Expanded Irrigation, McKenzie County, North Dakota

APPENDIX TABLE B1. ECONOMIC IMPACT, BY ECONOMIC SECTOR, OF EXPANDED IRRIGATION, MCKENZIE COUNTY, NORTH DAKOTA, 1994

| Economic Sector | Economic Activity (irrigation without potatoes) | | | | | |
|---|---|---|---|---|---|---|
| | 31,000 Acres | | | 155,000 Acres | | |
| | Direct | Secondary | Total | Direct | Secondary | Total |
| | 000s $ | | | | | |
| Ag-livestock | | 442 | 442 | | 2,209 | 2,209 |
| Ag-crops | | 169 | 169 | | 845 | 845 |
| Nonmetal Mining | | 18 | 18 | | 91 | 91 |
| Construction | | 270 | 270 | | 1,349 | 1,349 |
| Transportation | | 62 | 62 | | 309 | 309 |
| Communications and Public Utilities | 648 | 411 | 1,059 | 3,240 | 2,055 | 5,295 |
| Ag Processing and Misc Manufacturing | | 255 | 255 | | 1,277 | 1,277 |
| Retail Trade | 3,868 | 2,147 | 6,015 | 19,340 | 10,737 | 30,077 |
| Finance, Insurance, and Real Estate | 609 | 473 | 1,082 | 3,045 | 2,367 | 5,412 |
| Business and Personal Services | 95 | 178 | 273 | 477 | 889 | 1,366 |
| Professional and Social Services | | 242 | 242 | | 1,210 | 1,210 |
| Households | 477 | 3,139 | 3,616 | 2,384 | 15,696 | 18,080 |
| Government | 31 | 341 | 372 | 157 | 1,706 | 1,863 |
| Totals | 5,728 | 8,147 | 13,875 | 28,643 | 40,740 | 69,383 |
| Secondary Jobs | | | 142 | | | 729 |
| Secondary impacts per $1 of direct impacts | | $1.42 | | | $1.42 | |

| | Economic Impacts (irrigation with potatoes) | | | | | |
|---|---|---|---|---|---|---|
| | Direct | Secondary | Total | Direct | Secondary | Total |
| | 000s $ | | | | | |
| Ag-livestock | | 1,513 | 1,513 | | 7,567 | 7,567 |
| Ag-crops | | 586 | 586 | | 2,930 | 2,930 |
| Nonmetal Mining | | 72 | 72 | | 361 | 361 |
| Construction | | 1,088 | 1,088 | | 5,441 | 5,441 |
| Transportation | | 206 | 206 | | 1,028 | 1,028 |
| Communications and Public Utilities | 648 | 1,553 | 2,201 | 3,240 | 7,765 | 11,005 |
| Ag Processing and Misc Manufacturing | | 895 | 895 | | 4,477 | 4,477 |
| Retail Trade | 11,049 | 8,907 | 19,956 | 55,245 | 44,537 | 99,782 |
| Finance, Insurance, and Real Estate | 2,082 | 1,959 | 4,041 | 10,409 | 9,797 | 20,206 |
| Business and Personal Services | 722 | 748 | 1,470 | 3,612 | 3,738 | 7,350 |
| Professional and Social Services | | 1,055 | 1,055 | | 5,277 | 5,277 |
| Households | 5,199 | 10,863 | 16,062 | 25,996 | 54,318 | 80,314 |
| Government | 31 | 1,340 | 1,371 | 157 | 6,702 | 6,859 |
| Totals | 19,731 | 30,785 | 50,516 | 98,659 | 153,938 | 252,597 |
| Secondary Jobs | | | 534 | | | 2,691 |
| Secondary impacts per $1 of direct impacts | | $1.56 | | | $1.56 | |