Economic Impact of Reducing Hail and Enhancing Rainfall in North Dakota

An economic evaluation of the benefits and potential benefits of hail suppression and rain enhancement efforts through cloud seeding in North Dakota. The study projects impacts on eight common crops and actual cropping practices for the period 1988 - 1997.

by

Randall S. Sell

and

F. Larry Leistritz

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HIGHLIGHTS

North Dakota producers experience substantial losses to farm output and fixed assets because of hail. The North Dakota Cloud Modification Project (NDCMP) has actively practiced cloud modification in five or six counties in western North Dakota during the past 10 years. A recent study concluded that crop-hail damage in the cloud modification counties was reduced by 45 percent for the wheat, barley, oats, corn, sunflower, and flax. Another impact of the cloud modification project is enhanced rainfall. Enhanced rainfall does not always benefit all producers, depending on the subsequent impacts on yield, quality, and price. The economic impact to the state of enhanced rainfall is also estimated. The crops used in estimating the combined impacts of hail reduction and rainfall enhancement were wheat, barley, oats, sunflower, corn, flax, soybeans, and dry edible beans.

Estimates of crop-hail losses and crop losses prevented with cloud modification for all counties were based upon crop production and hail data from 1988 to 1997. These estimates required multiplying the county level gross values of production by its annual loss-cost ratio to get the expected hail loss and then multiplying the expected loss by the 45 percent reduction factor to estimate the crop output savable with cloud modification. Slightly different equations were necessary depending on whether the county had an on-going cloud modification project in place.

Changes in crop production due to increased rainfall were determined. The effects of increased wheat production on price received were considered. A change in crop production was estimated by changing yields per acre, not acres of crop harvested.

The direct impact of hail reduction was $34 million and the direct impact of rainfall enhancement was $52 million statewide, which resulted in a total direct impact of nearly $87 million annually. This direct impact results in an increase in total business activity of $267 million or an average $14.52 per planted acre. Seventy-five percent of the total economic impact occurred in two sectors of the economy, 'households' and 'retail trade.' Pembina County is projected to experience a slight negative impact from the additional rainfall (-$0.28 per planted acre), but this is more than offset by the projected benefits from hail suppression activities (+$3.05 per planted acre). All other counties are expected to be positive in both categories. Total impacts were generally greater in the eastern one-half of North Dakota while the impacts as a percentage of gross receipts were greater in western North Dakota.

The estimated annual cost of operating the NDCMP statewide was $3.2 million. Increased state tax revenue from sales and use tax, personal income tax, and corporate income tax as a result of the program was $5.1 million annually. Thus, the increased state tax revenue would substantially exceed the cost of the program.

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Economic Impact of Reducing Hail and Enhancing Rainfall in North Dakota

Randall S. Sell and F. Larry Leistritz

INTRODUCTION

The North Dakota Atmospheric Resource Board (NDARB) is concerned about agricultural and nonagricultural losses due to hail. The NDARB (formerly known as the North Dakota Weather Modification Board) has been responsible for administrative oversight and conduct of the North Dakota Cloud Modification Project (NDCMP) since 1976, in cooperation with the participating counties. Cloud seeding efforts have been conducted in the state in a less-structured form since 1961. North Dakota typically experiences some of the highest insurance dollar losses to crops among all states in the United States (Changnon 1977, 1984). Furthermore, an area in southwestern North Dakota has the highest ratio of damage claims paid to insured crop liability (Miller and Fuhs 1987).

The objective of this study was to determine the economic impact of cloud seeding effects for the state of North Dakota. This study represents an attempt to quantify the benefits of hail suppression and rain enhancement for eight grain crops produced in North Dakota. The economic impact of hail reduction for the state was last estimated at $97.8 million annually using the crop production and hail loss ratios from 1976 to 1985 (Johnson et al. 1989). The economic impact of enhanced rainfall and changing the crop/livestock mix within the state was estimated at $676.9 million using crop and livestock prices and production averages from 1977 to 1981 (Schaffner et al. 1983).

METHODS

Determining the economic impact of cloud seeding efforts in North Dakota was accomplished in two parts 1) the economic impact of crop-hail reduction and 2) the economic impact of enhanced rainfall. The economic impact of crop-hail reduction predominantly followed the methodology established previously by Johnson et al. (1989) as follows: 1) calculate crop-hail loss-cost ratios by counties for 10 years, 2) compute gross values of production for each of the six crops used in the Smith et al. (1997) study for the years 1988-1997 using the North Dakota Tax Assessment Model data set (Vruegdenhil 1998), 3) multiply county loss-cost ratios times county values of crop production to measure county value of crop production (crop sales) lost each year due to hail, 4) multiply the county value of production lost by the Smith et al. (1997) reduction factor (0.45) to determine the crop output potentially savable through cloud seeding for hail suppression, 5) apply multipliers to measure what the value of crop output savable would mean to community and state economies, and 6) divide findings by total acres of the crops in each county to provide a common per-acre base for the analysis.

Some changes were made to the Johnson et al. (1989) methodology. Two additional crops were included (soybeans and dry edible beans). These crops were included because the cropping patterns have changed and soybeans and dry edible beans have surpassed several of the original crops included in the previous studies (Table 1). Although not included, canola has recently become an important crop to North Dakota; it displaced oats and flax in amount of harvested acres in 1997. The other change was a slight modification of the Smith et al. (1997)

reduction factor as applied to soybeans and dry edible beans, as these crops were not included among the crops used in arriving at the 0.45 damage reduction factor. The economic impact was only estimated for the eight crops included in the study (i.e., no other cash crops or forage crops were included in the estimate). Also, the impact of decreased property hail-loss was not included.

Table 1. Harvested Acres of Top Eleven Crops in North Dakota in 1988 and 1997

Crop	1988	Rank	1997	Rank
	- 000 -		- 000 -	
Wheat	7,230	1	11,025	1
Barley	2,150	2	2,250	2
Sunflower	1,410	3	1,410	3
Soybeans	690	4	1,190	4
Oats	400	5	400	8
Corn grain	380	6	605	5
Dry edible beans	370	7	530	6
Flax	185	8	110	10
Sugar beets	176	9	228	9
Potatoes	135	10	105	11
Canola	na	-	480	7

Source: North Dakota Agricultural Statistics Service (1989, 1998)

The steps used to calculate the economic impact of enhanced rainfall were as follows: 1) compute the gross value of production for all crops included in the study for 1988 to 1997, 2) increase the yields for each of the crops included in the study according to Schaffner et al. (1983), 3) calculate the increased supply for all wheat for the state of North Dakota, 4) calculate a 'new' average price for all wheat using the estimated 'flexibility' coefficient from Johnson et al. (1998), 4) compute the gross value of production for all crops using the increased crop yields and decreased all wheat price (other crop prices were not changed), 5) subtract the base value for

each county from the gross value of production with increased crop yields to determine the impact of enhanced rainfall, 6) apply multipliers to measure what the value of enhanced crop output would mean to community and state economies, 7) divide findings by total planted acres of the crops in each county to provide a common per-acre base for the analysis, and 8) calculation of additional potential revenue to the state general fund.

The six crops used in previous analysis (Johnson et al. 1989) and the crops used to determine the Smith et al. (1997) reduction factor were all wheat, all barley, oats, all sunflower, corn grain, and flax. To more accurately reflect the current cropping practices in North Dakota, soybeans and dry edible beans were included to estimate the impact of NDCMP. To be conservative it was assumed that the crop-hail reduction factor for soybeans and dry edible beans would be less than the Smith et al. (1997) reduction factor. The reduction factor for soybeans and dry edible beans was assumed to be 0.30 as opposed to the 0.45 calculated for the original six crops. The Smith et al. (1997) reduction factor was modified based upon the 10-year average proportion of soybeans and dry edible beans to the total planted acres of the original six crops. The state average adjusted reduction factor was 0.43. This adjusted reduction factor ranged from a high of 0.45 for six counties which had an average total of soybeans and dry edible beans of less than 100 acres to a low of 0.40 for Richland County. Richland County had an average of 34 percent of its planted acres in soybeans and dry edible beans.

Not all counties which had participated in the NDCMP from 1988 to 1997 did so on a continual basis (Table 2). McKenzie, Mountrail, and Ward Counties did participate every year.

Bowman and Slope Counties participated every year except 1990. Therefore 1990 average hail loss-cost data for Bowman and Slope Counties was not used. Hettinger and Williams Counties each participated one year; therefore, these counties were not included as treated counties and the average hail loss-cost data was not included for the year that each county did participate in the program. Those counties which were included in the analysis as treated counties are shown in Figure 1.

Table 2. North Dakota Cloud Modification Project Treated Counties from 1988 through 1997

Counties	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Bowman	X	X	O	X	X	X	X	X	X	X
Hettinger	X	O	O	O	O	O	O	O	O	O
McKenzie	X	X	X	X	X	X	X	X	X	X
Mountrail	X	X	X	X	X	X	X	X	X	X
Slope	X	X	O	X	X	X	X	X	X	X
Ward	X	X	X	X	X	X	X	X	X	X
Williams	O	O	O	O	O	O	O	O	O	X

Note: X means cloud seeding practiced, O means no cloud seeding practiced

The NDARB estimated the total cost of operating the NDCMP was $0.08 per acre for the total targeted land area in 1998 (Boe 1998). Assuming some economies of scale, the cost to operate the NDCMP statewide would be about $0.07 per acre. North Dakota's total land area is 45.249 million acres, which means the cost of operating the program statewide would be approximately $3.2 million.

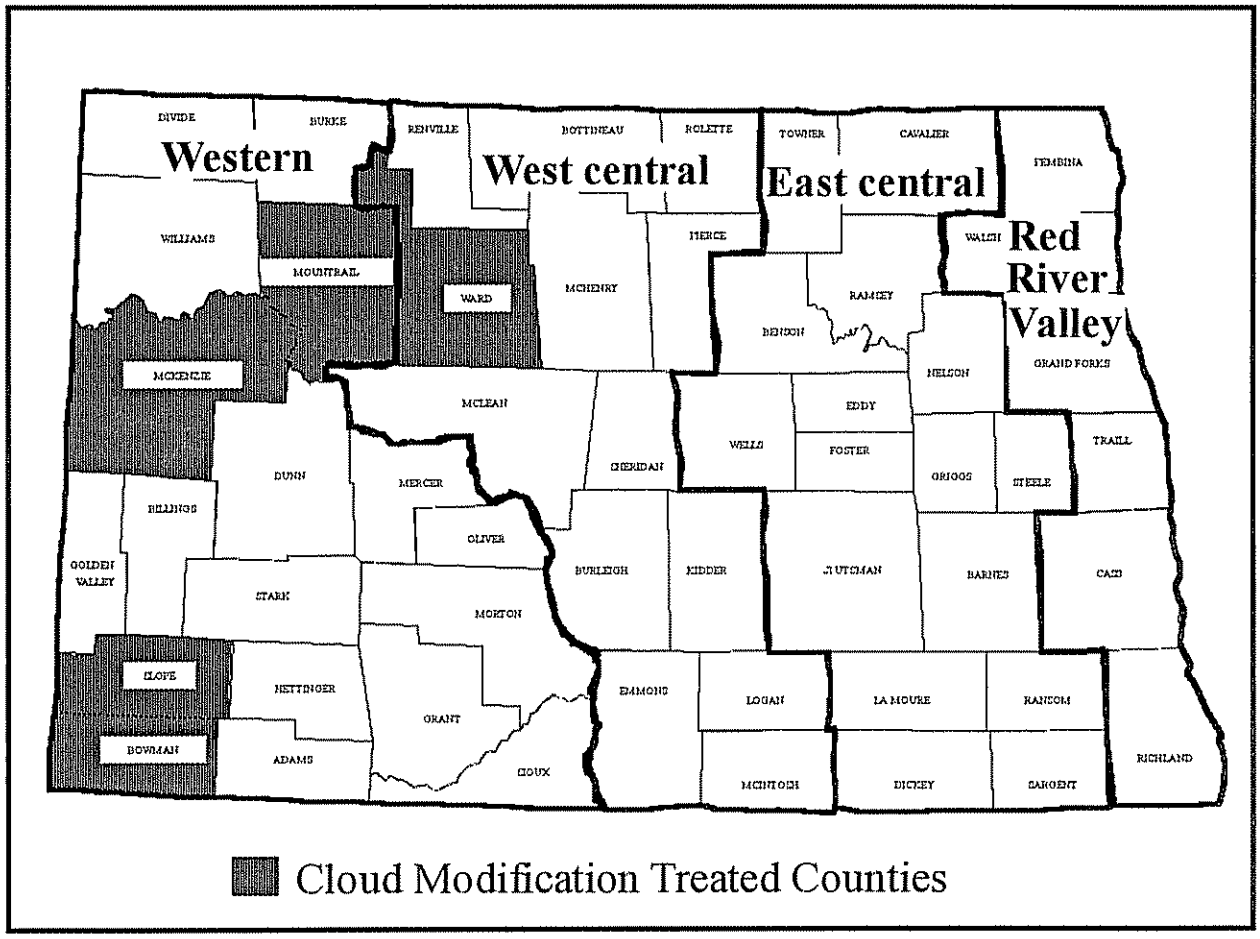

Figure 1. North Dakota Rain Enhancement Regions and Cloud Modification Treated Counties

Crop-hail loss-cost ratios for each county, year, and crop included in the study was used to develop a 10-year weighted loss-cost ratio for each county (National Crop Insurance Services 1988-1997). The loss-cost ratio is the total dollar losses due to hail divided by the total dollars of insured liability times 100. This ratio is calculated for a specified area (county) and crop, and it represents the dollars of loss per $100 liability resulting from hail damages to an insured crop.

Steps to Determine Hail Reduction Impact

Calculation of the gross values of production for each of the eight crops was accomplished using the North Dakota Tax Assessment Model data set from 1988 to 1997. This model used marketing year prices for each crop by crop reporting district. County average yields, planted and harvested acres by crop were also used to determine gross returns per planted acre and per county for all crops (North Dakota Agricultural Statistics Service 1989-1998).

To determine the possible crop sales lost due to hail the county loss-cost ratios were multiplied by the county values of crop production. These values were calculated on a year by year basis and then averaged across the ten-year period.

Possible crop output savable due to cloud modification involved multiplying the county value of crop production lost to hail by the adjusted Smith et al. (1997) reduction factor for each county. This value results in the direct economic impact of hail suppression attributed to successful cloud modification. It was necessary to use separate equations for the treated and non-treated counties. The equations for each are shown below.

1) Potential annual crop output savable due to cloud seeding in each non-treated county is defined as:

Average County Value of Crop Production

x

Average County Loss-cost Ratio

x

County Adjusted Reduction Factor

This value represents the average annual amount of crop losses which would not have been lost to hail if the hail suppression efforts had achieved the level reported by Smith et al. (1997).

2) Potential annual crop output savable due to cloud seeding in each treated county is defined as:

[(*Average County Value of Crop Production* x *Loss-cost Ratio*)
/ (*1.0 - County Adjusted Reduction Factor*)]
minus (*Average County Value of Crop production* x *Loss-cost Ratio*)

The total crop output savable because of the suppression of hail results are then used in the North Dakota Input-Output model (Coon et al. 1985) to determine the total economic impact for each county and for the state. The overall economic impact is the result of the total value of crop output savable plus the indirect and induced changes which result from those losses not occurring. The overall economic impact for the state is then divided by all acres planted to the eight crops within each county to provide a common per-acre base for analysis.

Steps to Determine Rain Enhancement Impact

Gross value of production was the same calculation for rain enhancement impact as for the hail reduction impact. Yields were changed for each crop based on the enhanced rainfall (Schaffner et al. 1983). Yield changes for dry edible beans were not available; therefore, dry edible beans yields were not changed (Table 3). Soybeans were produced in all four regions of the state; however, increased yields were only available for the Red River Valley region of the state.

Increased supply of wheat was determined each year, and the rain enhanced supply was compared to the original supply to determine the percentage increase in wheat supply for each year. The percentage increase in wheat supply was used to adjust the wheat price by crop

reporting district using an estimated 'flexibility' coefficient of 0.856 (Johnson et al. 1998). Essentially this coefficient means that for every one percent change in the supply of wheat, the price of wheat can be expected to change by 0.856 percent in the opposite direction. The estimated coefficient was calculated for hard red spring wheat using the Minneapolis Grain Exchange nearby futures market. Flexibility coefficients for the other North Dakota crops were not available. North Dakota's total production of corn and soybeans is just a small fraction of total United States production, and a small increase per acre on relatively few acres would not likely have a significant impact on price. However, North Dakota is an important producer of the United States' total production of barley, oats, flax, and sunflower. If 'flexibility' coefficients were available for these crops, then their use in this study would likely be warranted.

The final steps in calculating the impact of increased rainfall involved computing the gross value of production for all crops using the increased crop yields and decreased wheat price (other crop prices were not changed) and subtracting the original base value for each county. Next, the North Dakota Input-Output model was used to determine what the value of enhanced rainfall would mean to communities and state economies. The last step was to divide the direct and total impacts by the total planted acres of the crops in each county to provide a common annual per-acre base for the comparison.

Table 3. Average Yield Increase Per Harvested Acre Due to Growing Season Rainfall in Four Regions of North Dakota

	Western	West Central	East Central	Red River Valley
June-July increased rainfall (inches)	0.83	0.82	0.81	0.80
June-Aug. increased rainfall (inches)	1.15	1.17	1.16	1.13
Wheat (bu/acre) [a]	2.25	2.2	1.7	1.4
Barley (bu/acre) [a]	2.08	2.3	2.4	2.0
Oats (bu/acre) [a]	2.91	4.1	3.2	2.4
Flax (bu/acre) [a]	0.5	1.6	1.3	1.0
Corn Grain (bu/acre) [b]	3.17	4.1	3.5	2.8
Sunflower (lbs/acre) [b]	156	158	139	136
Soybeans (bu/acre) [b]	c	c	c	1.7
Dry Edible Beans (hdwt/acre)	c	c	c	c

Source: Schaffner et al. (1983)
[a] June-July added rainfall was used in calculating yield increase.
[b] June-August added rainfall was used in calculating yield increase.
c Not available

RESULTS

Ten-year annual average crop-hail loss-ratios for all the eight crops considered in this study reveal that loss ratios ranged from a high of 10.27 in Sioux County to a low of 2.12 in Grand Forks County (Table 4). The annual values of crop production for all eight crops were calculated for each of the 10 years, 1988-1997, for each county. The 10-year average crop yields and prices are shown in Appendix A.

The 10-year average gross returns per acre were greatest for Richland and Cass Counties and lowest for Grant and Sioux Counties (Table 5). A comparison of the gross returns from the eight crops considered to all crops grown in each county reveals that the eight crops generally represent about 80 percent of gross returns for all crops. Comparing total harvested acres of the

individual crops revealed that 63 percent of harvested acres were wheat followed by barley, sunflower, soybeans, dry edible beans, corn grain, oats, and flax with 15, 8, 4, 3, 3, 3, and 1, percent, respectively (Table 6).

The greatest annual crop output savable per acre, for the crops included in the study, occurs in Golden Valley County, and the least in Stark County (Table 7). The ten-year average crop output savable per acre to North Dakota was $1.87. The lowest direct impact for a county occurred in Billings County and the highest was in Cavalier County. The total direct impact (crop output savable because of hail reduction) to the state was $34.4 million. This resulted in a total impact of hail reduction of $106 million for the crops included in the study.

The direct impact of enhanced rainfall to the state of North Dakota, for the crops included in the study, was $52.2 million which resulted in a total impact of $160.7 million (Table 8). The largest direct impact was in Cass County followed closely by Richland County. Richland County also had the highest dollar/acre of direct impact ($4.73/acre) Increased rainfall did not always translate into increased gross returns to a county. Pembina County gross returns declined by $117,000 in the enhanced rainfall scenario.

Total direct impacts of hail reduction and rainfall enhancement amounted to nearly $87 million annually statewide for the eight crops (Table 9). The impacts tended to be greater in eastern North Dakota, with the leading four counties (Cass, Richland, Stutsman, and Barnes) accounting for nearly 20 percent of the total direct impact. Richland County also had the greatest

per acre direct impact of $6.69. Other counties which had a total direct impact of more than $6/planted acre were Pierce, Nelson, Ramsey, Eddy, and Foster Counties. The state average total direct impact was $4.72/planted acre. Counties which had the highest direct impacts of hail reduction and rain enhancement as a percentage of gross receipts were Sioux, Emmons, McIntosh, and Pierce Counties. All four of these counties had an increase in gross receipts of more than 7.5 percent. The average increase in gross receipts to the state was 4.5 percent.

The total economic impact of hail reduction and enhanced rainfall for the eight crops included in the study by economic sector reveals the greatest impact was to the *household* sector which represented about 50 percent of the total impact (Table 10). The *retail trade* sector also experienced a large share of total economic impact (25 %).

The increase in state tax revenues more than offset the expected cost of operating the program (Table 11). As mentioned previously, the NDCMP would cost about $3.2 million to operate statewide. The increase in sales and use tax, personal and corporate income tax was estimated to be $5.1 million.

Table 4. Ten-Year Average Loss-Cost Ratios by Counties, 1988-1997

County	Liability	Loss	Loss-Cost Ratio
Adams	$2,297,000	$152,600	6.64%
Barnes	19,566,500	453,500	2.32%
Benson	14,901,600	975,600	6.55%
Billings	540,100	24,100	4.46%
Bottineau	19,907,400	911,300	4.58%
Bowman	1,952,111	109,889	5.63%
Burke	4,044,400	237,800	5.88%
Burleigh	3,566,100	189,400	5.31%
Cass	44,783,700	1,063,400	2.37%
Cavalier	25,535,500	1,335,100	5.23%
Dickey	10,441,900	274,900	2.63%
Divide	2,024,200	86,700	4.28%
Dunn	1,927,600	71,000	3.68%
Eddy	4,381,200	209,100	4.77%
Emmons	4,767,400	461,500	9.68%
Foster	9,270,400	396,700	4.28%
Golden Valley	1,630,800	147,500	9.04%
Grand Forks	29,609,500	627,400	2.12%
Grant	1,824,600	94,100	5.16%
Griggs	7,762,000	314,600	4.05%
Hettinger	8,633,333	526,889	6.10%
Kidder	3,035,300	135,600	4.47%
LaMoure	11,512,100	438,100	3.81%
Logan	1,529,400	92,700	6.06%
McHenry	6,978,100	299,100	4.29%
McIntosh	1,668,100	118,100	7.08%
McKenzie	4,747,000	236,300	4.98%
McLean	9,793,700	264,600	2.70%
Mercer	1,339,700	73,900	5.52%
Morton	4,121,600	160,700	3.90%
Mountrail	9,397,200	289,800	3.08%
Nelson	17,338,400	983,700	5.67%
Oliver	1,323,000	54,200	4.10%
Pembina	18,684,700	1,164,700	6.23%
Pierce	8,913,100	582,800	6.54%
Ramsey	20,160,000	1,339,600	6.64%
Ransom	13,085,800	295,800	2.26%
Renville	11,385,900	519,000	4.56%
Richland	39,986,500	1,250,900	3.13%
Rolette	6,943,000	428,200	6.17%
Sargent	14,049,700	488,100	3.47%
Sheridan	3,866,600	138,300	3.58%

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Table 4. Continued

County	Liability	Loss	Loss-Cost Ratio
Sioux	$660,400	$67,800	10.27%
Slope	2,174,222	81,000	3.73%
Stark	2,697,500	71,200	2.64%
Steele	17,289,300	680,800	3.94%
Stutsman	14,104,800	618,000	4.38%
Towner	16,062,200	802,500	5.00%
Traill	23,572,500	568,100	2.41%
Walsh	28,459,700	814,600	2.86%
Ward	14,772,500	617,200	4.18%
Wells	14,571,700	405,600	2.78%
Williams	7,339,800	512,800	6.99%

Table 5. Average Annual Gross Returns Per County for All Crops and Eight Crops Used in Analysis (1988-1997)

County	Gross Returns Eight Crops		Gross Returns All Crops		Proportion of All Crops to Eight Crops Gross Returns
	— $ -----	$/plnted acre	— $ -----	$/plnted acre	
Adams	12,164,348	71.09	17,268,252	53.41	70.44%
Barnes	76,946,337	118.14	80,428,071	109.89	95.67%
Benson	41,150,790	92.45	44,668,738	75.60	92.12%
Billings	3,310,012	61.09	7,569,568	50.93	43.73%
Bottineau	59,562,354	102.20	62,629,762	83.35	95.10%
Bowman	11,060,760	79.25	14,824,937	53.22	74.61%
Burke	26,286,444	100.80	28,309,601	69.05	92.85%
Burleigh	15,902,202	65.97	24,826,200	59.91	64.05%
Cass	131,172,052	142.53	150,288,031	149.59	87.28%
Cavalier	66,452,789	98.74	67,209,407	86.82	98.87%
Dickey	40,854,343	122.15	47,901,824	113.30	85.29%
Divide	28,525,476	103.02	30,807,151	63.00	92.59%
Dunn	13,901,119	64.23	24,201,914	55.04	57.44%
Eddy	16,022,173	91.70	19,469,356	82.32	82.29%
Emmons	20,806,778	63.35	30,416,648	63.38	68.41%
Foster	26,974,066	104.90	30,185,841	99.85	89.36%
Golden Valley	10,339,820	82.98	12,018,483	59.85	86.03%
Grand Forks	82,850,204	136.09	125,141,663	175.56	66.21%
Grant	14,223,185	58.71	22,412,113	51.06	63.46%
Griggs	28,211,923	109.44	31,735,142	103.22	82.90%
Hettinger	27,926,425	90.39	32,339,061	65.13	86.36%
Kidder	10,009,090	67.76	23,450,315	71.53	42.68%
LaMoure	51,489,156	116.85	56,947,184	106.68	90.42%
Logan	13,882,004	74.76	20,423,486	67.12	67.97%
McHenry	29,306,736	85.57	41,153,754	71.17	71.21%
McIntosh	15,390,670	66.84	21,335,603	61.70	72.14%
McKenzie	19,492,673	86.13	34,024,372	75.06	57.29%
McLean	54,800,489	98.05	60,151,144	74.98	91.10%
Mercer	10,700,090	75.36	16,394,518	60.79	65.27%
Morton	18,551,252	61.14	31,309,903	59.58	59.25%
Mountrail	38,017,256	104.58	42,164,072	69.89	90.17%
Nelson	38,010,457	102.62	40,100,236	92.23	94.79%
Oliver	8,168,037	72.19	12,573,061	68.01	64.96%
Pembina	55,291,147	124.36	120,533,083	207.71	45.87%
Pierce	25,081,594	84.56	28,701,900	69.27	87.39%
Ramsey	46,550,546	96.88	47,766,518	85.36	97.45%
Ransom	40,297,726	137.77	47,175,853	137.23	85.42%
Renville	38,480,695	106.65	39,416,874	82.89	97.62%
Richland	106,752,561	156.78	130,171,817	171.82	82.01%
Rolette	20,830,129	94.67	25,020,607	78.17	83.25%
Sargent	40,981,071	132.91	47,086,083	132.88	87.03%
Sheridan	16,850,834	79.22	20,200,692	63.75	83.42%
Sioux	3,327,994	50.12	8,332,331	50.07	39.94%
Slope	11,781,711	86.94	15,092,095	55.79	78.07%
Stark	20,805,762	73.88	29,131,929	57.89	71.42%
Steele	46,057,181	130.81	47,994,820	125.32	95.96%
Stutsman	66,570,698	100.45	75,405,523	89.32	88.28%
Towner	37,897,242	92.24	41,870,665	82.17	90.51%
Traill	62,776,271	145.01	90,470,806	182.32	69.39%
Walsh	60,511,617	122.10	127,740,550	195.75	47.37%
Ward	65,713,658	103.64	70,608,701	80.89	93.07%
Wells	49,922,977	103.32	52,926,213	88.89	94.33%
Williams	37,914,060	90.29	45,679,479	57.49	83.00%
Total	$1,916,856,984	$104.37	$2,416,005,952	$94.64	79.34%

Table 6. Ten-Year Average Harvested Acres by Crop and County, 1988-1997

	Wheat	Barley	Oats	All Sunflower	Flax	Corn grain	Soybeans	Beans	Total
Adams	117,080	13,600	7,590	2,580	230	710	0	110	141,900
Barnes	337,310	120,120	6,300	122,880	3,940	9,680	18,570	2,600	621,400
Benson	260,980	80,110	9,790	44,510	4,880	2,940	830	4,010	408,050
Billings	30,790	3,660	5,950	310	30	100	0	0	40,840
Bottineau	383,430	132,850	14,340	24,830	8,490	530	640	560	565,670
Bowman	97,680	13,470	5,850	1,390	150	390	10	140	119,080
Burke	195,280	30,910	8,790	9,670	3,520	130	70	120	248,490
Burleigh	145,470	12,380	16,570	5,900	2,020	3,110	240	1,360	187,050
Cass	384,180	113,580	3,720	65,260	440	69,240	220,680	25,900	883,000
Cavalier	414,150	172,650	4,720	21,830	10,180	170	580	4,840	629,120
Dickey	146,790	24,960	10,510	55,380	1,720	51,020	6,490	8,570	305,440
Divide	230,350	20,700	6,920	3,230	1,620	0	10	40	262,870
Dunn	118,440	20,380	17,380	1,490	110	500	0	10	158,310
Eddy	92,490	16,590	7,940	33,790	2,710	2,850	770	2,590	159,730
Emmons	181,160	19,940	21,780	8,780	3,120	3,940	340	850	239,910
Foster	145,020	21,210	6,340	59,980	3,260	4,310	1,550	1,300	242,970
Golden Valley	84,390	15,390	6,520	470	380	520	10	10	107,690
Grand Forks	274,460	115,390	3,140	34,650	730	15,240	41,330	96,960	581,900
Grant	129,950	21,800	16,810	8,550	520	3,460	10	800	181,900
Griggs	132,270	55,650	4,200	31,540	2,340	2,360	4,350	10,510	243,220
Hettinger	239,450	21,290	10,580	5,680	2,150	450	120	1,550	281,270
Kidder	73,400	11,040	13,660	3,830	3,500	4,440	650	620	111,140
LaMoure	221,860	38,100	10,530	93,440	3,970	22,240	10,140	9,650	409,930
Logan	112,260	18,930	8,940	9,110	2,660	1,400	90	0	153,390
McHenry	200,910	46,900	22,630	35,720	5,480	2,900	0	440	314,980
McIntosh	136,640	16,350	20,080	13,690	4,900	990	460	50	193,160
McKenzie	160,660	17,830	7,010	740	110	810	0	930	188,090
McLean	402,350	48,090	25,260	22,380	9,360	2,530	140	15,740	525,850
Mercer	90,850	7,410	13,260	1,750	360	420	10	140	114,200
Morton	152,460	33,110	19,610	7,800	470	3,210	10	40	216,710
Mountrail	295,890	27,440	11,110	8,480	2,140	170	80	280	345,590
Nelson	212,490	70,750	5,010	51,560	3,470	1,330	3,660	5,630	353,900
Oliver	58,350	12,970	10,390	3,480	960	1,160	0	1,810	89,120
Pembina	268,230	69,380	1,940	9,780	1,070	5,520	6,990	49,830	412,740
Pierce	172,650	48,850	11,450	28,310	4,760	1,450	70	510	268,050
Ramsey	276,610	102,240	3,480	50,000	9,010	730	1,050	7,070	450,190
Ransom	119,030	27,490	5,550	41,490	230	50,180	15,610	12,810	272,390
Renville	241,070	82,790	9,600	12,640	5,830	200	10	30	352,170
Richland	209,190	23,840	4,290	33,930	310	154,340	214,830	13,210	653,940
Rolette	135,370	55,900	6,290	8,030	2,610	380	190	100	208,870
Sargent	129,930	22,850	3,900	31,180	360	45,430	46,600	7,960	288,210
Sheridan	128,700	27,270	9,150	23,690	3,730	1,070	160	360	194,130
Sioux	34,450	2,880	5,630	690	140	300	250	0	44,340
Slope	101,800	14,670	4,640	1,560	110	190	0	130	123,100
Stark	187,100	25,200	19,370	2,590	250	700	0	110	235,320
Steele	164,060	70,570	1,330	24,510	1,570	7,810	21,120	44,900	335,870
Stutsman	380,010	64,930	14,920	121,860	9,170	9,810	3,530	6,260	610,490
Towner	269,230	89,760	2,710	18,100	6,810	160	690	4,420	391,880
Traill	180,570	88,790	950	13,700	60	15,800	67,440	51,370	418,680
Walsh	305,390	71,240	3,900	23,330	1,610	4,270	3,930	52,670	466,340
Ward	451,150	88,220	24,680	30,760	12,750	1,300	90	380	609,330
Wells	274,750	63,640	9,590	75,240	3,630	5,770	1,170	20,760	454,550
Williams	357,550	26,560	9,400	1,780	540	210	0	260	396,300
Total	10,646,080	2,462,620	516,000	1,347,850	154,470	518,870	695,570	471,300	16,812,760
Relative share	63%	15%	3%	8%	1%	3%	4%	3%	100%

Table 7. Annual Average Crop Output Savable Due to Hail Reduction

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Adams	$363,567	$1,119,153	$2.12	$6.54
Barnes	793,361	2,442,167	1.22	3.75
Benson	1,207,334	3,716,483	2.71	8.35
Billings	66,464	204,592	1.23	3.78
Bottineau	1,226,092	3,774,225	2.10	6.48
Bowman	228,889	704,578	1.64	5.05
Burke	695,312	2,140,349	2.67	8.21
Burleigh	379,070	1,166,875	1.57	4.84
Cass	1,270,162	3,909,882	1.38	4.25
Cavalier	1,558,472	4,797,377	2.32	7.13
Dickey	476,220	1,465,926	1.42	4.38
Divide	549,762	1,692,307	1.99	6.11
Dunn	230,408	709,254	1.06	3.28
Eddy	341,692	1,051,816	1.96	6.02
Emmons	905,132	2,786,228	2.76	8.48
Foster	517,331	1,592,476	2.01	6.19
Golden Valley	420,806	1,295,349	3.38	10.40
Grand Forks	724,500	2,230,197	1.19	3.66
Grant	329,585	1,014,547	1.36	4.19
Griggs	503,435	1,549,702	1.95	6.01
Hettinger	765,066	2,355,068	2.48	7.62
Kidder	200,600	617,497	1.36	4.18
LaMoure	867,886	2,671,575	1.97	6.06
Logan	378,576	1,165,354	2.04	6.28
McHenry	564,994	1,739,195	1.65	5.08
McIntosh	489,964	1,508,236	2.13	6.55
McKenzie	355,612	1,094,665	1.57	4.84
McLean	659,340	2,029,618	1.18	3.63
Mercer	265,506	817,294	1.87	5.76
Morton	325,456	1,001,838	1.07	3.30
Mountrail	431,171	1,327,254	1.19	3.65
Nelson	961,594	2,960,034	2.60	7.99
Oliver	149,685	460,768	1.32	4.07
Pembina	1,475,270	4,541,260	3.32	10.21
Pierce	737,489	2,270,181	2.49	7.65
Ramsey	1,382,665	4,256,195	2.88	8.86
Ransom	396,127	1,219,381	1.35	4.17
Renville	789,295	2,429,652	2.19	6.73
Richland	1,330,198	4,094,690	1.95	6.01
Rolette	577,777	1,778,546	2.63	8.08
Sargent	601,736	1,852,298	1.95	6.01
Sheridan	270,955	834,070	1.27	3.92
Sioux	153,527	472,596	2.31	7.12
Slope	161,425	496,907	1.19	3.67
Stark	247,080	760,575	0.88	2.70

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Table 7. Continued

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Steele	$760,948	$2,342,393	$2.16	$6.65
Stutsman	1,305,464	4,018,551	1.97	6.06
Towner	847,823	2,609,818	2.06	6.35
Traill	614,943	1,892,952	1.42	4.37
Walsh	746,740	2,298,657	1.51	4.64
Ward	1,010,094	3,109,327	1.59	4.90
Wells	615,193	1,893,721	1.27	3.92
Williams	1,191,698	3,668,352	2.84	8.74
Total	$34,419,492	$105,952,000	$1.87	$5.77

Table 8. Annual Average Increased Gross Returns Due to Enhanced Rainfall

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Adams	$439,040	$1,351,496	$2.57	$7.90
Barnes	2,610,095	8,034,656	4.01	12.34
Benson	1,180,905	3,635,182	2.65	8.17
Billings	124,512	383,287	2.30	7.07
Bottineau	1,722,522	5,302,441	2.96	9.10
Bowman	319,814	984,483	2.29	7.05
Burke	662,041	2,037,962	2.54	7.81
Burleigh	700,347	2,155,879	2.91	8.94
Cass	3,318,368	10,214,933	3.61	11.10
Cavalier	1,224,097	3,768,139	1.82	5.60
Dickey	1,332,877	4,102,997	3.99	12.27
Divide	648,317	1,995,715	2.34	7.21
Dunn	461,976	1,422,102	2.13	6.57
Eddy	722,246	2,223,291	4.13	12.72
Emmons	940,372	2,894,748	2.86	8.81
Foster	1,080,528	3,326,190	4.20	12.94
Golden Valley	291,289	896,675	2.34	7.20
Grand Forks	777,459	2,393,254	1.28	3.93
Grant	743,258	2,287,972	3.07	9.44
Griggs	860,385	2,648,524	3.34	10.27
Hettinger	656,032	2,019,464	2.12	6.54
Kidder	468,093	1,440,932	3.17	9.76
LaMoure	1,664,181	5,122,848	3.78	11.63
Logan	606,481	1,866,931	3.27	10.05
McHenry	1,364,821	4,201,330	3.98	12.27
McIntosh	870,493	2,679,639	3.78	11.64
McKenzie	448,997	1,382,148	1.98	6.11
McLean	1,610,522	4,957,671	2.88	8.87
Mercer	308,903	950,897	2.18	6.70
Morton	789,342	2,429,833	2.60	8.01
Mountrail	959,663	2,954,132	2.64	8.13
Nelson	1,272,572	3,917,358	3.44	10.58
Oliver	298,495	918,857	2.64	8.12
Pembina	(117,342)	(361,212)	(0.26)	(0.81)
Pierce	1,171,013	3,604,730	3.95	12.15
Ramsey	1,534,141	4,722,546	3.19	9.83
Ransom	1,048,173	3,226,591	3.58	11.03
Renville	1,021,616	3,144,842	2.83	8.72
Richland	3,222,433	9,919,618	4.73	14.57
Rolette	722,318	2,223,511	3.28	10.11
Sargent	839,457	2,584,099	2.72	8.38
Sheridan	909,837	2,800,750	4.28	13.17
Sioux	166,736	513,262	2.51	7.73
Slope	311,796	959,803	2.30	7.08

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Table 8. Continued

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Stark	$679,613	$2,092,053	$2.41	$7.43
Steele	739,309	2,275,814	2.10	6.46
Stutsman	2,207,412	6,795,077	3.33	10.25
Towner	883,218	2,718,811	2.15	6.62
Traill	948,492	2,919,744	2.19	6.74
Walsh	9,340	28,750	0.02	0.06
Ward	1,847,832	5,688,181	2.91	8.97
Wells	1,498,181	4,611,850	3.10	9.54
Williams	1,086,383	3,344,212	2.59	7.96
Total	$52,209,006	$160,715,000	$2.84	$8.75

Table 9. Annual Average Increased Gross Returns Due to Reduced Hail and Enhanced Rainfall

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Adams	$802,607	$2,470,649	$4.69	$14.44
Barnes	3,403,456	10,476,824	5.23	16.09
Benson	2,388,239	7,351,664	5.37	16.52
Billings	190,976	587,879	3.52	10.85
Bottineau	2,948,614	9,076,666	5.06	15.57
Bowman	548,702	1,689,061	3.93	12.10
Burke	1,357,354	4,178,311	5.20	16.02
Burleigh	1,079,417	3,322,754	4.48	13.78
Cass	4,588,530	14,124,816	4.99	15.35
Cavalier	2,782,570	8,565,516	4.13	12.73
Dickey	1,809,097	5,568,923	5.41	16.65
Divide	1,198,079	3,688,022	4.33	13.32
Dunn	692,384	2,131,356	3.20	9.85
Eddy	1,063,938	3,275,107	6.09	18.74
Emmons	1,845,504	5,680,976	5.62	17.30
Foster	1,597,859	4,918,666	6.21	19.13
Golden Valley	712,095	2,192,024	5.71	17.59
Grand Forks	1,501,960	4,623,450	2.47	7.59
Grant	1,072,843	3,302,520	4.43	13.63
Griggs	1,363,820	4,198,226	5.29	16.29
Hettinger	1,421,098	4,374,532	4.60	14.16
Kidder	668,693	2,058,429	4.53	13.94
LaMoure	2,532,067	7,794,423	5.75	17.69
Logan	985,057	3,032,285	5.30	16.33
McHenry	1,929,815	5,940,525	5.63	17.35
McIntosh	1,360,457	4,187,875	5.91	18.19
McKenzie	804,609	2,476,813	3.56	10.94
McLean	2,269,862	6,987,288	4.06	12.50
Mercer	574,409	1,768,191	4.05	12.45
Morton	1,114,799	3,431,671	3.67	11.31
Mountrail	1,390,834	4,281,386	3.83	11.78
Nelson	2,234,166	6,877,391	6.03	18.57
Oliver	448,180	1,379,625	3.96	12.19
Pembina	1,357,929	4,180,047	3.05	9.40
Pierce	1,908,502	5,874,911	6.43	19.81
Ramsey	2,916,805	8,978,741	6.07	18.69
Ransom	1,444,300	4,445,972	4.94	15.20
Renville	1,810,911	5,574,494	5.02	15.45
Richland	4,552,632	14,014,308	6.69	20.58
Rolette	1,300,095	4,002,058	5.91	18.19
Sargent	1,441,193	4,436,398	4.67	14.39
Sheridan	1,180,792	3,634,820	5.55	17.09
Sioux	320,263	985,858	4.82	14.85
Slope	473,221	1,456,710	3.49	10.75

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Table 9. Continued

County	Direct Impact	Total Bus. Activity	Direct Impact per planted acre	Total Bus. Activity per planted acre
Stark	$926,693	$2,852,629	$3.29	$10.13
Steele	1,500,257	4,618,207	4.26	13.12
Stutsman	3,512,876	10,813,628	5.30	16.32
Towner	1,731,042	5,328,628	4.21	12.97
Traill	1,563,435	4,812,696	3.61	11.12
Walsh	756,080	2,327,408	1.53	4.70
Ward	2,857,925	8,797,508	4.51	13.87
Wells	2,113,374	6,505,571	4.37	13.46
Williams	2,278,081	7,012,564	5.43	16.70
Total	$86,628,497	$266,667,000	$4.72	$14.52

Table 10. Economic Impact of Reduced Hail and Enhanced Rainfall by Economic Sector

Sector	-- $000 --	-- % --
Households	134,481	50.4
Retail trade	64,512	24.2
Fin., Ins., and real estate	14,562	5.5
Services	13,748	5.2
Trans., Comm., and Pub. Util.	9,945	3.7
Construction	7,814	2.9
Other [1]	21,605	8.1
Total	$266,667	100%

[1] Other category includes: Ag. crops, Ag. livestock, nonmetal mining, Ag. proc., manufacturing, and government.

Table 11. Estimated Increase in State Revenue Due to Reduced Hail and Enhanced Rainfall

State Tax Revenues:	- $000 -
Sales and use tax	$2,987
Personal income tax	1,758
Corporate income tax	356
Total	$5,101

CONCLUSIONS

The results of the analysis presented here indicate that a statewide hail suppression program could offer very substantial benefits to North Dakota. The direct impact of hail reduction was estimated to be $34.4 million annually - - more than 10 times the $3.2 million annual cost of operating the program. When the impact of enhanced rainfall is added to the impact of hail reduction, the result is an estimated increase in the value of crop output of $86.6 million. When these direct impacts are applied to the North Dakota input-output model, the total annual impact of $267 million is estimated. The increases in household income, retail sales, and gross business volume in various sectors of the state economy resulting from the statewide program would result in increases in the state tax revenue of more than $5 million annually. Overall, the statewide hail suppression program offers the prospect of substantial benefits to North Dakota.

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APPENDIX A. TEN-YEAR AVERAGE YIELDS AND PRICES FOR WHEAT, BARLEY, OATS, SUNFLOWER, FLAX, CORN GRAIN, SOYBEANS, AND DRY EDIBLE BEANS BY NORTH DAKOTA COUNTIES, 1988-1997

Appendix Table A1. Annual Average Crop Yields Per Harvested Acre (1988-1997)

Counties	All Wheat	All Barley	Oats	All Sunflower	Flax	Corn grain only	Soybeans	Dry edible beans
	Bu/acre	Bu/acre	Bu/acre	Lbs/acre	Bu/acre	Bu/acre	Bu/acre	Cwt/acre
Adams	23.3	32.0	40.5	718.2	11.5	32.2	NA	3.4
Barnes	32.2	51.7	55.7	1,321.3	17.4	64.8	23.5	9.5
Benson	27.3	44.7	44.2	1,027.8	13.9	53.6	14.1	9.5
Billings	23.5	34.8	44.5	666.3	10.7	45.3	NA	NA
Bottineau	29.6	46.1	59.8	1,108.1	16.4	47.0	12.6	9.0
Bowman	25.4	33.4	43.0	940.8	9.3	32.4	16.0	2.6
Burke	29.1	40.8	50.2	876.1	13.5	34.2	8.3	7.1
Burleigh	22.0	33.7	41.7	836.6	11.8	67.0	14.3	7.8
Cass	37.0	56.1	59.7	1,396.6	16.9	80.5	26.0	11.6
Cavalier	29.5	49.6	56.2	1,096.5	19.0	58.9	16.6	9.6
Dickey	30.2	45.0	54.6	1,373.7	13.4	84.3	22.8	13.9
Divide	27.6	34.5	48.6	826.7	14.2	NA	8.0	7.3
Dunn	24.5	36.1	47.2	746.9	11.0	35.2	NA	2.5
Eddy	26.1	44.0	46.9	1,044.7	14.6	56.9	15.5	9.8
Emmons	21.2	35.5	46.8	814.3	10.5	88.3	17.8	9.1
Foster	29.4	49.0	52.6	1,180.4	15.5	73.4	19.1	10.0
Golden Valley	26.2	36.8	49.6	1,020.1	16.2	62.7	17.0	9.0
Grand Forks	37.6	56.5	53.9	1,222.6	15.8	79.2	23.5	11.0
Grant	21.0	29.2	40.5	827.7	12.1	57.3	12.0	4.4
Griggs	29.8	49.4	54.6	1,298.2	14.6	76.5	18.6	9.9
Hettinger	27.7	36.2	44.4	835.2	12.2	35.8	18.5	3.6
Kidder	22.3	35.7	42.6	1,080.9	14.7	99.1	22.2	9.8
LaMoure	31.4	49.8	55.2	1,331.6	14.8	74.6	25.3	12.0
Logan	24.2	37.8	50.7	1,014.5	12.3	91.6	16.5	NA
McHenry	26.1	42.7	49.1	1,106.8	13.9	61.8	NA	8.1
McIntosh	21.1	34.0	46.1	998.9	11.3	55.5	23.3	10.0
McKenzie	27.6	35.7	49.1	719.5	10.6	84.4	NA	15.2
McLean	27.2	41.1	48.4	945.9	13.7	68.0	13.8	8.3
Mercer	26.3	36.2	49.1	709.8	12.4	71.9	7.0	6.3
Morton	22.6	33.4	44.6	754.9	9.8	72.2	5.0	9.3
Mountrail	28.0	42.4	52.8	887.4	14.3	43.9	10.3	7.3
Nelson	28.8	49.3	50.6	1,175.5	15.7	58.2	21.4	10.3
Oliver	24.3	37.5	46.4	884.0	11.6	63.4	NA	7.6
Pembina	35.2	58.0	58.6	1,343.1	20.9	72.4	22.6	11.0
Pierce	25.5	41.9	45.7	1,083.6	13.9	53.5	9.8	10.1
Ramsey	27.8	47.0	49.8	1,082.8	16.0	54.9	15.7	10.0
Ransom	33.1	49.9	58.8	1,385.8	14.0	92.5	24.7	13.4
Renville	30.5	45.9	54.2	1,100.6	17.6	32.9	9.0	10.0
Richland	37.0	53.4	55.6	1,402.0	17.4	88.2	27.2	13.3
Rolette	27.5	47.0	51.8	1,015.5	15.9	48.2	10.3	7.0
Sargent	32.6	50.1	58.4	1,309.3	14.4	84.0	24.7	12.2
Sheridan	24.1	37.2	43.3	913.5	12.9	40.2	12.8	7.2
Sioux	19.5	28.5	39.1	714.3	9.8	89.4	15.9	NA
Slope	26.7	39.1	43.4	807.0	9.2	24.5	NA	4.3
Stark	24.2	32.1	45.6	767.5	10.9	41.0	NA	3.2
Steele	32.9	53.9	56.8	1,391.4	16.9	83.7	24.5	11.3
Stutsman	29.1	48.8	53.6	1,166.5	17.0	72.0	20.5	10.2
Towner	26.8	44.2	46.4	1,046.6	14.5	50.8	12.8	9.6
Traill	37.1	58.5	58.3	1,383.5	20.4	80.5	26.2	11.0
Walsh	35.1	53.1	54.5	1,166.1	15.6	67.9	21.6	10.5
Ward	29.2	46.3	54.1	1,129.0	15.5	47.2	9.3	8.6
Wells	28.8	46.7	49.6	1,092.9	15.4	53.3	14.9	10.0
Williams	25.2	32.2	43.5	769.4	12.5	67.5	NA	13.5
Average	27.9	42.7	49.8	1,035.1	14.1	62.6	17.1	9.0

Appendix Table A2. Annual Average Crop Marketing Year Price/Unit (1988-1997)

Counties	All Wheat	All Barley	Oats	All Sunflower	Flax	Corn grain only	Soybeans	Dry edible beans
Adams	$3.66	$2.00	$1.33	$0.10	$5.52	$2.33	NA	$19.50
Barnes	$3.58	$2.31	$1.45	$0 12	$5 29	$2.32	$6 05	$19.32
Benson	$3.73	$2.11	$1.33	$0.10	$5.31	$2.32	$6.05	$19.32
Billings	$3.63	$2.00	$1.33	$0.09	$5.15	$2.67	NA	NA
Bottineau	$3.72	$2.11	$1.33	$0.10	$5.31	$2.32	$5.83	$19.32
Bowman	$3 69	$2 00	$1.33	$0.10	$5.45	$2.26	$5 53	$21.93
Burke	$3.81	$2.17	$1.33	$0.09	$5.41	$2.17	$5.96	$19.63
Burleigh	$3.68	$1.97	$1.42	$0.10	$5.49	$2.32	$6.12	$19.32
Cass	$3.58	$2.31	$1.45	$0.12	$5.02	$2.32	$6 05	$19.32
Cavalier	$3.58	$2.09	$1.33	$0.13	$5.33	$2.31	$5.99	$19.32
Dickey	$3.64	$2 04	$1.35	$0.11	$5 55	$2.32	$6.05	$19.32
Divide	$4.02	$2.17	$1.33	$0 09	$5 52	NA	$5 32	$21.53
Dunn	$3.60	$2.03	$1.41	$0.10	$5.26	$2.36	NA	$25.50
Eddy	$3.66	$2 01	$1.31	$0.11	$5.49	$2 32	$5.94	$19.32
Emmons	$3.64	$1.97	$1.42	$0 10	$5 49	$2.32	$5.94	$19 32
Foster	$3.63	$2.01	$1.31	$0 11	$5.49	$2.32	$6.05	$19.08
Golden Valley	$3.75	$2.00	$1.33	$0.10	$4 89	$2.33	$5 53	$16.90
Grand Forks	$3.50	$2.09	$1.33	$0.12	$5.33	$2.32	$6.05	$19.32
Grant	$3.64	$1.97	$1.42	$0.10	$5.49	$2.32	$5.19	$19.08
Griggs	$3.58	$2.31	$1.45	$0.12	$5.29	$2.32	$6.05	$19.32
Hettinger	$3.65	$2.00	$1.33	$0.10	$5.42	$2.33	$6.24	$19.63
Kidder	$3.67	$2.01	$1.31	$0.11	$5.49	$2.32	$6.27	$19.32
LaMoure	$3.64	$2.04	$1.35	$0.11	$5.55	$2.32	$6.05	$19.32
Logan	$3.64	$2.04	$1.35	$0.11	$5.55	$2.33	$6.23	NA
McHenry	$3.58	$2.11	$1.33	$0.10	$5.31	$2.32	NA	$19.08
McIntosh	$3.64	$2.04	$1.35	$0.11	$5.55	$2.32	$6.38	$16.90
McKenzie	$3.74	$2.03	$1.41	$0.10	$5.41	$2.33	NA	$19.08
McLean	$3.89	$2.03	$1.41	$0 10	$5.49	$2.32	$5.89	$19.32
Mercer	$3.66	$2.03	$1.41	$0 11	$5.26	$2.33	$5.32	$18.98
Morton	$3.65	$1.97	$1.42	$0.10	$5.27	$2.32	$6.95	$20.30
Mountrail	$4.06	$2.17	$1.33	$0.09	$5.52	$2.34	$6.01	$21.00
Nelson	$3.55	$2.09	$1.33	$0.12	$5.33	$2.32	$6.05	$19.32
Oliver	$3.60	$2.03	$1.41	$0.10	$5.49	$2.33	NA	$19.32
Pembina	$3.50	$2.09	$1.33	$0.11	$5.33	$2.32	$6.05	$19.32
Pierce	$3.68	$2.11	$1.33	$0.10	$5.31	$2.33	$5.96	$18.71
Ramsey	$3.61	$2.09	$1.33	$0.13	$5.33	$2.33	$5.97	$19.32
Ransom	$3.64	$2.04	$1.35	$0.11	$5.34	$2.32	$6.05	$19.32
Renville	$3.75	$2.17	$1.33	$0.09	$5.52	$2.20	$5.32	$16.90
Richland	$3.64	$2.04	$1.35	$0.11	$5.46	$2.32	$6.05	$19.32
Rolette	$3.81	$2.11	$1.33	$0.10	$5.31	$2.33	$7.00	$19.24
Sargent	$3.64	$2.04	$1.35	$0.11	$5.42	$2.32	$6.05	$19.32
Sheridan	$3.63	$2.01	$1.31	$0.10	$5.49	$2.32	$5.95	$19.65
Sioux	$3.69	$1.97	$1.42	$0.10	$5.11	$2.19	$5.80	NA
Slope	$3.68	$2.00	$1.33	$0.10	$4.45	$2.32	NA	$20.68
Stark	$3.64	$2.00	$1.33	$0.10	$5.18	$2.36	NA	$20.65
Steele	$3.58	$2.31	$1.45	$0.12	$5.17	$2.32	$6.05	$19.32
Stutsman	$3.65	$2.01	$1.31	$0.10	$5.49	$2.32	$6.05	$19.32
Towner	$3.71	$2.09	$1.33	$0.12	$5.33	$2.30	$6.10	$19.32
Traill	$3.58	$2.31	$1.45	$0.14	$4.67	$2.32	$6.05	$19.32
Walsh	$3.50	$2.09	$1.33	$0.12	$5.33	$2.32	$6.05	$19.32
Ward	$3.83	$2.17	$1.33	$0.09	$5.52	$2.32	$5.96	$19.32
Wells	$3.68	$2.01	$1.31	$0.11	$5.49	$2.32	$5.94	$19.32
Williams	$3.81	$2.17	$1.33	$0.09	$5.41	$2.31	NA	$19.08
Average	$3.67	$2.08	$1.36	$0.11	$5.35	$2.32	$5.99	$19.48