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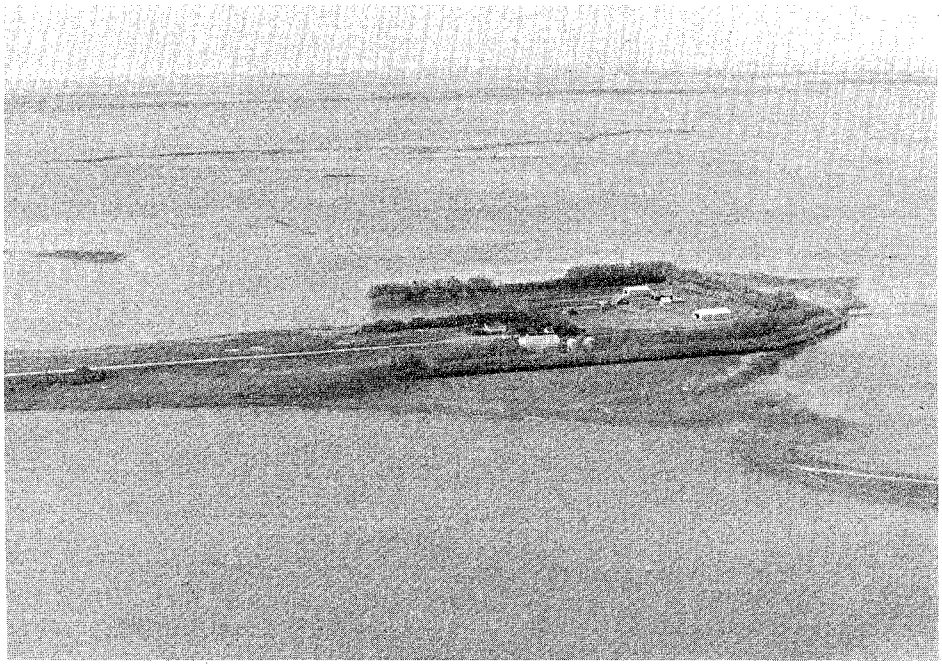
ECONOMIC IMPACT OF FLOODING ON AGRICULTURAL PRODUCTION In Northeast Central North Dakota



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FOREWORD

The Devils Lake Basin is a closed basin in which a number of damaging floods have been recorded in recent decades. Flooding occurs in the spring as a result of snowmelt and in the summer as a result of severe summer rainstorms. The main flood problem in the Basin is damage to agricultural land and crops. This report presents a procedure for estimating flood damages in the Basin and preliminary flood damage estimates are given. Also included are selected statistics on wetland and drainage in the Devils Lake Basin.

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In addition, we appreciate the time and cooperation of residents of the Devils Lake Basin who were interviewed and information provided by other participants in the Devils Lake Basin Study.

The research for this report was part of a project conducted by a team representing state and federal agencies to develop a plan for water management in the Devils Lake Basin.

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Highlights

Two farm operator surveys were conducted in the Devils Lake Basin of North Dakota to collect information on farmer attitudes and dollar losses associated with flooding of agricultural land. A preliminary survey was drawn to assess farm operator attitudes toward wetland, drainage, and flooding; and to identify problem areas relative to collecting information on dollar losses due to flooding. Respondents felt that wetlands were a nuisance to their farm operations and should be drained. One-third of the respondents felt their flood problems were associated with drainage upstream.

A detailed survey was conducted to estimate flood damage on the basis of a composite acre for the Basin. The estimated annual average loss on land that may be affected by flooding in the Devils Lake Basin was $8.71 using long-run price relationships, and $13.03 using 1974 price relationships. The annual average total dollar loss due to flooding in the entire Basin was estimated to be $1.9 million using long-run price relationships, and $2.9 million using 1974 price relationships. A methdology for determining composite flood losses is presented.

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ECONOMIC IMPACT OF FLOODING ON AGRICULTURAL PRODUCTION IN NORTHEAST CENTRAL NORTH DAKOTA

by

Jay A. Leitch and Donald F. Scott*

With an increased concern about the environment in recent years, traditional agricultural land-use practices intended to increase overall productivity have come under scrutiny by various groups. Drainage of agricultural land, once condoned by almost everyone, has become the subject of much controversy in the United States and in North Dakota in particular (Bray, Herbison, Sorenson). All costs and benefits of drainage have not been evaluated in the past, especially when drainage was done by individuals. The costs and benefits of drainage and flood control in the Devils Lake Basin are considered in this report. In addition, various aspects of the flooding and wetland controversy in the Devils Lake Basin are examined.[1]

The Devils Lake Basin, which is divided into nine watersheds, is a subdivision of the Red River Basin encompassing an area of 3,728 square miles in north central North Dakota (Figures 1 and 2). The drainage pattern of the Basin, which is a closed basin, includes numerous streams, some of which interconnect shallow lakes along their lower reaches. The flowage ultimately empties into Devils Lake in the southern part of the drainage area.[2]

The principal flood problem in the Basin is damage to agricultural land and crops. During the spring, floodwaters overflow the banks of low capacity channels and inundate thousands of acres of adjacent cropland. Summer rainstorms also produce stream flows in excess of channel capacities that cause sheetwater flooding. These floods result in serious reductions in agricultural production which in turn have a depressing effect on the economy of the Devils Lake Basin region.

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[1]Much of an earlier version of this report can be found in the Devils Lake Basin Advisory Committee's final report: The Devils Lake Basin Study, Volumes I - IV, Bismarck, North Dakota, October, 1976.

[2]For a discussion of the physical characteristics of the Devils Lake Basin see The Devils Lake Basin Study, Volume I, pp. 17-23.

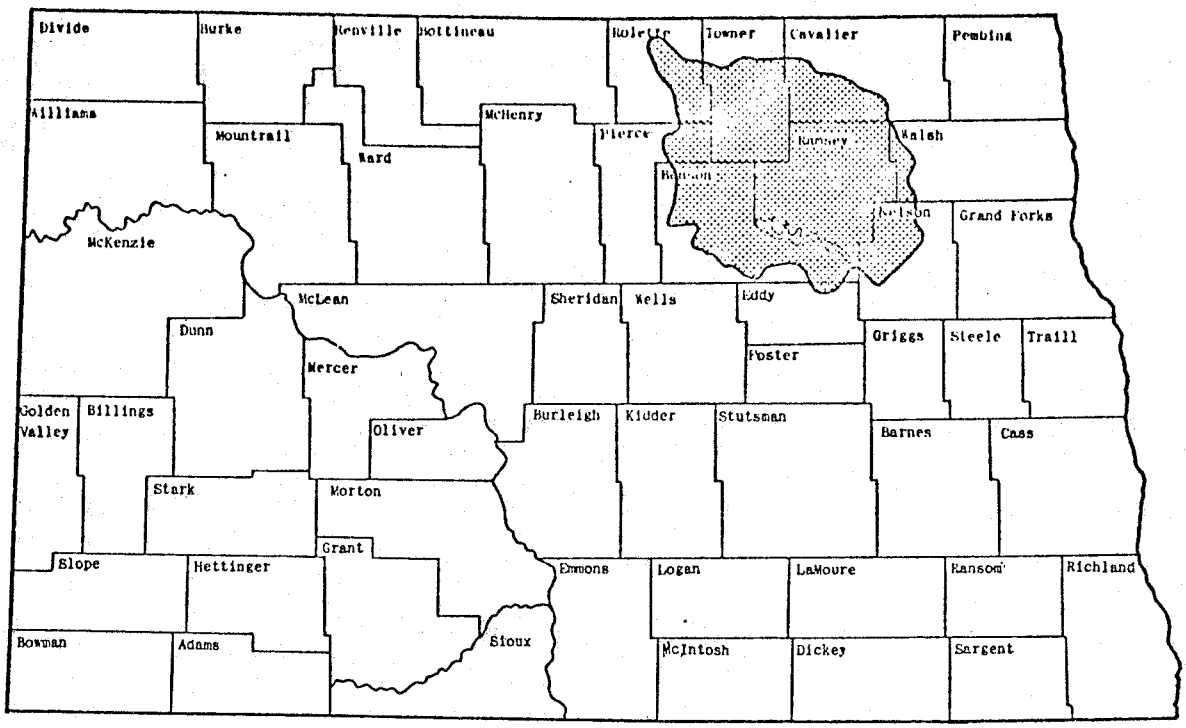
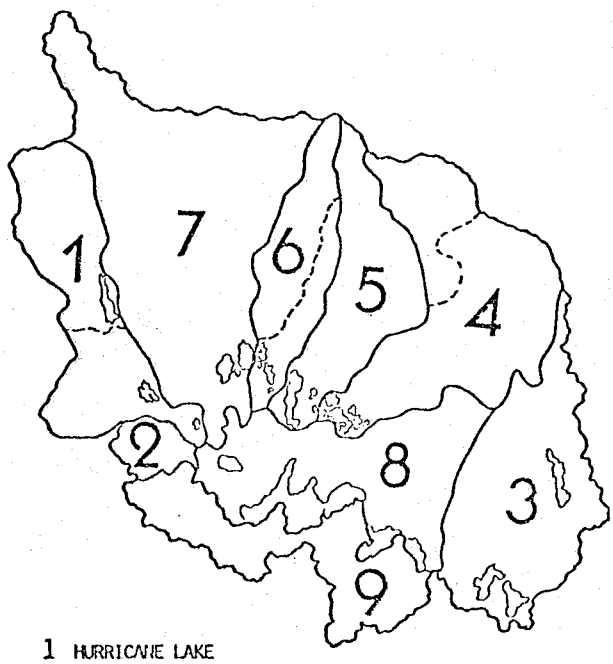


Figure 1. Location of Devils Lake Basin, North Dakota.



1 HURRICANE LAKE
2 COMSTOCK
3 STUMP LAKE
4 EDMORE
5 STARKWEATHER
6 CHAIN LAKES
7 MAUVAIS COULEE
8 DEVILS LAKE
9 SOUTH SLOPE

Figure 2. Watersheds in the Devils Lake Basin.

A number of damaging floods have been recorded in recent decades.[3] There have been attempts by various groups and agencies to develop flood damage reduction plans for many areas in the Basin. However, none of these attempts has been completely successful.

One reason for the lack of success has been the opposition by various groups and agencies to plans that would be detrimental to wildlife production and habitat in the Basin. Besides being one of the nation's prime waterfowl breeding areas, the Devils Lake Basin is very important to waterfowl during migration.

There is a need to develop a plan to reduce flood damages in the Basin that will take into account the conflicting interests of all concerned. The North Dakota State Legislature, recognizing this need, passed House Bill No. 1587 in 1975 to create the Devils Lake Basin Advisory Committee. The responsibility of the Committee was to develop and recommend to the governor a comprehensive plan for water and related resource conservation for the Basin.

An important element in evaluating alternative strategies for reducing flood damages in the Basin is an economic evaluation of those strategies. Ultimately, a final decision will depend heavily on a comparison of the economics of alternative strategies.

The purpose of this report is two-fold: (1) to present the results of two farm operator surveys designed to assess attitudes about wetlands and obtain information related to flood damages; and (2) to use that data to develop the necessary information to evaluate alternative flood plans for the Basin.

Preliminary Survey of Farm Operators in the Devils Lake Basin

A preliminary survey was conducted to identify farm operators and landowners in the Devils Lake Basin who would be willing to participate in a follow-up survey by providing detailed information on flood damages, costs of drainage, and wildlife losses and to obtain information on:

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[3]For a discussion of the history of flooding and past investigations see: The Devils Lake Basin Study, Volume I, pp. 107-115.

1) agricultural losses in the Basin resulting from flooding over the period 1966-1975;
2) attitudes toward wetland and the drainage of wetland;
3) the extent of awareness of the work of the Devils Lake Basin Advisory Committee and attitudes concerning that effort.

For the purpose of the preliminary survey, farm operators and landowners were identified on the basis of a 2 percent random sample of quarter sections in the state that were used in the 1967 Conservation Needs Inventory (CNI) survey. Two hundred nineteen quarter sections in the Basin were included in the sample. Information relating to 181 quarter sections was obtained and forms the basis for part of this report.[4]

In those instances where the quarter section was rented or farmed by someone other than the landowner, an effort was made to contact the farm operator. It was believed that he would be in a better position to respond to the questionnaire. In some instances more than one individual farmed a quarter section so that 190 individuals participated in the preliminary survey (Table 1).

TABLE 1. NUMBER OF FARMERS AND LANDOWNERS IN THE DEVILS LAKE BASIN PARTICIPATING IN PRELIMINARY FARM OPERATOR SURVEY

Watershed[a]	Number of Respondents	County	Number of Respondents
Hurricane Lake	28	Benson	30
Comstock	7	Cavalier	14
Stump Lake	26	Eddy	0
Edmore	23	Nelson	20
Starkweather	14	Pierce	9
Chain Lakes	7	Ramsey	48
Mauvais Coulee	57	Rolette	20
Devils Lake	15	Towner	44
South Slope	13	Walsh	5
Total	190		190

[a]See Figure 2.

[4]A distinction must be made between this survey and the second survey which sought more detailed information on flood related occurrences. The preliminary survey was a random sample of all farm operators in the Devils Lake Basin. The second survey was not random since participants were volunteer respondents from the original sample.

Awareness of Devils Lake Basin Study

Farm operators were asked if they knew of the Devils Lake Basin Advisory Committee and the study being done by that Committee. Sixty-two percent (118) indicated they were aware of the Committee and the effort being undertaken, 38 percent of the respondents (71) indicated they were not, and one respondent did not answer the question. Approximately 78 percent of the respondents who expressed an opinion concerning the Devils Lake Basin study approved of the effort while only 3 percent disapproved (Table 2).

TABLE 2. FEELINGS OF SURVEYED FARM OPERATORS TOWARD THE DEVILS LAKE BASIN STUDY[a]

Feelings Toward Study	Number of Respondents	Percent of Respondents
Strongly Approve	2	1.3
Approve	116	76.8
No Feelings One Way or Another	28	18.6
Disapprove	5	3.0
Strongly Disapprove	0	0.0
Total	151	100.0

[a]The "no answer" responses were excluded from the analysis.

Those who approved of the study did so either because of flood problems experienced in the Basin and the fact that better flood relief measures were needed, or because they felt that compromises between wildlife interests and agricultural interests in the Basin were necessary. Reasons for disapproval included the concern that higher taxes would result from the recommendations made by the Advisory Committee. Concern was also expressed that problems in the Basin would not be solved through the efforts of the Advisory Committee (Appendix A).

Awareness and Participation in Wildlife and Water-Oriented Programs

Respondents' knowledge of wildlife and water-oriented programs was quite high (Table 3). Approximately 97 percent of the respondents indicated they were aware of the U.S. Fish and Wildlife Service Easement and Fee Title programs. About 89 percent of the respondents indicated they were aware of the Water Bank program, and about 65 percent indicated an awareness of the

TABLE 3. AWARENESS AND PARTICIPATION OF SURVEYED FARM OPERATORS IN THE DEVILS LAKE BASIN IN WILDLIFE AND WATER-ORIENTED PROGRAMS

Program	Knowledge of Program		Participation in Program	
	Number of Respondents	Percent of Respondents	Number of Respondents	Percent of Respondents
U.S. Fish & Wildlife Service Easement & Fee Title Programs	184	96.8	76	40.0
Water Bank	169	88.9	16	8.4
Pilot Lure Crop	123	64.7	0	0.0

pilot lure crop program. Forty percent of the respondents indicated they had participated in the Easement and Fee Title programs, while approximately 8 percent of the respondents indicated they had participated in the Water Bank program. None of the respondents indicated participation in the pilot lure crop program.

Wetland and Drainage

Farmers expressed their feeling regarding wetland by providing a numerical ranking for a number of statements related to wetland (1 for most important, 2 for next most important, and so on). In many instances the same ranking was given to more than one statement. The statement ranked as most important by the largest number of respondents was that wetland creates a nuisance to farm operations (Table 4). Other statements that were ranked most important by many respondents were that wetland creates a flooding problem and that it provides habitat for wildlife. Six respondents ranked as most important the statement that they were not concerned about wetland.

Approximately 76 percent of the respondents felt wetland is a nuisance to farm operations. About 37 percent of the respondents felt wetland creates flooding problems and approximately 34 percent felt wetland provides habitat for wildlife. Less than 4 percent of the respondents indicated no concern about wetland.

Wetland provides many of the surveyed farmers with an opportunity to participate in outdoor recreational activities. Forty-four percent (84 respondents) used wetland for their own hunting or other recreational purposes. Four percent (7 respondents) indicated they had realized income from the sale of hunting privileges.

TABLE 4. FEELINGS OF SURVEYED FARM OPERATORS IN THE DEVILS LAKE BASIN REGARDING WETLAND

Statement	Degree of Importance[a]					Total Number[b] of Responses	Percent of Respondents
	Most Important	Second Most Important	Third Most Important	Fourth Most Important	Least Important		
	number of responses						
Not Concerned About Wetland	6	1	--	--	--	7	3.7
Water Supply for Livestock	16	10	2	--	1	29	15.3
Groundwater Recharge	14	13	3	1	--	31	16.3
Create a Nuisance to Farm Operation	123	18	3	--	--	144	75.8
Considered Part of Our Natural Landscape	18	15	7	2	--	42	22.1
Create a Flooding Problem	47	13	9	1	--	70	36.8
Provide Habitat for Wildlife	43	7	10	4	1	65	34.2
Create a Salt Problem	5	27	3	--	--	35	18.4

[a]Some respondents gave the same ranking to more than one statement.
[b]Respondents not expressing an opinion on one or more wetland statements were obviously not concerned or affected by that particular statement.

Occurrence and Drainage of Wetland

Approximately 91 percent of surveyed farmers indicated that their quarter section has contained wetland (Table 5). No distinction was made between different types of wetland. Forty-four percent of the farmers (83) indicated they had drained wetland on the quarter section. Seventy-four percent indicated they would like to see drainage of wetland on the quarter section in any plans that might be developed for the Basin.

TABLE 5. NUMBER OF FARMERS SURVEYED IN EACH WATERSHED WHOSE QUARTER SECTION HAS CONTAINED WETLAND, WHO HAVE DRAINED, AND WHO WOULD LIKE TO DRAIN WETLAND

Watershed	Quarter Section Has Contained Wetland		Have Drained on Quarter Section		Would Like to Drain On Quarter Section	
	Number	Percent of Respondents	Number	Percent of Respondents	Number	Percent of Respondents
Hurricane Lake	26	92.9	12	42.9	20	71.4
Comstock	7	100.0	2	28.6	6	85.7
Stump Lake	22	84.6	8	30.8	21	80.8
Edmore	22	95.6	11	47.8	19	82.6
Starkweather	13	92.9	11	78.6	14	100.0
Chain Lakes	7	100.0	4	57.1	6	85.7
Mauvais Coulee	49	86.0	26	45.6	35	61.4
Devils Lake	14	93.3	6	40.0	11	73.3
South Slope	12	92.3	3	23.1	8	61.5
Total	172	90.5	83	43.7	140	73.7

Those individuals who indicated they would like to drain wetland would do so to bring more land into production and/or for convenience of farming operations. Several reasons were given by those individuals who did not wish to drain. Some considered wetland a part of the natural landscape, some indicated that wetland provides water for livestock, others felt wetland is a source of groundwater recharge, while others used wetland for hunting or other recreational purposes.

Water from existing and potential drainage projects is disposed of several ways. The most common would be to drain into a natural coulee and the least common into an existing artificial drain (Table 6). Drainage into existing marshes is also quite prevalent.

A majority of the respondents (82 percent) felt that drainage from the quarter section would not cause flooding problems downstream. Approximately one-third (35 percent) of the respondents felt their flood problems were associated with drainage upstream.

TABLE 6. MODE OF DISPOSAL OF WATER FROM EXISTING OR POTENTIAL DRAINAGE PROJECTS ON QUARTER SECTION SAMPLES[a]

Mode of Disposal	Number of Respondents
Road Ditch	10
Natural Coulee	103
Artificial Drain	7
Another Marsh	53
Other[b]	22
Total	195

[a]Some respondents indicated more than one mode of disposal.
[b]A local lake was the most frequent answer given in this category.

Agricultural Losses Resulting From Flooding

Agricultural losses resulting from flooding in the Devils Lake Basin may occur as the result of floods that delay or prevent seeding in the spring or sheetwater flooding after crops have been seeded. Approximately three-fourths of the farmers who responded to the first survey had flood problems that delayed or prevented seeding in the past 10 years, while about 77 percent of those who responded experienced crop losses after seeding as a result of flooding in the past 10 years. The average number of years (average for farms with flooding) between 1966 and 1975 that flooding delayed or prevented seeding was 5.1 years (Table 7). The average number of years (average for farms with flooding) between 1966 and 1975 that flooding caused losses after seeding was 3.6 years.

Flooding That Delayed or Prevented Seeding

Respondents were asked to estimate the average annual dollar losses on the quarter section samples for the years in which flood problems delayed or prevented seeding. These estimates are not presented here for several reasons. First, the losses represent average dollar losses over a 10-year period and no specific year was used for basing prices. In addition, respondents were being asked to provide information related to a 10-year time period on something for which few records are kept. A good deal of judgment and "guesswork" on the part of the respondents was, therefore, involved. However, since the information may be useful in considering the relative severity of flood damages between watersheds and counties, the losses have been indexed for the purpose of making comparisons.

TABLE 7. NUMBER OF YEARS BETWEEN 1966 AND 1975 THAT FLOODING DELAYED OR PREVENTED SEEDING OR CAUSED CROP LOSSES AFTER SEEDING IN THE DEVILS LAKE BASIN

No. of Years	Flooding Delayed or Prevented Seeding		Flooding Caused Crop Losses After Seeding	
	Number of Respondents	Percent of Respondents	Number of Respondents	Percent of Respondents
0	47	26.6	32	23.3
1	10	5.6	14	10.2
2	22	12.4	27	19.7
3	21	11.9	28	20.4
4	13	7.3	10	7.3
5	17	9.6	10	7.3
6	4	2.3	2	1.5
7	9	5.1	2	1.5
8	11	6.2	6	4.4
9	6	3.4	2	1.5
10	17	9.6	4	2.9
Total	177	100.0	137	100.0
Average Years[a]	5.1		3.6	

[a]Average years in 10 for those that had flooding.

Respondents in Ramsey County and Starkweather Watershed had the highest average dollar loss due to flooding before seeding (Table 8). Rolette County and the South Slope Watershed had the lowest average dollar loss due to flooding before seeding.

The frequency of flooding before seeding ranged from "never" to "every year" between 1966 and 1975. The average number of years that flooding delayed or prevented seeding over the 10-year period was 5.1 years--with Pierce County having the highest occurrence, 6.7 years, and respondents in Cavalier County having the lowest occurrence, 3.9 years out of 10.

Flooding After Seeding

Estimates of the average annual dollar value of losses in the sample of quarter sections for the period 1966-1975 in which flooding was a problem after seeding were provided by respondents. These estimates are not presented for the same reasons as outlined in the preceding section. In addition, it is possible that when respondents estimated average losses

TABLE 8. RELATIVE DOLLAR LOSS TO SURVEYED FARMERS IN THE DEVILS LAKE BASIN DUE TO FLOOD PROBLEMS THAT DELAYED OR PREVENTED SEEDING AND FREQUENCY OF OCCURRENCE, 1966-1975

Location	(1) Relative Annual Dollar Loss Index (Basin Average = 100)	(2) No. of Years in 10 That Flooding Before Seeding Occurred	(3) 10-Year Relative Loss (1 X 2)
County			
Ramsey	133	5.5	731
Nelson	116	4.8	557
Walsh	113	4.7	531
Cavalier	103	3.9	402
Devils Lake Basin	*100*	*5.1*	*510*
Benson	77	4.4	339
Pierce	69	6.7	462
Towner	47	4.8	226
Rolette	45	5.4	243
Watershed			
Starkweather	161	5.0	805
Stump Lake	138	5.1	704
Edmore	114	5.5	627
Comstock	110	5.8	638
Devils Lake Basin	*100*	*5.1*	*510*
Chain Lakes	89	3.4	303
Devils Lake	69	5.4	373
Mauvais Coulee	66	4.6	304
Hurricane Lake	55	5.4	297
South Slope	48	4.7	226

due to flooding after seeding, they also included losses before seeding which would cause some double counting to occur and result in inflated losses. The losses have been indexed and are presented in Table 9.

Ramsey County and Devils Lake Watershed respondents had the highest relative losses due to flooding after seeding on the quarter section samples (Table 9). The frequency of occurrence was 4.4 years out of 10 in Ramsey County, the highest of any county in the sample. For the Basin, the average years of occurrence in 10 was 3.6.

Rolette County and South Slope Watershed respondents experienced the lowest relative average dollar loss due to flooding after seeding between 1966 and 1975. The frequency of occurrence was lowest in Benson County and in South Slope Watershed with 2.9 and 2.3 years out of 10, respectively (Table 9).

TABLE 9. RELATIVE DOLLAR LOSS TO SURVEYED FARMERS IN THE DEVILS LAKE BASIN DUE TO FLOOD PROBLEMS AFTER SEEDING AND FREQUENCY OF OCCURRENCE, 1966-1975

Location	(1) Relative Annual Dollar Loss Index (Basin Average = 100)	(2) No. of Years in 10 That Flooding Before Seeding Occurred	(3) 10-Year Relative Loss (1 X 2)
County			
Ramsey	147	4.4	647
Walsh	123	4.0	492
Cavalier	110	3.1	341
Devils Lake Basin	*100*	*3.6*	*360*
Nelson	98	3.2	
Benson	66	2.9	191
Pierce	56	3.6	202
Towner	49	3.0	147
Rolette	14	3.8	53
Watershed			
Devils Lake	181	4.6	833
Starkweather	147	3.6	529
Chain Lakes	122	4.0	488
Stump Lake	121	3.7	448
Edmore	100	3.8	380
Devils Lake Basin	*100*	*3.6*	*360*
Comstock	94	4.0	376
Mauvais Coulee	54	3.2	173
Hurricane Lake	43	3.0	129
South Slope	33	2.3	76

Other Agricultural Losses

Other water related types of losses farm operators were asked to respond to were (1) wet weather in harvest, (2) wildlife, and (3) hunters.

Wet weather in harvest caused some losses to surveyed farm operators on the quarter section samples between 1966 and 1975. Wet weather in harvest occurred an average of 2.7 years over the 10-year period. About one-half of the surveyed farm operators indicated a loss due to wet weather in harvest over this time period.

Fifty-five percent of the respondents indicated they experienced crop losses due to wildlife between 1966 and 1975. Wildlife caused damage as often as every year to only one year in ten on those quarter sections that had wildlife damage. Ramsey County farmers had the highest relative

annual dollar loss (Table 10). Walsh County, however, had the most frequent damage by wildlife. The 10-year relative loss was highest for Walsh County due to the high frequency of occurrence. Surveyed farm operators in Pierce County did not provide estimates of dollar losses although they indicated damages occurred 1.7 years out of 10, the least frequent of the 8 counties.

TABLE 10. RELATIVE DOLLAR LOSS TO SURVEYED FARMERS IN THE DEVILS LAKE BASIN DUE TO WILDLIFE DAMAGE AND FREQUENCY OF OCCURRENCE, 1966-1975

Location	(1) Relative Annual Dollar Loss Index (Basin Average = 100)	(2) No. of Years in 10 That Wildlife Damage Occurred	(3) 10-Year Relative Loss (1 X 2)
County			
Ramsey	135	5.1	688
Walsh	130	8.3	1,079
Nelson	110	6.0	660
Devils Lake Basin	*100*	*5.3*	*530*
Towner	82	6.7	549
Cavalier	79	4.3	340
Benson	74	5.2	384
Rolette	46	3.7	170
Pierce	a	1.7	---
Watershed			
Devils Lake	175	5.4	945
Edmore	149	4.2	626
Stump Lake	127	6.2	787
Devils Lake Basin	*100*	*5.3*	*530*
Mauvais Coulee	83	6.6	548
Chain Lakes	80	5.7	456
Hurricane Lake	78	4.2	328
Starkweather	62	4.4	273
Comstock	59	2.3	136
South Slope	32	5.5	176

[a]No estimates given by respondents.

The Devils Lake Watershed was most affected of the nine watersheds with the highest annual index of damages and the highest 10-year index. South Slope Watershed respondents had the lowest relative annual dollar loss. Comstock Watershed had the lowest frequency of occurrence and the lowest 10-year index.

Care must be taken in interpreting the data on crop losses due to wildlife. The estimates provided by the farm operators involved considerable speculation. In addition, such losses are highly variable from year to year. Unlike flood damages which generally occur in the same locations, wildlife depredation occurs in different areas depending on weather during harvest. Another precaution that should be noted is that the number of respondents in each county or watershed is quite small. The degree of confidence diminishes with the sample size.

Hunters cause some damage on 15 percent of the 181 quarter sections for which information was obtained. The average dollar loss due to hunters was approximately one-half the damage due to wildlife and occurred only one-third as often as wildlife damage.

Flood Damages, Wetland Use, and Crop Losses To Wildlife in the Devils Lake Basin

A second farm operator survey was conducted in the Basin to collect information on cropping practices on flood affected land, wetland use, the cost of drainage, and wildlife depredation of crops. Information was collected for five crop years: 1971 through 1975. As indicated in the previous section, flood damage information obtained from the preliminary survey could not and was not intended to be used to determine specific monetary flood losses. The second survey was designed for that purpose.

Survey Procedure

Respondents to the preliminary survey who expressed a willingness to cooperate in a more detailed questionnaire were asked to attend one of several meetings held in the Devils Lake Basin to complete the questionnaire.[5] Questionnaires were mailed to those individuals not attending one of the meetings. A total of 69 questionnaires were completed.

Sixty-four respondents were owners or operators of part of the 219 quarter sections from the 1967 Conservation Needs Inventory. Five respondents whose land was not part of the CNI sample completed survey forms and the information they provided was included in the analysis.

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[5]One hundred seventy-one respondents to the preliminary survey expressed a willingness to cooperate in the second survey. Meetings were held February 9-12, 1976, at Leeds, Rolla, Cando, Starkweather, Munich, Nekoma, Lakota, and Devils Lake.

Although the sample lacked randomness regarding flood problems, respondents were evenly distributed geographically throughout the Basin.[6] Each of the nine watersheds and 8 of 9 counties in the Basin were represented by three or more respondents (Table 11). There were no respondents from Eddy County, but only 0.55 percent of that county's land area is in the Basin.

Surveyed farmers operated 108,249 acres of land, or 4.43 percent of the total land area in the Basin. Respondents indicated 82,941 acres were cropland, which is 4.78 percent of the Basin's cropland.

Wetland

Surveyed farm operators indicated there were 7,929 acres of wetland on the land they farm (Table 12). Wetland was classified by type of wetland (A, B, or C). For comparison with the classification scheme used by the U.S. Fish and Wildlife Service, Type "A" wetland corresponds to Type I wetland that is generally only wet in spring. Type "B" wetland corresponds most closely to Type III wetland or wetland generally deep enough to hold water until midsummer. Type "C" wetland corresponds most closely to Type IV and V wetland or the deeper wetland that generally holds water all year. There were 5,647 acres of wetland in cropland, and this respresents 6 percent of the total cropland in the survey. Respondents in Stump Lake Watershed indicated 14.5 percent of their cropland was wetland, while Comstock Watershed respondents indicated they did not have any wetland on their farms. For cropland areas, there were 2,854 acres of wetland that "generally hold water only in the early spring;" 1,850 acres of wetland that "generally hold water until midsummer;" and 943 acres that "generally hold water all year." Nine percent of the pasture was identified as wetland of one of the three types.

Participation in Wetland Programs

Surveyed farm operators indicated 13.3 percent of land they farmed was committed to some type of wetland program with U.S. Fish and Wildlife

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[6]The purpose of this survey was to collect information on the impact of flooding on crop production. It was not intended as a sample to expand to a larger area.

TABLE 11. DISTRIBUTION OF SURVEYED FARM OPERATORS, ACRES OF LAND OPERATED, AND CROPLAND ACRES BY WATERSHED AND COUNTY

Location	Percent of Devils Lake Basin Land Area	Respondents		Total Area in Farm Operation		Cropland Area in Farm Operation	
		Number	Percent of Respondents	Acres	Percent of Area	Acres	Percent of Area
County							
Benson	17.6	8	11.6	34,492	31.9	20,575	24.8
Cavalier	9.1	6	8.7	6,400	5.9	5,989	7.1
Eddy	.5	0	--	0	--	0	--
Nelson	8.9	5	7.2	4,852	4.5	4,267	5.1
Pierce	2.9	4	5.8	5,780	5.3	5,018	6.1
Ramsey	32.7	20	29.0	24,606	22.7	21,801	26.3
Rolette	5.8	8	11.6	10,459	9.7	8,080	9.7
Towner	18.9	14	20.3	16,220	15.0	14,290	17.2
Walsh	3.3	4	5.8	3,440	3.2	3,012	3.6
Total	100.0	69	100.0	108,249	100.0	82,941	100.0
Watershed							
Hurricane Lake	11.0	9	13.0	11,689	10.8	9,118	8.4
Comstock	1.5	3	4.3	5,372	5.0	5,095	6.1
Stump Lake	12.8	7	10.1	7,772	7.2	6,644	8.0
Edmore	13.1	12	17.4	10,838	10.0	9,518	11.5
Starkweather	10.3	9	13.0	12,915	11.9	12,354	14.9
Chain Lakes	6.1	3	4.3	2,800	2.6	2,650	3.2
Mauvais Coulee	23.1	18	26.1	27,470	25.4	21,650	26.1
Devils Lake	13.4	5	7.2	5,773	5.3	4,612	5.6
South Slope	8.6	3	4.3	23,620	21.8	11,300	13.6
Total	100.0	69	100.0	108,249	100.0	82,941	100.0

TABLE 12. ACRES OF WETLAND BY TYPE ON SURVEY AREA FOR EACH WATERSHED

Watershed	Wetland by Type[a] in Cropland				Wetland by Type in Pasture				All
	"A"	"B"	"C"	Total % of Cropland	"A"	"B"	"C"	Total % of Pasture	Wetland % of All Land
	acres								
Hurricane Lake	175	255	220	650 7.1%	15	97	10	122 4.7%	772 6.1%
Comstock	0	0	0	0 --	0	0	0	0 --	0 --
Stump Lake	120	574	268	962 14.5%	0	56	11	67 5.9%	1,029 13.2%
Edmore	295	318	175	788 8.3%	55	150	0	205 15.5%	993 9.1%
Starkweather	540	125	25	690 5.6%	10	0	5	15 2.6%	705 5.4%
Chain Lakes	35	20	10	65 2.4%	0	0	0	0 --	65 2.3%
Mauvais Coulee	1,024	453	211	1,688 7.8%	1,190	405	145	1,740 29.8%	3,428 12.4%
Devils Lake	165	70	34	269 5.8%	7	10	16	33 2.8%	302 5.2%
South Slope	500	35	0	535 4.7%	100	0	0	100 1.0%	635 2.6%
Total Acres Average %	2,854	1,850	943	5,647 6.0%	1,377	718	187	2,282 9.0%	7,929 7.3%

[a]Type "A": "Generally hold water only in the early spring."
"B": "Generally hold water until midsummer."
"C": "Generally hold water all year."

Service easements accounting for 12.7 percent (Table 13). Twenty-two respondents (32 percent) had all or part of their farming operation in a wetland program.[7]

TABLE 13. LAND ON SURVEYED FARM OPERATIONS COMMITTED TO WETLAND PROGRAMS

Wetland Program	Acres Committed	Percent of Land in Survey
U.S. Fish and Wildlife Service Easement	13,730	12.70
U.S. Fish and Wildlife Service Fee Title[a]	40	.03
Water Bank Wetland	415	.38
Water Bank Dryland	240	.22
Total	14,425	13.33

[a]Land sold to the U.S. Fish and Wildlife Service and no longer a part of the farm operation.

Wetland Drainage

Surveyed farm operators indicated a desire to drain 36 percent of their existing wetland (Table 14). Respondents from Edmore Watershed would like to drain 83 percent of their wetland, while respondents from Devils Lake Watershed expressed no desire for further drainage.

Respondents indicated they had drained wetland on their farms as early as 1945. Drainage occurred at a slow but steady rate until 1965 when it began to accelerate. During the 1970's drainage on the surveyed area averaged about 130 acres annually, or about 2 percent of the existing wetland area per year.

The cost of draining wetland varies considerably due to differences in topography, equipment used, and labor required. For instance, a shallow ditch only a few yards long may be all that is required to drain a several

[7]Easement - 18, Fee Title - 1, Water Bank wetland - 6, Water Bank dryland - 5 (some respondents had land committed to more than one program).

TABLE 14. NUMBER OF ACRES OF WETLAND RESPONDENTS WOULD LIKE TO DRAIN BY TYPE OF WETLAND AND WATERSHED

Watershed	Wetland Type "A"	"B"	"C"	Total	Percent of Total Wetland in Survey Area Owners Would Like to Drain
	- - - - - *acres* - - - - -				
Hurricane Lake	105	165	230	500	65.0
Comstock	0	0	0	0	0.0
Stump Lake	93	336	37	466	45.0
Edmore	315	323	190	828	83.0
Starkweather	137	90	15	242	34.0
Chain Lakes	0	0	5	5	8.0
Mauvais Coulee	432	255	63	750	22.0
Devils Lake	0	0	0	0	0.0
South Slope	0	35	0	35	5.0
Total	1,082	1,204	540	2,826	36.0

acre wetland, or a deep ditch hundreds of yards long may be necessary to drain a smaller wetland. Estimates of hourly equipment and labor costs are provided in Table 15.

TABLE 15. ESTIMATED EQUIPMENT AND LABOR COSTS FOR WETLAND DRAINAGE, 1974

Equipment Type	Cost Per Hour Equipment[a]	Labor[b]	Total
Four-Wheel-Drive Tractor with Small Scraper	$ 9.12	$2.30	$11.42
Self-Propelled Scraper	$17.36	$6.00	$23.36
Crawler or Four-Wheel-Drive Tractor with Dozer	$15.80	$6.00	$21.80

[a] Equipment Rental Rates, 1974, North Dakota State Highway Department.
[b] North Dakota State Employment Service, Fargo, Personal Communication, April 1, 1976.

Surveyed farm operators provided estimates of what equipment and labor were required to drain wetland on their farms. Drainage costs were estimated using the hourly equipment and labor requirements provided by surveyed farm

operators. The average estimated cost to drain an acre of type "A", "B", and "C" wetland was $11.24, $14.18, and $18.56, respectively. The average cost to drain all wetland types was estimated to be $14.00 an acre.[8]

Drained wetland would be used primarily to raise durum and other spring wheat. The mix of crops on wetland was similar to the composite acre developed for May 1.[9] Many respondents said they would seed a variety of crops on the wetland areas if they were drained.

Use of Existing Wetland

Wetland that has not been drained may be cropped in years it is dry. Production from type "A" wetland that is dry in time to seed can be as good, if not better, than adjacent dryland due to moisture retention. Respondents indicated they would have to perform some additional production practices on wetland before seeding it. For example, additional cultivation may be required on wetland that was not cropped the previous year to eliminate weed growth or to help dry them out. Additional production expenditures are, therefore, usually incurred in farming wetland. Table 16 presents information regarding the frequency of farming wetland and the additional production practices required to farm them. Type "A" wetland, for instance, requires two production practices (i.e., tillage) in addition to those practices the farm operator would normally do on dryland.

TABLE 16. NUMBER OF YEARS IN 10 THAT WETLAND CAN BE FARMED AND ADDITIONAL PRODUCTION PRACTICES REQUIRED

Wetland Type	Average Number of Years in 10 Wetland Can be Farmed[a]	Additional Production Practices Required
"A" (Hold Water Only in Early Summer)	5.8	2
"B" (Hold Water Until Midsummer)	3.1	2
"C" (Hold Water All Year)	2.1	3

[a]Brown (1976) reports that Types I (A), III (B), and IV/V (C) wetland can be farmed 7, 3, and no years out of 10, respectively.

[8]See Goldstein (1971) for a discussion of the problem of estimating drainage costs.

[9]See page 30 for a discussion of the May 1 composite acre.

Wildlife

Crop depredation by wildlife is frequently a problem in the Devils Lake Basin (Bray, Herbison). Three factors contribute to the problem. First, three flyways cross the Basin, bringing large numbers of waterfowl through the area each spring and fall. Second, the Basin is in the prairie pothole region of North America, which attracts scores of species of breeding waterfowl and shore birds. And third, the crops grown and the manner in which they are harvested are conducive to depredation. That is, small grains make up the majority of the crops grown, and these crops are swathed in the fall when migrations of waterfowl begin.

Most of the respondents, 87 percent, indicated wildlife use the wetland on their farm. Nine percent of those said just ducks use their wetland, while the rest said two or more kinds of wildlife use the wetland on their farm.

Losses to Wildlife

About one-half of the respondents indicated they had experienced losses due to wildlife in each year between 1971 and 1975 (Table 17). Ducks, geese, and blackbirds were the types of wildlife causing most of the damage, while deer caused some damage to haystacks.

TABLE 17. SURVEYED FARM OPERATORS WITH WILDLIFE LOSSES, 1971-1975[a]

Year	Number of Respondents with Wildlife Loss	Percent of Respondents
1975	31	41.9
1974	45	60.8
1973	37	50.0
1972	36	48.6
1971	32	43.2
5-Year Average	36	48.6

[a]Sixty-nine respondents completed all portions of the survey, and 5 respondents completed only that portion of the survey dealing with wildlife.

Surveyed farmers who had depredation problems were asked to estimate the number of bushels of crop lost to wildlife. Durum and other spring wheat appear to be the crops most affected by wildlife. In 1974, the year of

greatest losses, the average loss (using 1974 prices) was slightly over $2,780 per farm, or $1.77 an acre for the average size sample farm of 1,568 acres. Sorenson reported the loss per farm in nearby Stutsman County to be $73 in 1973. Although losses to wildlife represent a hardship to farm operators in the Basin, they are the hardest loss to specify in monetary terms.

Countermeasures to Prevent Crop Depredation

Countermeasures to reduce depredation were used by 80 percent of the respondents who indicated wildlife damage to crops. Guns were the single most often used countermeasure (Table 18). A combination of guns, exploders, scarecrows, and chasing was used by many of the respondents in attempts to keep wildlife from causing damage to crops. The countermeasures were effective for about one-half of those who used them although they were never completely effective.

TABLE 18. USE AND EFFECTIVENESS OF COUNTERMEASURES TO PREVENT DEPREDATION ON SURVEYED FARM OPERATIONS

Type of Countermeasure	Number of Respondents	Effective[a]	
		Yes	No
Guns	14	6	6
Exploders[b]	2	1	1
Scarecrows[b]	6	5	1
Chasing	2	--	--
A Combination of the Above	28	13	15
Total	52	25	23

[a]Respondents indicated countermeasures were effective to some degree. Some said they were not effective but worked somewhat, others said they were effective but only part of the time. Therefore, a "yes" or "no" answer is somewhat misleading.
[b]Scarecrows were effective if put up in advance of depredation.

Nine respondents indicated they had requested assistance from someone in the use of countermeasures. Assistance ranged from obtaining shotgun shells to exploders and advice on the use of various countermeasures.

Lure crops - the practice of planting crops specifically to lure wildlife away from other crops, were used by three respondents. One respondent said it was an effective method of reducing depredation.

Wetland Leasing for Hunting

Three respondents had leased their wetland for hunting purposes in the period 1971-1975. One had leased his wetland one year, one for two years, and the third had leased wetland all five years. The average income received for leasing wetland for hunting was $175 per year per farm.

Furbearer Harvest

Thirteen respondents harvested furbearers on their property between 1971 and 1975. Six of those had taken furbearers every year in the past five, and the average yearly income was $130.

Saline Problems

Seventy-two percent of the surveyed farm operators indicated they had experienced saline problems on some part of their farm.[10] The size of the area affected ranged from 2 acres to 250 acres. The total acreage affected was 3,122 acres (Table 19). This represents 3.7 percent of the cropland in the survey sample. The Land Use Task Force of the Devils Lake Basin Study identified 2.5 percent of the land in the Basin as being affected by saline conditions.[11]

Small areas affected by saline conditions are a nuisance to farm operations and cause lower yields for crops grown where those conditions exist. On larger areas where saline conditions exist, a salt resistant crop is usually planted. Of the small grains grown in the Basin, barley is the most resistant to salt. Surveyed farm operators indicated they seeded barley more frequently than any other crop where saline conditions exist (Table 20). Flax is the least resistant crop to salt and was not reported as being seeded on salt affected areas by respondents.

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[10] Saline problems in this part of North Dakota consist of excessive amounts of soluable salt in the soil. For a discussion of salt problems, see Salt Affected Problem Soils In North Dakota, Ext. Bulletin No. 2, North Dakota State University, 1967.

[11] The Devils Lake Basin Study, p. 47.

TABLE 19. NUMBER OF ACRES IDENTIFIED BY SURVEYED FARM OPERATORS THAT ARE AFFECTED BY SALINE CONDITIONS BY YEAR OF DEVELOPMENT

Year Problem Began	Number of Separate Saline Areas	Number of Acres Affected
Prior to 1966	25	1,272
1967	1	32
1968	2	20
1969	2	330
1970	7	640
1971	8	474
1972	3	77
1973	1	2
1974	2	160
No Year Indicated	3	115
	54	2,122

TABLE 20. CROPS SEEDED BY SURVEYED FARM OPERATORS ON AREAS AFFECTED BY SALINE CONDITIONS AND THE AVERAGE YIELD REDUCTION THAT OCCURRED

Crop	Percent of Salt Affected Area Seeded	Percent Average Yield Reduction	Salt Resistance Rank[a]
Durum	11.0	55.0	4 (least resistant)
Other Spring Wheat	6.0	59.0	3
Oats	6.0	48.0	2
Barley	38.0	51.0	1 (most resistant)
Hay	1.0	37.0	-
Not Specified[b]	38.0	58.0	-
	100.0	55.0 average	

[a]Relative resistance to salt for crops listed. See North Dakota . . . Crop Rotations for Profit. Ext. Bull. No. 114, North Dakota State University.

[b]Crops seeded on saline areas would vary from year to year accounting for percentage of "not specified."

Survey results indicate the average yield reduction as a result of saline conditions is about 55 percent (Table 20). A yield reduction of this size would put the farm operator near the break-even point (using the long-run costs and returns developed in this report) on that particular area. However, it may be just as profitable and more convenient to seed saline areas as to leave them in summer fallow or convert them to grass.

Flood Problems Before Seeding

Flood problems that delay or prevent seeding are costly to the farm operator and to the Basin's economy. Flooding lowers yields and quality, causes higher production costs, and/or increases summer fallow acreage. Flooding before seeding in the Basin usually occurs from April to June with a peak in May, depending on spring runoff. Flooding before seeding affected nearly 16,000 acres of the sample area in 1974, and nearly 11,000 acres in 1975 (Table 21).[12]

Farmers surveyed in the Starkweather Watershed had over 24 percent of their cropland affected by flooding in 1975. In that same year surveyed farm operators in the Chain Lakes Watershed had only 2.3 percent of their cropland affected by flooding before seeding.

Farmers in the Stump Lake Watershed were most affected by spring floods in terms of acres affected. They had the highest percentage of cropland affected in three of the years between 1971 and 1975, and the second highest one other year. The worst year was 1974 when over 43 percent of their cropland was affected by flooding before seeding. South Slope farmers were least affected by floods before seeding in 1974 when only 5.2 percent of their cropland was affected.

Frequency of Flooding

Thirty-two percent of the respondents had flood problems before seeding in all five years from 1971 to 1975. Only 10 percent indicated they never had flood problems before seeding over the five-year period.

More respondents had flood problems before seeding in 1974 than in any other year, with 59 of the 69 respondents indicating flood damages that year (Table 22).[13] Over half of the surveyed farmers indicated 1975 was the most recent year of flood damage. For most of the others the most recent year was 1974. The most severe year for over half of the respondents was 1974, and for most of the others it was 1975.

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[12] For a discussion of historical flood occurrences in the Devils Lake Basin see Bray (1968).

[13] Since this was not a random survey, Basin-wide flood damages most likely were not as great as these figures would suggest.

TABLE 21. NUMBER OF ACRES ON WHICH SEEDING WAS DELAYED OR PREVENTED AS A RESULT OF FLOODING AS INDICATED BY SURVEYED FARMERS IN EACH WATERSHED IN THE DEVILS LAKE BASIN, 1971-1975

Watershed	Number of Acres Affected by Flooding Before Seeding	Percent of Acres in Sample Affected by Flooding	Number of Acres Unable to Seed As Result of Flooding	Percent of Acres in Sample Unable to Seed As Result of Flooding
		1975		
Hurricane Lake	695	7.62	234	2.57
Comstock	473	9.28	260	5.10
Stump Lake	1,320	19.86	354	5.33
Edmore	741	7.78	272	2.86
Starkweather	3,004	24.31	530	4.29
Chain Lakes	60	2.26	60	2.26
Mauvais Coulee	3,482	16.08	819	3.78
Devils Lake	218	4.72	146	3.16
South Slope	635	5.61	355	3.14
	10,628	12.81	3,030	3.65
		1974		
Hurricane Lake	745	8.17	199	2.18
Comstock	320	6.28	320	6.28
Stump Lake	2,865	43.12	1,234	18.57
Edmore	2,296	24.12	505	5.30
Starkweather	4,105	33.22	925	7.49
Chain Lakes	295	11.13	170	6.41
Mauvais Coulee	3,733	17.24	890	4.11
Devils Lake	940	20.38	597	12.94
South Slope	585	5.17	355	3.14
	15,884	19.15	5,195	6.26
		1973		
Hurricane Lake	150	1.64	10	0.11
Comstock	260	5.10	260	5.10
Stump Lake	30	0.45	185	2.78
Edmore	1,071	11.25	300	3.15
Starkweather	270	2.18	170	1.38
Chain Lakes	60	2.26	60	2.26
Mauvais Coulee	825	3.81	590	2.72
Devils Lake	173	3.75	100	2.17
South Slope	160	1.41	65	0.57
	2,999	3.61	1,740	2.09
		1972		
Hurricane Lake	580	6.36	50	0.55
Comstock	260	5.10	260	5.10
Stump Lake	1,260	18.96	279	4.20
Edmore	561	5.89	205	2.15
Starkweather	430	3.48	185	1.50
Chain Lakes	220	8.30	125	4.72
Mauvais Coulee	1,115	5.15	440	2.03
Devils Lake	207	4.48	94	2.04
South Slope	85	0.75	55	0.49
	4,718	5.68	1,693	2.04
		1971		
Hurricane Lake	559	6.13	74	0.81
Comstock	260	5.10	260	5.10
Stump Lake	1,260	18.96	307	4.62
Edmore	616	6.47	252	2.65
Starkweather	330	2.67	190	1.54
Chain Lakes	60	2.26	60	2.26
Mauvais Coulee	860	3.97	445	2.05
Devils Lake	95	2.05	73	1.58
South Slope	35	0.30	35	0.31
	4,075	4.91	1,696	2.04

TABLE 22. YEAR FLOOD DAMAGES BEFORE SEEDING WERE EXPERIENCED BY SURVEYED FARM OPERATORS AND YEAR MOST SEVERE DAMAGE WAS INCURRED, 1971-1975

Year	Flood Damages Before Seeding		Year Flood Damages Before Seeding Were Most Severe	
	Number of Respondents	Percent of Respondents	Number of Respondents[a]	Percent of Respondents
1975	45	65.0	19	32.0
1974	59	85.0	35	58.0
1973	30	43.0	4	7.0
1972	36	52.0	--	--
1971	29	42.0	2	3.0

[a]Some respondents did not have flood damages or did not indicate in which year flooding was most severe.

Changes in Production Practices

The farm operator often cannot perform tillage operations he would normally perform because of flooding before seeding. He may also have to perform extra tillage practices in order to prepare the flood affected seedbed.

The majority of respondents indicated some type of cultivation or tillage practice either was not done because of floods, or had to be done in addition to normal production practices. Many respondents indicated there had been no change in their production practices because of flooding. Farm operators, on the average, spend an additional $.67 per acre on production practices on land affected by floods (Table 23).

Estimating Flood Damages That Occur Before Seeding

Estimating agricultural flood damages requires a knowledge of the extent and degree of flooding. The extent of flooding, or the area affected, can be estimated from past occurrences or by hydrologic modeling. The degree to which those acres are affected also can be estimated in these ways. To estimate the economic losses incurred, composite acres were developed for the area affected.

A composite acre is a representation of agricultural land use in a region. It shows what proportion of the cropland is seeded to the various

TABLE 23. COST OF CHANGES IN PRODUCTION PRACTICES RESULTING FROM FLOODING BEFORE SEEDING FOR SELECTED CROPS[a]

Crop Seeded	Costs Per Acre of Additional Production Practices Performed	Costs Per Acre of Production Practices Unable to Perform	Net Cost Per Acre of Changes in Production Practices
Durum	$1.60	$0.77	$0.84
Other Spring Wheat	1.53	1.01	0.52
Oats	1.14	0.48	0.66
Barley	1.33	0.84	0.50
Flax	1.30	0.80	0.50
All Crops			0.67

[a]Respondents provided information on the number and type of additional production practices performed. Costs of additional production practices are custom rates from North Dakota Crop and Livestock Statistics for 1974.

crops and the proportion of land in pasture and summer fallow. A composite acre also can be used to represent the mix of crops grown over time, and it may also be used to represent the mix of crops that would be planted during a specific period in the planting season. It does not reflect exactly what an individual farm operator would seed, but it reflects the overall mix of crops grown by all farm operators in the region.

Composite acres representing different periods in the planting season were developed for cropland affected by flooding in the Devils Lake Basin. Information on crops affected by flooding between 1971 and 1975 was obtained from surveyed farm operators in the Basin and used to develop the composite acres.

Five crops predominate in the planting patterns in the Devils Lake Basin. They are durum, other spring wheat, barley, flax, and oats. Specialty crops, such as potatoes, sunflowers, and mustard, are of minor importance to the Basin's agriculture and were excluded from the analysis.[14] The contribution made by these crops to the composite acre values was considered too small to be significant in a Basin-wide analysis.

[14]To the Basin, these specialty crops are of minor significance. To the individual who grows them, flood damages can be quite significant.

Three dates May 1, May 20, and June 1 were chosen to represent planting periods in the Basin. A composite acre was developed from the beginning of seeding to May 10 to represent a "flood free" situation. May 20 represents the period from May 11 to May 31. June 10 was chosen to represent the latest planting period, from June 1 to the end of the planting period.

Each composite acre represents the mix of crops that was seeded (or would have been seeded had there been no flooding) by the farm operators cooperating in the survey during the time period covered by the survey. For example, if seeding was accomplished during the time period represented by the May 1 composite acre, 34.5 percent of the flood prone cropland in the Basin would be seeded to durum (Figure 3). Other spring wheat would be seeded on 13.9 percent of all cropland or on 13.9 percent of the composite acre. The same interpretation may be used for oats, barley, flax, and summer fallow.

In comparing the composite acres, some shifting of crops occurs over the planting season. However, the most important changes occur as a result of an increase in forced summer fallowing of flood affected land. This in turn affects the proportion of each composite acre devoted to different crops.

The value of each composite acre is determined by the yields of the various crops and the prices received for those crops. Average yields per acre were allocated to the proportion of the acre represented by each crop. Yields for each crop that can be expected in the Devils Lake Basin Region are shown in Table 24.

Delayed seeding caused by flooding results in losses of potential crop production in four ways. First, delay results in more summer fallow acres; therefore, fewer acres of crops are planted.[15] Second, delay normally results in lower yields per acre.[16] Third, delay normally results in a reduction in crop quality. And fourth, delay forces farmers to substitute less profitable crops for the higher profit crops.

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[15]Summer fallowing is done for the purpose of retaining moisture and reducing the need for nitrogen fertilizer. This increases crop yields. Summer fallow in excess of what the farm operator desires or on areas where he is forced to summer fallow due to flooding is treated as having no value to overall farm production.

[16]In some cases delayed seeding may result in higher than normal yields but this is the exception rather than the rule.

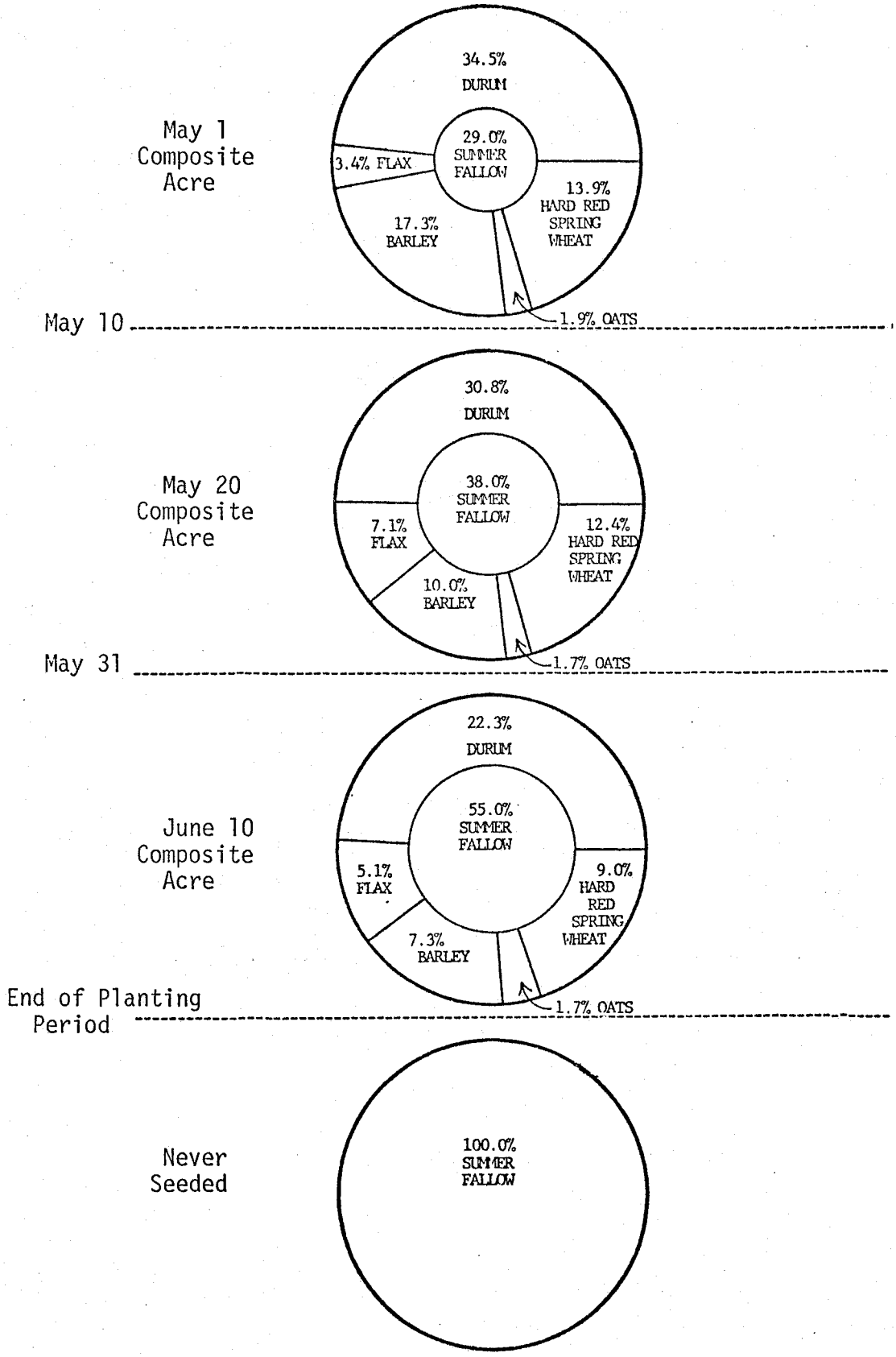

Figure 3. Composite Acres for Devils Lake Basin Cropland With Flood Potential for Four Periods.

TABLE 24. PROJECTED YIELDS FOR NORTHEAST CENTRAL NORTH DAKOTA FOR SELECTED CROPS, 1974

Crop	Projected Yield[a] (bushels/acre)
Durum	28.8
Other Spring Wheat	32.0
Barley	40.1
Oats	45.1
Flax	11.2

[a]These are average yields from all farmland, based on the trend for 1956-1971 which may include some flood affected areas; higher yields are expected with above average management and using only nonflood affected cropland.

SOURCE: Farm Management Planning Guide, Cooperative Extension Service, North Dakota State University.

The undamaged value of each composite acre is the combined value of the yield of each of the five crops (Table 25). Spring flooding causes damages in addition to decreased acres planted. Yields are also reduced because of late seeding. Yield loss curves (Figure 4) were developed using the farm operator survey data and advice from farm management personnel at North Dakota State University. The yield loss curves show what percent of the projected yield remains after a delay in seeding from the optimum seeding date (through May 10).

A further loss in value results from the delayed crop having a lower quality and, therefore, bringing a lower price. Quality losses due to delayed seeding were estimated by farm management specialists[17] (Table 26).

The effect of flooding that delays seeding can be seen in a comparison of the value of the various composite acres. The flood-free acre, May 1, has a gross value of $70.19 (Table 25). The acre delayed until May 20 has a gross value of $43.98 or $26.21 less than the flood-free acre. The acre delayed until June 10 has a gross value of only $12.12 or $58.07 less than the flood-free acre. If seeding is prevented on an acre, the potential loss in foregone crop sales is $70.19.

[17]LeRoy Schaffner, Department of Agricultural Economics, North Dakota State University, personal communication.

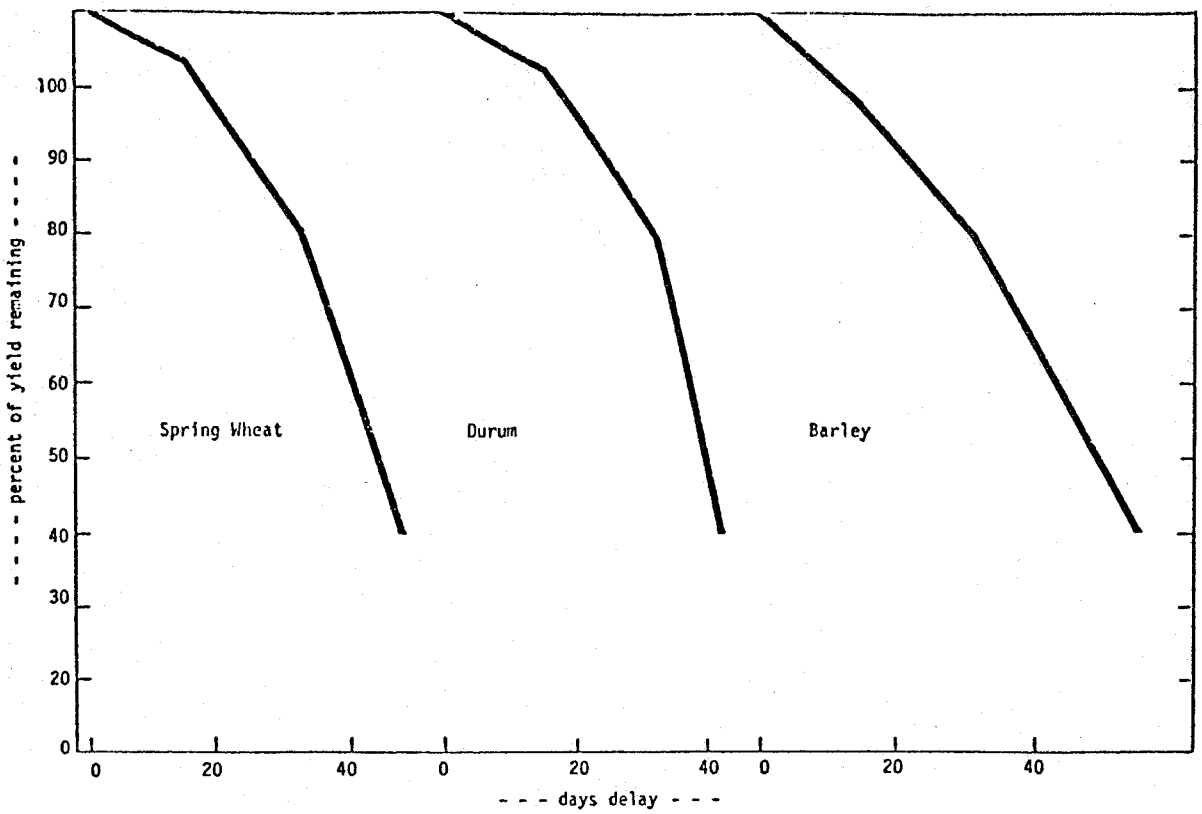

Figure 4. Yield Reduction Curves for Selected Crops Due to Delayed Seeding.

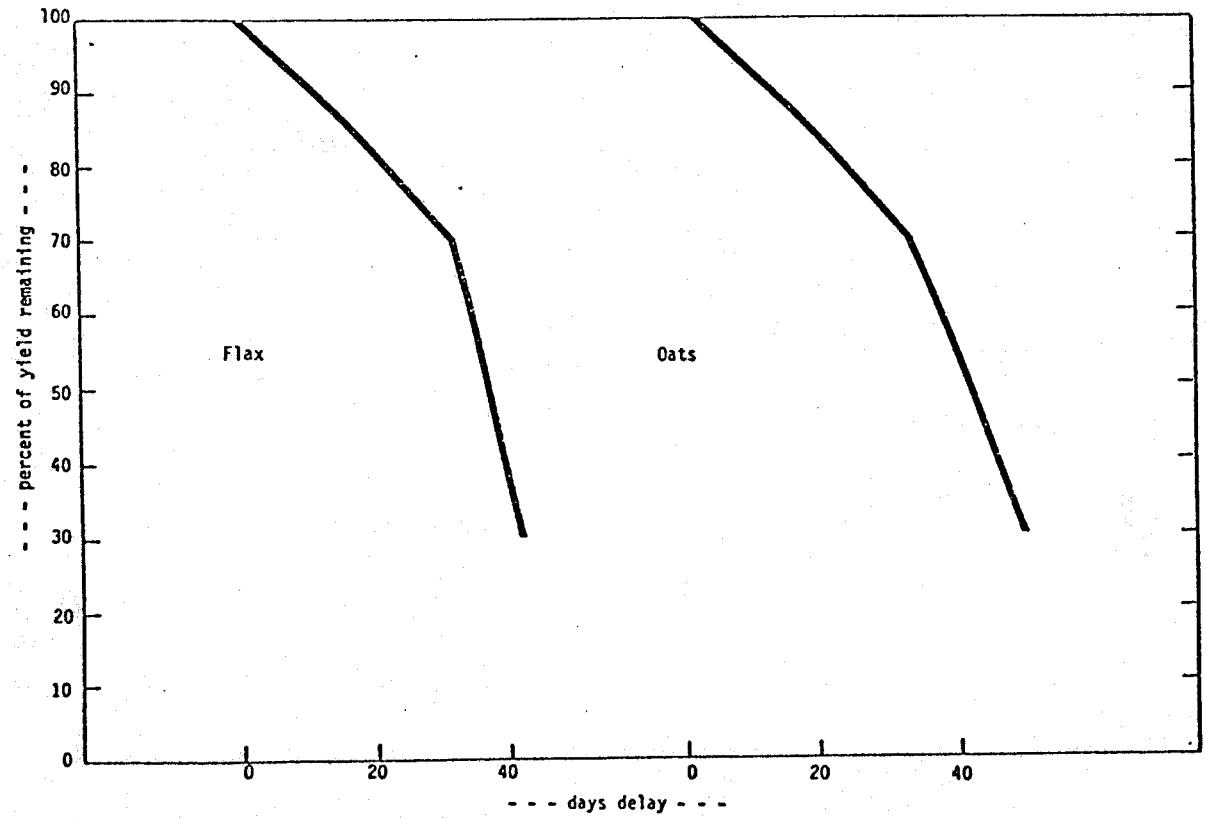

Figure 4. Yield Reduction Curves for Selected Crops Due to Delayed Seeding (Continued).

TABLE 25. VALUE OF COMPOSITE ACRES FOR LAND THAT WOULD BE AFFECTED BY FLOODING IN THE DEVILS LAKE BASIN, LONG-RUN PRICES[a] (IN 1974 DOLLARS)

Crop	Percent of Composite Acre	Undamaged Value	Delay Reduction		Value Remaining	Production Cost[b]	Net Revenue[c]
			Yield	Quality			
			- - - *percent* - -				
May 1							
Durum	34.5	9.94 bu. @ $3.89	0.0	0.0	$38.67	$27.01	
HRS	13.9	4.45 bu. @ 3.27	0.0	0.0	14.55	10.37	
Barley (Feed)	17.3	1.04 bu. @ 1.58	0.0	d	1.64		
(Malting)		5.90 bu. @ 2.06	0.0	d	12.15	12.09	
Flax	3.4	0.38 bu. @ 6.02	0.0	0.0	2.29	1.64	
Oats	1.9	0.86 bu. @ 1.04	0.0	0.0	0.89	.87	
Summer Fallow	29.0	0	--	--	0	0	
	100.0				$70.19	$51.98	$18.21
May 20							
Durum	30.8	8.87 bu. @ $3.89	11.7	20.0	$24.37	$24.11	
HRS	12.4	3.97 bu. @ 3.27	11.0	20.0	9.24	9.25	
Barley (Feed)	10.0	1.00 bu. @ 1.58	17.5	d	1.30		
(Malting)		3.00 bu. @ 2.06	e	d	5.10	6.99	
Flax	7.1	0.79 bu. @ 6.02	18.0	15.0	3.31	3.41	
Oats	1.7	0.77 bu. @ 1.04	18.0	0.0	.66	.77	
Summer Fallow	38.0	0	--	--	0	2.47	
	100.0				$43.98	$47.00	-$3.02
June 10							
Durum	22.3	6.42 bu. @ $3.89	66.5	35.0	5.44	17.46	
HRS	9.0	2.88 bu. @ 3.27	54.0	35.0	2.82	6.71	
Barley (Feed)	7.3	2.05 bu. @ 1.58	44.5	d	1.80	5.10	
(Malting)		0.88 bu. @ 2.06	e	d	1.01		
Flax	5.1	0.57 bu. @ 6.02	66.5	35.0	.75	2.45	
Oats	1.3	0.59 bu. @ 1.04	51.0	0.0	.30	.59	
Summer Fallow	55.0	0	--	--	0	7.11	
	100.0				$12.12	$39.42	-$27.30
Not Seeded							
Summer Fallow	100.0	0	0.0	0.0	0	$27.41	-$27.41

[a] Long-run prices are for the period 1966-1975 adjusted upward for increase in prices paid for inputs. A coefficient was included in the calculation for government payments which averaged approximately 15 percent for the period 1966-1973. See Appendix B for composite acre values using 1974 price relationships.
[b] Production cost includes all costs of production including land, taxes, and labor (Appendix C).
[c] Net revenue = value remaining (gross sales) - production cost. The farm operator will continue to seed when his net revenue is negative as long as he recovers his variable costs.
[d] Quality reduction for barley is shown as a shift to feed grade from malting barley.
[e] The yield and price are for that portion representing malting grade barley.

TABLE 26. QUALITY REDUCTIONS DUE TO DELAYED SEEDING

Crop	Percent Reduction in Price Due to Quality Loss		
	To May 10	May 11 - May 31	June 1 - on
Durum and Other Spring Wheat	--	20%	35%
Flax	--	15%	35%
Barley[a]	15% feed 85% malting	25% feed 75% malting	70% feed 30% malting

[a]The quality loss for barley is shown in the shift from malt to feed grade.

SOURCE: LeRoy Schaffner, Agricultural Economics Department, North Dakota State University, Personal Communication.

To estimate the total losses due to flooding before seeding requires information on the time, duration, and extent of flooding. Given the number of acres delayed until May 10, May 31, June 10, and never seeded, the gross loss in production can be estimated.

For example, suppose there were 100,000 acres flooded after spring snowmelt. By May 10, however, 25,000 acres had dried well enough to seed. Given the assumptions and conclusions above, there would be no loss on these acres. Farmers would seed them to the crops in the May 1 composite acre.

Of the remaining 75,000 acres, 50,000 are dry in time to plant by May 31. As a result of this delay, there is a loss in production from 50,000 acres. The May 20 composite acre has a value of $43.98 which is $26.21 less than that possible without flooding. The total loss is 50,000 X $26.21, or $1,310,500. That figure represents the loss of gross revenue from those acres. The actual out-of-pocket loss to the farmer is the difference between his production expenditures and his gross returns, or $1.76 per acre.

Of the remaining 25,000 acres, 15,000 dry out in time to be seeded by June 10. They are seeded in the pattern of the June 10 composite acre. The total loss in production is $58.07 an acre, or $871,050 total.

The remaining 10,000 acres do not dry out in time to seed and, therefore, the loss is $70.19 per acre, or $701,900.

The total loss in crop sales due to flooding before seeding would be:

$1,310,500
871,050
701,900
$2,883,450

After the consequences of spring flooding have passed, summer flooding, or flooding after seeding, may occur. The number of possible combinations of flooding before and after seeding is large.

Flood Problems After Seeding

Flooding of agricultural land that occurs after seeding can be as costly as flooding before seeding, and possibly more costly to the individual who has incurred production expenditures. The magnitude of flooding after seeding as compared to flooding before seeding on land operated by surveyed farm operators in the Basin was small. In terms of acres affected, flooding after seeding was much less severe than flooding before seeding (Table 27). In terms of frequency, after seeding flooding occurred about one-third as often as flooding before seeding. Flood problems rarely occurred after seeding on land that had not been affected by floods before seeding.

TABLE 27. ACRES AFFECTED BY SUMMER FLOODING AFTER SEEDING ON SAMPLE AREA, 1971-1975

Year	Acres Flooded After Seeding	Percent of Total Cropland in Sample
1975	759	0.9
1974	1,937	2.3
1973	438	0.5
1972	895	1.1
1971	563	0.7

Estimating Damages Caused by Summer Floods

The information on flood damages after seeding obtained from surveyed farm operators was not sufficient to establish patterns of loss by month or severity of flood. Therefore, estimates of probable yield and quality losses due to a variety of summer flood conditions were made.[18] Losses were

[18] E. H. Vasey, Extension Soils Specialist, North Dakota State University, Personal Communication.

estimated for the three principal and two secondary crops for the months of May through August, and for one to four days flood duration (Table 28).

TABLE 28. YIELD REDUCTION RESULTING FROM SUMMER FLOODING FOR SELECTED CROPS GROWN IN THE DEVILS LAKE BASIN

Crop	Days Flooded	May	June	July	August
		(- - - - *percent reduction* - - - - -)			
Durum	1	20	20	30	20
	2	30	40	60	30
	3	50	80	100	30
	4	70	100	100	40
Hard Red Spring Wheat	1	20	20	30	20
	2	30	40	60	30
	3	50	80	100	30
	4	70	100	100	40
Oats	1	20	20	30	20
	2	50	60	80	30
	3	80	80	100	30
	4	100	100	100	40
Barley	1	20	20	30	20
	2	50	60	80	30
	3	80	80	100	30
	4	100	100	100	40
Flax	1	10	10	20	10
	2	20	30	50	20
	3	30	40	80	20
	4	50	60	100	30

SOURCE: E. H. Vasey, Extension Soils Specialist, North Dakota State University, Personal Communication.

The yield reduction due to summer flooding was estimated for each composite acre. For example, a one-day flood in May could occur on an acre that was not flooded before seeding, or it could occur on an acre where flooding was delayed until May 20. The losses from summer flooding could range from $16.80 for a one-day flood in May on a previously flood-free acre, to $70.19 for a four-day flood in July on a previously flood-free acre (Table 29). The additional losses on acres previously affected by flooding would be less than the losses on flood-free acres. For example, there would be no additional loss due to summer flooding on an acre where seeding was prevented in the spring.

TABLE 29. DOLLAR DAMAGE OF LOSSES DUE TO SUMMER FLOODING OF ONE TO FOUR DAYS DURATION ON EACH COMPOSITE ACRE (LONG-RUN PRICE RELATIONSHIPS)

Days Inundated	Month of Summer Flood			
	May	June	July	August
	Summer Flood Occurring on May 1 Composite Acre			
1	$13.81	$13.81	$20.83	$13.81
2	14.70	30.78	25.37	20.83
3	39.04	55.24	69.73	20.83
4	53.08	69.27	70.19	27.85
	Summer Flood Occurring on May 20 Composite Acre			
1	$ 8.46	$ 8.46	$12.86	$ 8.46
2	14.27	18.67	27.47	12.86
3	23.45	33.86	41.33	12.86
4	32.24	42.66	43.98	17.26
	Summer Flood Occuring on June 10 Composite Acre			
1	$ 2.35	$ 2.35	$ 3.56	$ 2.35
2	4.18	5.39	7.82	3.56
3	6.84	9.40	11.52	3.56
4	9.27	11.82	12.12	4.77
	Summer Flooding Occurring On Composite of May 1 (21%), May 20 (39%), June 10 (5%), and Never Seeded (35%)			
1	$ 6.32	$ 6.32	$ 9.57	$ 6.32
2	8.86	14.01	16.43	9.57
3	17.69	25.28	31.34	9.57
4	24.18	31.78	32.50	12.82

An alternative to losses from flooding after seeding is reseeding. However, of 132 separate fields affected by flooding after seeding as indicated on the farm operator survey, only 10 were reseeded. Only crops flooded in June were reseeded.[19] Generally, yields on reseeded crops were enough to cover variable production costs. Flax, a late crop, showed the greatest potential for reseeding. The short growing season and lack of alternative crops generally make reseeding after flooding impractical and uneconomical in the Devils Lake Basin.

[19]It is likely that some reseeding would occur if flooding after seeding occurred in May. None of the farmers surveyed, however, indicated they had reseeded crops that were affected by flooding in May.

Economic Impact of Flooding Losses

Losses resulting from flooding have an economic impact on both the farm operator and the Devils Lake Basin economy. The farm operator loses part of his profit and he experiences an out-of-pocket loss when gross revenue is less than his production expenditures. The Basin's economy is affected whenever the farm operator's income declines as a result of flood losses.

The extent and degree of flooding varies from farm to farm and from year to year resulting in a large number of possible combinations of before and after seeding flooding situations. Information on actual flood occurrences is required to estimate overall flood damage using the composite acres developed above and the estimates of yield reduction for summer flooding. For purposes of illustration, however, one value for all of the specified combinations of flooding was developed for losses in the Basin.

The average annual damage per acre resulting from spring and summer flooding was estimated to be $8.71 using long-run price relationships.[20] The procedure used to estimate this figure is discussed in Appendix D. This figure represents a mixture of 70 percent cropland, 20 percent pasture or grassland, and 10 percent nonagricultural land which was necessary because the area identified as flood affected by the Water Management Task Force of the Devils Lake Basin Study was not all cropland.[21]

A flood frequency of 0.3 was used in estimating the average annual damage. This is based on the frequency of floods between 1960 and 1975 in Mauvais Coulee Watershed and between 1960 and 1973 in Edmore Watershed. In other words, a flood of the magnitude estimated by the Water Management Task Force (221,000 acres) was expected to occur three years out of ten. This estimate of flood frequency is based on information available from gauging

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[20]Using 1974 price relationships, the average annual damage per acre was estimated to be $13.03. Long-run relationships were estimated using prices paid and prices received for the period 1966-1975. The analysis was done using 1974 and long-run price relationships for two reasons. First, the dramatic increase in prices in recent years over historic trends creates uncertainty as to whether 1974 prices reflect a stable relationship between prices. And second, the sensitivity of the overall analysis to a change in prices is shown by using two sets of prices.

[21]The Devils Lake Basin Study, p. 47.

stations in the Basin. Since channel flows in other watersheds are not measured and since there are a number of other variables to consider in estimating flood frequency (such as storage capacity of wetlands and lakes in the Basin) the flood frequency of 0.3 used in this report may not accurately reflect actual flood occurrences in the Basin. It is presented for use in working through the procedure developed in this report for estimating flood damages in the Basin. A hydrology model of the Basin is being developed which will provide the necessary data for more accurately estimating damages associated with specific flood occurrences in the Basin.

Under existing conditions in the Devils Lake Basin, approximately 221,000 acres[22] are potentially affected by sheetwater[23] flooding. Of this total, some of the land is actually inundated for a period of time while other areas are dry but farmers are prevented access because of flooding of adjacent land. The proportion of these acres affected in any one year varies from very few in a relatively dry year to nearly all in a wet year. Based on an average annual damage of $8.71 per acre, and 221,000 acres, total average annual flood damages in the Basin amount to $1.9 million (Table 30).[24]

Damages to land and property other than agricultural land are not included in the above estimates. Surveyed farm operators in the Basin indicated that property damages caused by flooding have been relatively small as compared to crop damages. Damage to fences caused by water and water carried debris was mentioned most often. Fence damage amounted to an average of $161 per farm annually for those who experienced such damage (Table 31). Soil erosion and saline problems were also given as flood caused damages. Other types of property damage did not occur frequently enough to be significant.

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[22] The Devils Lake Basin Study, Vol. I, p. 138.

[23] The definition of sheetwater flooding adopted by the Devils Lake Basin Advisory Committee is: shallow water which accrues to a closed basin from stream or channel overflow (sheetflow), and is prevented from returning to a stream or channel. Heavy snowmelt or rain can be a cause and this may include a Type I wetland.

[24] Using 1974 price relationships, total average annual flood damages in the Basin amount to $2.9 million.

TABLE 30. AVERAGE ANNUAL FLOOD DAMAGES BY WATERSHED IN THE DEVILS LAKE BASIN USING LONG-RUN AND 1974 PRICES

Watershed	Acres Affected by Sheetwater Flooding	Dollar Damages Using Long-Run Prices	Dollar Damages Using 1974 Prices
Hurricane Lake	9,000	$ 78,390	$ 117,270
Comstock	1,600	13,936	13,936
Stump Lake	20,700	180,297	269,721
Edmore	32,500	283,297	423,475
Starkweather	65,000	566,150	846,950
Chain Lake	26,000	226,460	338,780
Mauvais Coulee	48,000	418,080	625,440
Devils Lake	5,400	47,034	70,362
South Slope	12,800	111,488	166,784
Total	221,000	$1,924,910	$2,879,630

TABLE 31. FREQUENCY OF PROPERTY DAMAGE CAUSED BY FLOODING ON SURVEY SAMPLE AREA IN THE DEVILS LAKE BASIN

Damage Type	Year					5-Year Total
	1971	1972	1973	1974	1975	
	number of respondents					
Soil Erosion	2	1	1	2	2	8
Saline Increase	1	1	1	1	1	5
Fence Damage	3	4	5	4	8	24
Building Damage	-	-	-	3	1	4
Machinery Damage	1	1	1	1	1	5
Other	-	-	-	1	-	1

Payments Received For Crop Losses Resulting From Flooding

About one-third of the respondents indicated they had received payments for income foregone as a result of flooding between 1971 and 1975. Payments to surveyed farmers for flood losses over their total farming operation were highest in 1974--$49,596; lowest in 1972--$1,440 (Table 32).

Payments received by farm operators above the cost of participating in the program(s) should be deducted from the total estimated flood damage. However, information on payments for crop losses was inadequate for this purpose for two reasons. First, participation in insurance-type programs by individuals varies from year to year. Second, government insurance and disaster relief programs were variable during the time covered by the survey.

TABLE 32. PAYMENTS PER FARM MADE BY AGENCIES TO SURVEYED FARMERS FOR LOSSES CAUSED BY FLOODING, 1971-1975[a]

Agency	Year				
	1971	1972	1973	1974	1975
ASCS	$2,200(1)	--	$5,000(1)	$44,276(13)	--
Federal Crop Insurance	--	--	--	$ 5,320(4)	--
Private Insurance	--	$1,440(1)	--	--	--
Other	--	--	--	--	$1,702(1)
Total	$2,200	$1,440	$5,000	$49,596	$1,702
Cost to Farmers	--	$ 288	--	$ 1,149	--
Net	$2,200	$1,152	$5,000	$48,447	$1,702

[a]The number of respondents receiving payments is in parentheses.

Impact of Flooding on Farm Management

Flooding, or the threat of flooding, influences farm management decisions in a number of ways. A farm operator may plant a different mix of crops on a flood-prone area, he may be forced to delay seeding, or he may have more summer fallow than he would prefer.

Surveyed farm operators were asked how they would change their cropping practices if flooding were reduced by one-half and if it were nearly eliminated. Reduction by one-half would change the area on which problems occur, but probably would not drastically alter cropping practices. Nearly eliminating the threat of flooding would allow farmers the opportunity to manage their farming operations in a manner more suitable to them.

Nearly two-thirds (64 percent) of the respondents indicated they would make no change in their cropping practices if flooding were reduced by one-half. They may, however, find it more convenient to carry-out their existing management practices.

The majority of those indicating some change in their cropping practices would summer fallow less and seed more to small grains (Appendix E). Flood reduction would allow them to summer fallow the areas they want to rather than being forced into summer fallowing flooded land. It would also permit them to get their crops seeded earlier and in a more orderly fashion. Some shifting away from late-seeded crops, such as flax, would also take place.

Nearly eliminating the threat of flooding would enable farm operators to make long-run management decisions without the danger of having those decisions altered by flooding. Most importantly, it would nearly eliminate one of the major risk factors to farm operations in the Devils Lake Basin. The changes indicated by surveyed farm operators, although not in agreement with one another, would more closely fit the individual operator's management scheme. Some respondents indicated more and some indicated less summer fallow would be used in rotation (Appendix E).

Summary

A preliminary farm operator survey was conducted to identify farm owners and operators of the quarter section samples in the Basin used in the 1967 Conservation Needs Inventory survey. This was done to identify those farm owners and operators who would be willing to participate in a more detailed survey at a later date. Some information was collected regarding attitudes toward the Devils Lake Basin Study, attitudes toward wetland and the drainage of wetland, and agricultural losses due to flooding and other causes.

Respondents were generally in favor of the study. The feeling regarding wetland was that it (wetland) is basically a nuisance to farm operations and that many wetland areas should be drained. A majority of the respondents felt that drainage from the quarter section samples would not cause flooding problems downstream. Approximately one-third of the respondents, however, felt that their flood problems were associated with drainage upstream.

Dollar losses resulting from flooding on the quarter section samples either before or after seeding are not included in this report for several reasons. Respondents were asked to estimate the average annual dollar losses to crops due to several causes occurring over the past 10 years, but they were not told to base their dollar estimates on any particular year's prices. Also, they were approached unexpectedly and presented with difficult questions without the benefit of their farm records. The losses estimated on the preliminary survey, both in terms of dollars and acres, can at most be used to compare relative damages between counties or watersheds.

A second survey was conducted to obtain more precise information on flood damages, wetland use, and crop losses to wildlife.

Saline soil causes reductions in crop yields in the Devils Lake Basin. Seventy-two percent of those surveyed indicated they had saline problems on some part of their farm. About 3.7 percent of the sampled area was identified as saline. Yield reductions on saline areas averaged 55 percent for all crops.

Wetland was a nuisance to most farmers surveyed. They indicated a desire to drain approximately 36 percent of their existing wetland which makes up about 6 percent of their cropland. Some farmers may benefit by draining some of their wetland because of relatively low costs of drainage compared to the returns to production after draining.[25]

About half of the respondents indicated they had suffered losses to wildlife, although estimating the dollar loss is not easy. Counter-measures to reduce losses to wildlife were used by about 75 percent of the respondents and were effective about half the time.

From the information on the second survey a composite flood damage acre was developed for the Basin. The annual average loss on land that may be affected by flooding was estimated to be $8.71 per acre using long-run price relationships. Using 1974 price relationships, the average annual loss was estimated to be $13.03. The annual average total dollar loss due to flooding in the entire Basin was estimated to be $2.9 million using 1974 price relationships or $1.9 million using long-run price relationships.

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[25]Goldstein reports that unsubsidized drainage can be done profitably on temporary wetlands but not on the more permanent wetlands.

APPENDICES

COMMENTS OF FARM OPERATOR RESPONDENTS TO PRELIMINARY SURVEY

Respondents were asked to make comments as to whether or not they were in favor of the Devils Lake Basin Study. The ratio of favorable comments to unfavorable was approximately twenty-four to one. No attempt is made to maintain that ratio in the selected comments presented below.

"Flood problems and wildlife restrictions are too much. Wildlife has its place but farming and making a living comes first."

"Flooding is a problem."

"(I) think that the more you study and monkey the worse it gets. It develops more power for wildlife people."

"There has been flooding and wildlife people have too much interference with farming and drainage."

"Would like to see farmers get rid of water, but would like to see wildlife balance kept. The farmer's economic survival is of primary importance. Wildlife is important and should be kept in balance. The water situation is making neighbors angry, suspicious, and mean to one another."

"Shelterbelts cause the biggest problem by catching snow."

"It's 20 years too late, but planning now is better than not doing anything."

"There is a flooding problem that needs solving, but it does not affect me."

"I do not like flooding problems and wildlife regulations. I agree that wildlife has a place, but so does farming."

"Small shallow areas need drainage, deeper ones should be kept."

"There are flood problems that need solving. The Fish and Wildlife Service is getting too much grip on the country."

"If taxes go up I would not like to have the Basin problems solved at our expense. I am not in the flood plain and think the problem area should be assessed not us."

"Farmers need relief from flooding, but the flooded people have done quite well to real well when its dry. In a dry cycle they do real well."

"Studied already too much."

"Floodings are too much. Wildlife is more ornery than hell."

"If the people downstream can handle the water, drainers do not care where the water goes."

"I'm on the receiving end of draining. It had ruined my farming more every year.

APPENDIX TABLE B-1. VALUE OF COMPOSITE ACRES FOR LAND THAT WOULD BE AFFECTED BY FLOODING IN THE DEVILS LAKE BASIN, 1974 PRICES[a]

Crop	Percent of Composite Acre	Undamaged Value	Delay Reduction Yield	Delay Reduction Quality	Value Remaining	Production Cost[b]	Net Revenue[e]
			- - - *percent* - -				
May 1							
Durum	34.5	9.94 bu. @ $5.97	0	0	$ 59.34	$ 27.01	
HRS	13.9	4.45 bu. @ 4.35	0	0	19.36	10.37	
Barley	17.3	1.04 bu. @ 2.22	0	c	2.31	--	
		5.90 bu. @ 3.43	0	c	20.24	12.09	
Flax	3.4	0.38 bu. @ 9.57	0	0	3.64	1.64	
Oats	1.9	0.86 bu. @ 1.34	0	0	1.15	0.87	
Summer Fallow	29.0	0	--	--	0	0	
	100.0				$106.04	$ 51.98	$ 54.06
May 20							
Durum	30.8	8.87 bu. @ $5.97	11.7	20.0	$ 37.41	$ 24.11	
HRS	12.4	3.97 bu. @ 4.35	11.0	20.0	12.30	9.25	
Barley	10.0	1.00 bu. @ 2.22	17.5	c	1.83	--	
		3.00 bu. @ 3.43	d	c	8.49	6.99	
Flax	7.1	0.79 bu. @ 9.57	18.0	15.0	5.27	3.41	
Oats	1.7	0.77 bu. @ 1.34	18.0	0.0	0.85	0.77	
Summer Fallow	38.0	0	--	--	0	2.47	
	100.0				$ 66.15	$ 47.00	$ 19.15
June 10							
Durum	22.3	6.42 bu. @ $5.97	66.5	35.0	$ 8.34	$ 17.46	
HRS	9.0	2.88 bu. @ 4.35	54.0	35.0	3.75	6.71	
Barley	7.3	2.05 bu. @ 2.22	44.5	c	2.53	5.10	
		0.88 bu. @ 3.43	d	c	1.68	--	
Flax	5.1	0.57 bu. @ 9.57	66.5	35.0	1.19	2.45	
Oats	1.3	0.59 bu. @ 1.34	51.0	0.0	0.39	0.59	
Summer Fallow	55.0	0	--	--	0	7.11	
	100.0				$ 17.88	$ 39.42	$-21.54
Not Seeded							
Summer Fallow	100.0	0	0.0	0.0		$ 27.41	$-27.41

[a]The use of 1974 prices may overstate the value in the long-run of the composite acres.
[b]Production cost includes all costs of production including land, taxes, and labor (Appendix C).
[c]Quality reduction for barley is shown as a shift to feed grade from malting barley.
[d]The yield and price are for that portion representing malting grade barley.
[e]Net revenue = value remaining (gross sales) - production cost. The farm operator will continue to seed when his net revenue is negative as long as he recovers his variable costs.

APPENDIX TABLE C-1. CROP YIELDS AND PRODUCTION COSTS FOR NORTHEAST CENTRAL NORTH DAKOTA, INCLUDING TOWNER, CAVALIER, BENSON, RAMSEY, AND NELSON COUNTIES, MARCH 1974

Cooperative Extension Service
North Dakota State University

FARM MANAGEMENT PLANNING GUIDE
Revised Section VI: No. 2

Billy B. Rice, L. W. Schaffner, and Roger G. Johnson

	Wheat on Fallow	Wheat on Nonfallow	Durum on Fallow	Durum on Nonfallow	Barley on Fallow	Barley on Nonfallow	Oats on Nonfallow	Flax on Nonfallow	Rye on Nonfallow
					Average				
1. PROJECTED YIELDS	34.20	26.70	29.90	23.40	43.70	38.60	45.10	11.20	21.60
Direct Costs									
2. Seed	8.04	8.04	11.02	11.02	6.30	6.30	4.58	10.44	3.68
3. Fertilizer	4.23	4.82	4.23	4.82	2.82	5.56	2.94	.95	--
4. Chemicals	.56	.56	.56	.56	.36	.36	.08	.15	--
5. Machinery Repairs	3.00	2.05	3.00	2.05	3.02	2.12	2.15	1.86	2.02
6. Fuel & Lubricants	4.26	2.80	4.26	2.80	4.22	2.90	3.05	2.40	2.72
7. Int. on Operating Cap.	.89	.81	1.02	.94	.71	.74	.52	.68	.64
8. Crop Insurance	1.96	1.96	1.96	1.96	1.51	1.51	1.23	1.76	1.87
9. Custom Costs	1.35	1.44	1.35	1.44	.87	.96	.74	.90	.50
10. TOTAL DIRECT COSTS	24.29	22.48	27.40	25.59	19.81	20.45	15.29	19.14	11.43
Fixed Costs									
11. Machinery Depr. & Ins.	7.02	4.70	7.02	4.70	7.02	4.88	4.58	4.43	4.59
12. Interest on Machinery	4.42	2.96	4.42	2.96	4.42	3.07	2.89	2.79	2.89
13. Labor ($2.30 per hour)	6.77	4.62	6.77	4.62	6.74	4.78	4.70	4.16	4.50
14. Land Cost (incl. taxes)	26.82	13.41	26.82	13.41	26.82	13.41	13.41	13.41	13.41
15. TOTAL FIXED COSTS	45.03	25.69	45.03	25.69	45.00	26.14	25.58	24.79	25.39
16. TOTAL COSTS PER ACRE	69.32	48.17	72.43	51.28	64.81	46.59	40.87	43.93	36.82
17. TOTAL COST PER BUSHEL	2.03	1.80	2.42	2.19	1.48	1.21	.91	3.92	1.70
With better management and these direct costs, many farmers consistently obtain the yield and incur costs shown on lines 22, 23, and 24 below.									
18. Seed	7.52	7.52	10.88	10.88	5.84	5.84	4.22	9.80	4.99
19. Fertilizer	5.80	14.18	5.16	12.02	6.25	13.15	13.64	4.20	15.26
20. Chemicals	1.15	1.15	1.15	1.15	1.15	1.15	.46	.46	.46
21. Other Direct Costs	12.08	9.69	12.13	9.70	11.18	8.90	8.97	8.02	7.27
22. TOTAL YIELD PER ACRE	41.10	32.00	35.90	28.10	54.00	47.00	62.00	15.00	34.00
23. TOTAL COSTS PER ACRE	71.58	58.23	74.35	59.44	69.42	55.18	52.87	47.27	53.37
24. TOTAL COSTS PER BUSHEL	1.74	1.57	2.07	2.12	1.29	1.17	.85	3.15	1.57

SOURCE: Cooperative Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. K. A. Gilles, Acting Director, Fargo, North Dakota. Distributed in futherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all people without regard to race, creed, color, sex, or national origin.

AVERAGE ANNUAL FLOOD DAMAGE

The average annual flood damage for land identified by the Water Management Task Force as affected by flooding was estimated using survey data and data from other task forces. Survey data gave the following distribution of composite acres: (1) the May 1 composite acre would represent approximately 21 percent of flooded land; (2) the May 20 composite acre would represent 39 percent of flooded land; (3) the June 10 compoiste acre would represent 5 percent of flooded land; and (4) the acre that was not seeded at all would represent 35 percent of land that was flooded. With this distribution, 21 percent of flood affected land would experience no damage, and 35 percent would have no production at all. The weighted loss for flood affected land would be $37.69 an acre in the year in which flooding occurred (Appendix Table D-1).

APPENDIX TABLE D-1. WEIGHTED LOSS FOR FLOOD AFFECTED LAND IN THE DEVILS LAKE BASIN, LONG-RUN PRICES (IN 1974 DOLLARS)

(1) Composite Acre	(2) Percent of Composite Acre[a]	(3) Dollar Loss[b]	(4) Weighted Dollar Loss (2 X 3)
May 1	21.0	$ 0.10	$ 0.00
May 20	39.0	26.21	10.22
June 10	5.0	58.07	2.90
Never Seeded	35.0	70.19	24.57
			$37.69

[a] Farm operator survey.
[b] See Table 25, p. 33.

Survey data indicated after seeding flooding occurs approximately one-third as often as before seeding flooding. Using this information and the information in Table 28, page 36, the average damage by flooding after seeding was estimated to be $2.32 per acre.

The total flood damage was then expressed on an annual basis by multiplying by an estimated frequency of .3, or a flood every three and one-third years. The annual average damange to an acre of cropland affected by flooding was estimated to be $12.00 which was computed in the following way:

Before seeding damage:	$37.69
After seeding damage:	2.32
	$40.01
	X .30
	$12.00

Since only 70 percent of the land in the Basin is cropland, the damage to other land uses was also considered. The damage to pasture was estimated by estimating the annual return to an acre of pasture ($60.40/a.u./month X 4-1/2 months X .8 a.u./acre = $23.04/acre). Then assuming that damage would occur to pasture in the same proportion as it does to cropland ($\frac{\$12.00}{\$70.19}$ X $23.04 = $3.94) and that damage to pasture only occurs after the May 20 composite acre time period ($3.94 X .4 = $1.57), the resulting annual average damage on 20 percent of the flood affected land that represents pasture was $1.57.

The remaining 10 percent of flood affected land had no agricultural production value. This portion consisted of roads, wasteland, and farmsteads. No annual average damage was assigned to this land use.

Weighting the damages on the three types of land use--70 percent cropland, 20 percent pasture, and 10 percent nonagricultural--resulted in an annual average damage to flood affected land of $8.71 per acre when using long-run price relationships expressed in 1974 dollars (Appendix Table D-2). The annual average damage using 1974 price relationships was estimated to be $13.03 per acre for land affected by flooding.

APPENDIX TABLE D-2. ANNUAL AVERAGE FLOOD DAMAGE ON A PER ACRE BASIS IN THE DEVILS LAKE BASIN, LONG-RUN PRICES (IN 1974 DOLLARS) AND 1974 PRICES

(1)	(2)	(3)	(4)	(5)	(6)
		Long-Run Prices		1974 Prices	
Land Use	Percent of Total Land Use	Loss Per Acre	Annual Average Loss (2 X 3)	Loss Per Acre	Annual Average Loss (2 X 5)
Cropland	70	$12.00	$8.40	$18.70	$12.72
Pasture[a]	20	1.57[a]	0.31	1.57[a]	0.31
Nonagricultural	10	0.00	0.00	0.00	0.00
	100		$8.71		$13.03

[a]The annual loss to pasture due to flooding was estimated using 1974 cash rent for pasture as a basis. Since land rent does not fluctuate like crop prices, the long-run and 1974 price relationship values were assumed to be equal.

CROPPING PRACTICES WITH REDUCED FLOODING

Flooding Reduced by Half

Respondents were asked how they would change their cropping practices if the frequency of flooding were reduced by half. Over one-half of them (44) said they would not change their cropping practices. The others indicated they would change as follows:

"We would raise more small grains, such as durum and barley, and we would have more summer fallow. We would be able to have more pasture so we could raise more cattle. It would also be easier for us to get to fields because of lower water levels."

"Summer fallow otherwise flooded land."

"Crop more land" (4).

"Four-year crop rotation."

"Seed earlier" (2).

"Less summer fallow" (3).

"Seed more to wheat."

"Less or no summer fallow."

"Keep a better rotation, as 1974 I had to seed ground that should have been summer fallow but had to seed it in order to get a few acres in."

"Seed an alternate crop."

"Three-year rotation."

"We would be able to make production plans with some degree of accuracy."

"Crop that half to help dry it up."

"Less flax on late seeding after water dries."

"Not seed third crop."

"Areas would get cropped more because you would not have to wait for them to dry up."

"Seed more acres to grain crop, less hay and pasture."

"More summer fallow."

"NO CHANGE" (44 respondents)

Flooding Nearly Eliminated

Respondents were asked how they would change their cropping practices if the frequency of flooding were nearly eliminated. Thirty-five said they would not change. The others indicated they would change as follows:

"We would raise more row crops, such as pinto beans and corn silage we would also have better rotations which would inlcude more clover, alfalfa, and summer fallow."

"Less barley and more durum and spring wheat."

"Summer fallow otherwise flooded land."

"Crop more."

"Three-year crop rotation."

"Seed earlier, use more fertilizer."

"More crop rotation, like wheat, to barley, to oats or flax."

"Less summer fallow."

"Seed early."

"Seed a normal crop."

"Continuous crop."

"Seed to crop."

"Crop one more year and feed another nation."

"Use these acres as part of three-year crop rotation."

"Probably go to three-year crop rotation (four years at present)."

"Crops could be seeded on time, late seeding costs in yields and quality."

"Would not have to return to seed in low lands at a later date."

"Seed on summer fallow and second crop."

"Seed more acres to grain crop, less hay and pasture."

"Try to eliminate salinity."

"Go to 1/3 summer fallow."

"Seed more acres and have straight two-year rotation."

"More summer fallow every third year."

"Less summer fallow and go to four- or five-year rotation."

"Less summer fallow."

"Two-year rotation."

"Practices? If it were like it should be, I could again have fields and practice rotations, instead of seeding hills or ridges where you can get them and have to let the rest go to weeds."

"NO CHANGE" (35 respondents)

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