Agricultural Wetland Management

Final Report for ANC96-033

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Project Coordinator:

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Project Information

Summary:

The majority of wetlands in the Prairie Pothole Region of South Dakota are owned and managed by farmers and ranchers. Studies have shown that farming through and/or adjacent to these Prairie Pothole wetlands has environmental and economic risks. The questions asked in this study are:
1. Will buffer strips reduce negative environmental and economic effects of farming wetland landscapes?
2. Are buffer strips socially acceptable?
3. Are buffer strips around wetlands economically feasible?

A farm site with 10 seasonal and temporary wetlands was chosen in Lake County, SD. This site had been environmentally and economically monitored for five years. Buffer strips were established in blocks around eight of the wetlands in 1995. In 1997 and 1998, soil/water/plants were analyzed for nutrient content in the buffered and non-buffered wetlands. Surveys were used to determine farmer attitudes about wetland problems and benefits on agricultural land in SD. Budgets were developed for four wetland management scenarios: all acres cropped, buffer blocks and wetlands not cropped (hay cut from buffers), 75' buffers and wetlands not cropped (buffers cut for hay), and buffer blocks and wetlands enrolled in the Wetland Reserve Program (WRP).

Results of nutrient analyses show that the wetland buffer vegetation is effectively removing nutrients. This means that the nutrients removed by the buffer are being utilized as hay instead of being lost from agricultural production into the wetland system.

Farmer surveys indicated that wetland problems included the inability to plant and harvest crops and the maintenance of weedy species in the field. Wetland benefits included wildlife habitat and groundwater recharge. Opinions about the capacity of wetlands to reduce flooding were divided. Although the wetlands store water which

can reduce downstream flooding, they retain water so that farmed fields are flooded. Most frequently, economic costs and profitability were cited as the major problem. Survey comments suggested that wetland policies should consider private costs to farmers and not just wildlife habitat or flood control functions of wetlands.

Economic comparisons of several wetland management scenarios were completed. Long-term cost and return budgets for transitional no-till, conventional and organic systems were prepared for each of the following scenarios: (1) no wetland buffer strips, (2) wetland buffer strips developed by the owner, (3) 75' wetland buffers strips around wetlands (4) enrolling wetlands and buffer strip acreage in the Wetland Reserve Program (WRP). Returns were greatest for the WRP scenario regardless of farming system.

Two wetland demonstration sites were developed. One located on a farm in eastern South Dakota, and one at a university field station. Information centers were constructed at each site as part of a university class service project. The farm demonstration site was utilized for the Northern Plains Sustainable Agriculture, Harvest Festival and Farm Tour and numerous groups have utilized the university demonstration site.

Project Objectives:

The overall goal of this project was to increase understanding and public awareness of the role of wetland management in the sustainability of agriculture in the Prairie Pothole Region. Following are three specific objectives.

1. Select sites for wetland management
2. Develop and utilize the sites for demonstration and data collection
3. Evaluate the project from social, economic, agronomic, and environmental perspectives

Research

Materials and methods:

Methods / Approach

Objective 1. Select sites for wetland management.

Two demonstration / education sites, one including the research site were selected in the Prairie Pothole Region of Eastern SD. Demonstration / education sites are located at the SDSU, Oak Lake Biological Field Station and at Charlie Johnson's farm in Lake County, SD. The Oak Lake site is approximately 25 miles from the SDSU campus. It was selected based on the criteria of seasonal wetlands in agricultural fields and because of it's utilization for university and community educational activities. The second demonstration / education site, at Charlie Johnson's farm, is located approximately 30 miles from SDSU. It was selected because it is adjacent to the research wetlands being monitored in the research portion of this wetland management investigation, and because we have several prior years of data from the site. The research sites contain 10 seasonal wetlands, 8 buffered and two non-buffered.

Objective 2. Develop and utilize the sites for demonstration and data collection.

Demonstration sites. One of the highlights of this year's activities was the construction of gazebos as information centers at the demonstration sites. The Water Quality in Agriculture class at SDSU constructed the gazebos as an environmental service project. The gazebos were built from kits and were completed by enthusiastic students in less than a morning. Students also selected appropriate materials to be distributed at the information centers. The feedback from the class participants was very positive.

A second highlight was the Northern Plains Sustainable Agriculture, Harvest Festival and Farm Tour held at the Charlie Johnson farm. Participants learned about Native American uses of wetland and prairie plants, about the nutrient filtering capacity of wetlands, and about wetland invertebrates as a waterfowl food source. One of the elementary students attending the field day kept the invertebrate samples to share with his classmates. The project was incorporated into an environmental exchange class with students in Minnesota. They shared information about the benefits of buffers and the measurement of scientific parameters related to water quality.

Data collection sites. Ten seasonal wetlands were selected as data collection sites. The wetlands are located in two fields in near proximity to each other. In 1995, eight of the wetlands were buffered by areas established with a pasture mix. Wetlands 1 and 2 in Field 1 were surrounded by buffer blocks. The blocks allow farmers to square off areas of the field which are not farmed. Wetland 3 in field 1 has a narrow contiguous buffer following the contours of the wetland. In field 3, a group of five small wetlands are contained within a block buffer. Two large wetlands have not been buffered, but have dense wetland vegetation in portions of the wetland (maps of the study sites are contained in the Appendix).

Objective 3. Evaluate the project from environmental, social , and economic perspectives.

Environmental evaluation. From April until wetland dry-down, wetland surface water was sampled every two weeks at four points around the circumference of the wetland. Samples were analyzed using Hach procedure 8039 for nitrate and 8048 for ortho-phosphate (Hach, 1992). Soil samples were collected in the fall and analyzed for nitrate-N, kjeldahl-N, and Bray-P (available P). The samples were collected at five points along four axes extending from the wetland edge. The sample points were: wetland vegetation, inner buffer and outer buffer (when buffers were present), 75' upland and 150' upland. Plant samples were collected in July from the same four axes at wetland vegetation, inner buffer, and outer buffer locations. Plant samples were analyzed for dry weight, nitrogen and phosphorus concentration, and species richness. Nutrient uptake was determined as the product of dry weight and nutrient concentration.

Social evaluation. In order to survey farmers' and others' attitudes in regard to the costs and benefits associated with wetlands, we developed a short survey and presented it to the public at the Farm Fest, a farm-machinery equipment expo, in Mitchell, SD, and at the South Dakota State Fair in Huron, SD. Our survey instrument included sixteen items of which respondents were to respond using a five point ordinal scale. Response categories varied on a continuum from "Not Important" to "Very Important", and included an NA or "Not Applicable" response. We included background questions to allow us to correlate age of respondent, size of farm, number of wetlands on farm and regional variation with response patterns. There was also a section available for comments. (See 1-page survey in Appendix).

Economic evaluation. The economic evaluation was based on the natural resource conditions (cropland acres, soil types and acreage, wetland types and acreage) found in field 1 and field 3 of Charlie Johnson's farm. The key assumptions for the economic analyses follow.

1. Three farming systems and cropping patterns were examined:

______conventional________no till________organic

corn______50%___________50%___________25%
soybeans___26%___________50%__________30%
oats_______6%____________0%___________15%
alfalfa_____18%____________0%__________30%

2. Buffered lands (including farmed wetlands) were seeded and used for native grass hay production, while all other acres were used for field crop and alfalfa hay production.

3. Four crop / wetland management scenarios were evaluated (maps have been included in the Appendix).

A. No Buffers: farm through the wetlands and maximum acres of crop/alfalfa production

B. 75' Buffers: native grass around all wetlands

C. Farmer Designed Buffers: native grass in blocks around wetlands

D. Farmer Designed Buffers: with enrollment in the Wetland Reserve Program (WRP)

4. Farm budget generator (NRCS CARE) and spreadsheets were used to develop long term economic cost/return field budgets based on:

- farmer reported long term crop yields keyed to soil types.

  crop/hay harvested from farmed wetlands only 1/2 of time.

  farmer reported management practices used to estimate costs.

  federal farm program enrollment and current (1998) WRP rules.

  projected baseline crop/hay prices:

· grass hay = $ 46.15 / ton
· alfalfa hay = $ 62.35 / ton
· corn = $ 2.28 / bu.
· soybeans = $ 5.70 / bu. oats=$1.36/bu.

(Organic premiums effectively increased soybean prices by 30% and feed grain prices by 6.3%)

5. Three Economic Scenarios used for sensitivity analyses:

A. Baseline: long term yield and price projections

B. Optimistic: baseline yields and prices increased 10%

C. Pessimistic: baseline yields and prices decreased 10%

6. Annualized WRP returns of $28.10 / acre for a 30 year easement discounted at 8%. The WRP payment was 75% of the land bid price plus 75% cost share for restoration and establishment costs.

Research results and discussion:

This project had both research and demonstration/education goals. The sites were selected and developed, as described in the methods section, to meet objectives one and two. The questions being asked in the third objective were:
1. Will buffer strips reduce negative environmental effects of farming wetland landscapes?
2. Are buffer strips socially acceptable?

3. Are wetland buffer strips economically feasible?

1. Will buffer strips reduce negative environmental effects of farming wetland landscapes?

Wetland water nitrate-N concentrations were less than 1 ppm in both buffered and non-buffered wetland systems (Figure 1). This is significantly less than the 10 ppm nitrate -N standard for safe drinking water and points to the efficiency of the wetland to remove nitrates. Soluble phosphorus concentrations in the wetland surface water were influenced by year and sampling date. In 1997, ortho-P concentrations were less in buffered than non-buffered wetlands (Figure 2). In 1998 the ortho-P concentrations in the buffered wetlands tended to be lower than in the non-buffered wetlands during the early part of the season, but the reverse was true during the last half of the sampling season. This reversal is probably the result of interactions between inputs and P removal mechanisms in the wetland. In the early spring, when the risk of run-off is high, the buffer is growing rapidly and capable of trapping P and sediment before it enters the wetland. Later in the season, as the wetland begins to dry-up, plant decay in the wetland releases P to the system.

Soil nutrient analyses support the conclusion that buffers can reduce environmental risks to wetlands by removing nutrients from soils adjacent to the wetland. Total kjeldahl-N was .35% at the buffered wetland edge compared to .54% at the non-buffered edge (Figure 3). Nitrate-N was .84 ppm higher (Figure 4) and Bray-P 4.18 ppm higher (Figure 5) in soils near the wetland edge in non-buffered than buffered systems.

The analysis most useful to the farmer is the productivity and nutrient uptake of the buffer vegetation. Total nitrogen uptake was 173 pounds/acre in the buffered and 141 in the non-buffered landscapes (Figure 6) . The plant nutrient removal in the non-buffered system was through the wetland vegetation. These nutrients will continue to cycle through the wetland and be lost from agricultural productivity. In the buffered system, 98 pounds/acre of nitrogen were taken up by the buffer and utilized as hay. Plant P content was 22 pounds/acre in the buffered and 14 pounds/acre in the non-buffered system (Figure 7). In the buffered system, half of the total P content was in the buffer hay and half was in the wetland vegetation.

The average vegetative species richness in the zone of emergent wetland vegetation was 4.8 (Table 1). Buffer zone species richness increased to 8.5 near the wetland vegetation and 7.4 near the crop edge . The average vegetative species richness was 6.8 in the buffered system compared to 3.5 in the non-buffered system. Increasing the number of vegetative species improves the quality of the wildlife habitat offered in the field.

2. Are buffer strips socially acceptable?

A copy of the survey used to determine farmer perceptions of wetland problems and benefits can be found in the Appendix. We received 98 responses to the survey, all except two were completed at an SDSU booth at the SD State Fair and the Farm Fest at Mitchell. Two surveys were taken by respondents, completed and mailed in later.

Farmers considered the inability to plant and harvest crops as a major problem for wetland management (Figure 8). Farmers also ranked reduced yields and extra time for management as important problems. Equipment problems, unwanted wildlife, and pests were not ranked as important problems, however wetlands as a source of weeds was ranked as very important by more than 50% of the respondents (Figure 9).

Farmers ranked wildlife habitat and groundwater recharge as important wetland benefits (Figure 10). Opinions about the capacity of wetlands to reduce flooding were divided. Although wetlands store water which can reduce downstream flooding, they retain water so that farmed fields are flooded.

Many responses were in agreement that "the definition of wetlands is not satisfactory." In relation to our demonstration site and wider implications of our project the gathering and sharing of farmers attitudes helped us more favorably respond to farmer's concerns regarding wetlands and share these concerns with agency personnel. Knowledge of farmer's concerns regarding wetlands helped us in developing material to be presented at our demonstration site, and helped us in identifying farmers who show an interest in wetland management.

Knowledge of farmers' attitudes also allowed us to knowledgeably interact with and assist our second target audience (besides farmers) -- agency personnel responsible for enrolling farmers in federal conservation programs (personnel involved in enrolling farmers in the Wetland Reserve Program, for example). Our role was to facilitate an exchange of knowledge and information from farmers to agency personnel, and vice versa.

3. Are wetland buffer strips economically feasible?

Buffered compared to non-buffered wetlands in crop fields. Buffering wetlands reduced crop acres and production levels, but slightly increased average yields per acre (Tables 2-4). Buffering wetlands also reduced gross income and variable costs as lower value grass hay replaced crop production on buffered acres. The absolute and relative level of crop/hay prices and yields had a major influence on the economic performance of buffered wetlands. Higher crop prices and yields tended to favor crop production and non-buffered wetlands, while a higher number of wetlands in a field tended to favor buffered wetlands. The ability to harvest crops and yields obtained from cropped wetlands had a major influence on wetland management (buffered vs. non-buffered).

Net returns from buffered wetland sites were generally lower than net returns from maximum crop production, unless buffered acres were enrolled in WRP or other wetland programs (Figure 11). Net returns from entering buffered wetlands and surrounding other wetland management options, provided the approved WRP plan permits grass hay harvesting once per year. These results suggest that overall, buffered wetlands can be economically competitive with crop production.

Farming systems comparison. Gross income and crop yields were slightly higher and variable costs were lower in the conventional farming system compared to the no till system (Tables 2-4). The organic farming system had lower crop yields, lower gross income, and considerably lower production costs than the no till and conventional farming systems. Net returns to management in each wetland management scenario were (Figure 11):

ORGANIC > CONVENTIONAL > NO TILL

Organic premiums increased gross income from 8.7% to 10.2% depending on wetland management scenario, and were the MAJOR factor explaining superior net returns. Net returns to the organic system (without premiums) were similar to net returns in the conventional farming system.

Net returns from buffered wetland/upland sites were generally lower than net returns from maximum cropped acres for each farming system, unless buffered acres were enrolled in WRP or other wetlands programs. Net returns from entering buffered wetlands and uplands into the Wetland Reserve Program were superior to other wetland management options for the conventional and no till systems, provided the approved WRP plan permitted grass hay harvesting once per year. Net returns to buffered lands in WRP were similar to net returns for maximum crop production in the organic system because of organic premiums.

Research conclusions:

The research and educational aspects of this project will: (1) introduce farmers and others to sustainable wetland management techniques; (2) increase academic' and agency personnel's knowledge of farmer's attitudes and actions in regard to wetlands; (3) clarify the process and problems involved in translating agricultural research into practice; and (4) follow and shed light on the actions and organizational processes of different stake-holding groups acting in different capacities toward wetlands. Perhaps communication channels among the groups will be enhanced or further developed. Another potential contribution is that increased dissemination of the knowledge of economically sound sustainable wetland management techniques will enhance the perceived importance and acceptance of sustainable agricultural techniques. By being able to tie an economic benefit to environmentally sound land -- here wetland -- improvements, the project will work to enhance the acceptance and reputation of sustainable production techniques and government farm-improvement conservation programs. Acceptance of wetland management procedures will also function to protect groundwater, enhance areas for wildlife, and adoption of buffer strips for example will help keep wetlands free of farm chemicals. Tying a productive economic benefit to wetland management thus may mean a greater retention of wetland areas, and more area for flood water storage among other benefits.

Farmer Adoption

Wetland demonstration sites were developed and utilized this year. A keen interest in wetland management was evident in both the student and farmer audiences. A specific recommendation that can be made to farmers is that buffer strips improve environmental impacts of farming wetland landscapes. When coupled with programs such as WRP buffer strips can also improve economic returns from farmed wetland landscapes.

Involvement of Other Audiences

Results of this project have been presented at the "21st Century Agriculture - Creating a Sustainable Future" conference in Aberdeen, SD and at the Wetland Alliance meeting in Huron, SD. "Agricultural Wetland Management" was presented at an Ag-Bio Poster Day at SDSU and at the annual meetings of the American Society of Agronomy. The research results from the study have been incorporated into a class project for two upper level classes at SDSU. Students also constructed the gazebos as information centers at the demonstration sites and selected educational materials for dissemination at the centers.

Farm audiences have been reached through the NPSAS tour and the Farm and Home Research bulletin. Information about wetland functions and values as well as environmental sampling techniques were presented at the demonstration sites and extended to an elementary school program. Many telephone, e-mail, and written requests for information about the project have been met and plans for future outreach are already underway.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

The demonstration sites were intended to educate farmers, students, the general public, and agency personnel on the benefit of wetland buffers. One of the highlights of this year's outreach activities was the construction of gazebos as information centers at the demonstration sites. The Water Quality in Agriculture class at SDSU constructed the gazebos as an environmental service project. The gazebos were built from kits and were completed by enthusiastic students in less than a morning. Students also selected appropriate materials to be distributed at the information centers. The philosophy of service projects was discussed as a powerful mechanism for accomplishing environmental goals. The feedback from the class participants was very positive. Many of them thought it was the most significant part of the course.

A second highlight was the Northern Plains Sustainable Agriculture Society, Harvest Festival and Farm Tour held at the Charlie Johnson farm. More than 100 farmers were present. A farmer's market was organized, an organically produced lunch was served, and panel discussions as well as field tours were well attended. During the "wetland" portion of the conference, participants learned about Native American uses of wetland and prairie plants, about the nutrient filtering capacity of wetlands, about wetland invertebrates as a waterfowl food source, and about ways to manage wetlands and increase economic returns to farmers. Wetland educational materials selected by the SDSU class were distributed to participants. One of the elementary students attending the field day kept the invertebrate samples to share with his classmates. The project was incorporated into an environmental exchange class with students in Minnesota. They shared information about the benefits of buffers and the measurement of scientific parameters related to water quality. A newspaper article about the exchange is included in the appendix along with photographs of NPSAS activities.

The project was also featured in an SDSU Agricultural Experiment Station publication, "South Dakota Farm and Home Research". Five thousand copies of the bulletin are distributed to farmers, agribusiness people and educators in the area.

Participants in this SARE project have joined the SD Wetland Alliance. Members of the Alliance include personnel from US Fish and Wildlife Service, SD Game Fish and Parks, Natural Resource and Conservation Service, Farm Bureau, and the Nature Conservancy. One meeting focused on the economic comparisons developed for wetland management in several farming systems. Members utilized the computer spreadsheets to analyze additional scenarios and test management options. They also took computer disk copies with them to demonstrate in their own agencies.

Two future outreach activities are in the works. Plans for a tri-state sustainable agriculture meeting scheduled for fall of 1999 include a wetland management session and a portion of the SARE project results will also be published in Minnesota and Dakota Farmer. In addition participants will continue to utilize the demonstration sites and educational materials collected as part of the SARE project.

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