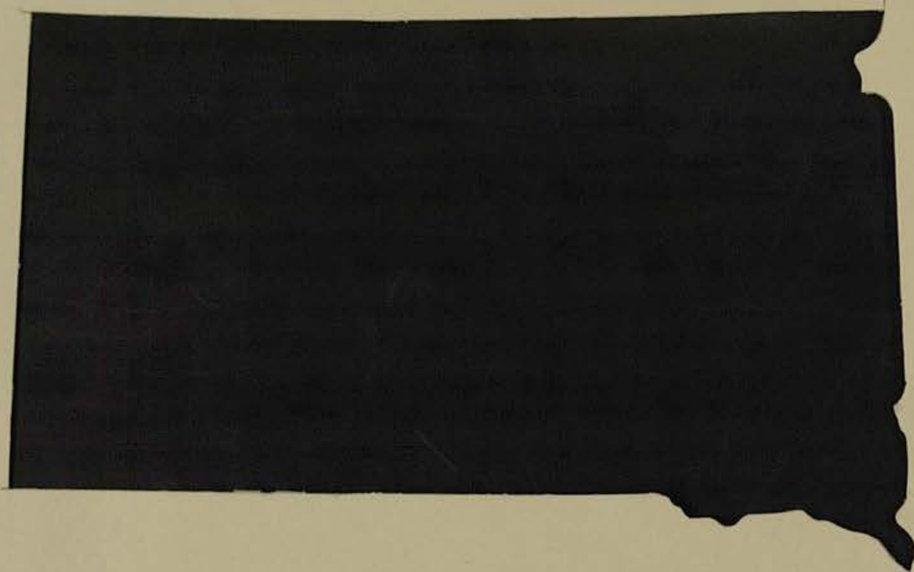

ECONOMICS DEPARTMENT

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Economic and Environmental Contributions of Wetlands in Agricultural Landscapes[1,2]

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ECONOMIC AND ENVIRONMENTAL CONTRIBUTIONS OF WETLANDS IN AGRICULTURAL LANDSCAPES

Larry Janssen, Diane Rickerl, Eric Stebbins, Tom Machacek and Dave Kringen

ABSTRACT

The purpose of this project was to determine key environmental and economic relationships between agricultural practices and wetlands in the Prairie Pothole Region (PPR) of eastern South Dakota. Water quality and water quantity variables were the key environmental parameters examined. Economic cost and returns by farm management system and wetland proximity were the key economic parameters.

The three farm management systems examined were conventional (CON), transitional no-till (TNT), and organic (ORG). The TNT and CON management systems used synthetic fertilizers and chemical pesticides. The ORG system used no synthetic fertilizers and generally no chemical pesticides. The ORG system had greater emphasis on alfalfa and lower emphasis on corn and soybean production.

Water budgets were determined for upland and wetland sites. At the wetland site, runon was the major input to the water budget (60%). Overflow accounted for 36% of the wetland output and surface storage /seepage accounted for 40%. Evapotranspiration at the wetland site was much lower than at the upland site.

Nitrate concentrations were consistently higher in the semipermanent wetland areas than the seasonal wetland areas. The data show a steady decrease in phosphate concentration as we move upland in the landscape. Higher concentrations in wetland than upland groundwater may indicate that some soluble P is moving through the system and/or the sorption capacity of wetland soils is exceeded.

Economic returns and costs of the three farming systems were estimated for 1992 - 1994 at the whole-farm and crop field level. The relative ranking of net returns by management systems were: TNT > CON > ORG, unless organic premiums are a major source of gross income.

Production costs per acre by management system from lowest to highest were ORG < TNT < CON. The organic (ORG) system had lower reported average yields and considerably lower production costs per acre than the other management systems. The TNT system had the least diversity of crop rotations, intermediate-level production costs, and similar yields or higher yields than reported in the CON system. The added costs of more tillage and machinery operations in the CON system exceeded any reduction in chemical costs compared to the TNT system.

Biomass production and most corn/soybean yields were lowest adjacent to wetland sites and increase to peak production at 150' to 300' feet out. Several years of crop budget estimates for ORG, CON, and TNT fields adjacent to monitored wetland sites indicated substandard net returns in most years.

INTRODUCTION

Wetlands are an integral part of agricultural systems in the Prairie Pothole Region (PPR) of eastern South Dakota. South Dakota still retains 60% of its natural wetland acres, compared to 45% in Minnesota, 40% in North Dakota and only 1% in Iowa. The PPR is an integral part of the migratory waterfowl flyway, supporting 138 bird species and more than 1000 plant species. South Dakota has been the number one producer of dabbling ducks in the contiguous United States and annually produces 50-80% of the total duck population. Wildlife habitat is the most commonly cited role of wetlands, but wetlands perform many other roles and functions in agricultural landscapes. Wetlands impact agriculture by storing water for groundwater and soil moisture recharge, trapping sediment and runoff from upland areas, and providing hay and forage.

Maintaining wetlands in the agricultural landscape may play an important role in storing water for agricultural use. Groundwater recharge in the Northern Plains can rely on ponded water in depressions rather than on uniform infiltration over the entire soil surface (Malo 1975). Studies by MacLeod (1977) indicate that wetland drainage has a negative impact on hydrologic stability in vulnerable areas. Modelling studies in Iowa (Campbell and Johnson 1975) predict greater topsoil moisture in undrained than completely drained depressional watersheds. Water movement from the surface of the water table to surrounding landscape positions (Malo 1975) or to overlying topsoil in response to thermal gradients during winter months has been documented.

A critical role of wetlands in agricultural landscapes is nutrient pollution abatement. Wetlands act as nutrient filters, for nitrogen and phosphorus (Sather and Smith, 1984; Nixon and Lee, 1986; Johnston, 1991). Nitrogen and phosphorus may be transported into wetlands via agricultural runoff. Nutrients may also be introduced to wetlands as a result of farm through practices during dry years. The nutrient filtering function of wetlands includes the denitrification of nitrates to nitrogen gases and the sorption of phosphorus by wetland sediments.

Gaseous loss of nitrates through denitrification is well documented for many wetland systems (Johnston, 1991). Alternate wetting and drying cycles typical of seasonal wetlands favor denitrification (Reddy, and Patrick 1975). Davis *et al.* (1981) reported that 86% of NO_3-N entering a marsh (located in a basin dominated by corn/soybean agriculture) was removed. Jones, *et al.* (1976) investigated the relationship between land use and nutrient output in 34 watersheds in northwestern Iowa. They found that NO_3-N was negatively related to the percentage of area in wetland.

The fate of phosphorus in wetlands is generally linked to the sorption capacity of the wetland soil. Both organic (Reddy and Graetz,1981) and inorganic (Richardson,1985); components of the soil are capable of sorbing P. Davis, *et al.* (1981) measured phosphorous levels in the influent and effluent throughout an entire draw-down, refill cycle of a semipermanent wetland. During the drought years (3 out of the 4 years studied) there was no effluent, and the marsh served as a sink for P. In freshwater systems, P is bound by sediments and recycles with the water column at a slower rate than in marine systems (Caraco, *et al.*, 1990).

Investigations in which wetlands have received wastewater with high concentrations of nitrogen and phosphorus indicate that while nitrate removal through denitrification is relatively efficient (Bartlett *et al.*, 1979, Brodrick *et al.*, 1985), the capacity of soils to sorb phosphorus is limited (Richardson, 1985) and phosphorus saturation can occur within a few years. Brinson, *et al.* (1984) reported that the capacity of an alluvial floodplain swamp to remove added nutrients was highest for nitrate, intermediate for ammonium, and lowest for phosphate. The limiting factor for phosphorus removal was the ability of sediments to sorb phosphorus.

It is possible that nitrogen that is not lost to the atmosphere through denitrification and phosphorus that is not sorbed to sediments could be passed through the aqueous system between wetland and groundwater. Although semipermanent wetlands in the PPR are typically groundwater flow-through systems, temporary and seasonal wetland basins in the PPR are known to be groundwater recharge sites (Hubbard 1988, Hubbard, *et al.* 1988).

Wetland linkage to both surface water and groundwater makes non-point source pollution a double threat. In addition, ecological impacts on the wetland and actual costs to producers have traditionally been ignored. Regardless of the nutrient filtering efficiency of wetlands, it is not agronomically or economically efficient to convert crop nutrients into forms which are generally less available.

A more efficient use of runoff nutrients would be return to an agronomic product. This could be accomplished through the establishment of buffer areas surrounding wetlands. The buffers could be used for hay, forage, or biofuel production. To maximize productivity, species selection for the buffer area should include vegetation adapted to wet soil conditions and yet suitable to the intended use.

The social value of wetlands arises from wetland functions that contribute to human satisfaction. Wetland functions include biodiversity, groundwater recharge/discharge, water storage / conveyance, water quality provision, habitat provision, and direct human use of wetlands for hay, livestock forage, game production and hunting, and other recreation. These wetland functions produce outputs that may be valued by society. These economic and environmental variables are the major factors that influence the social value of wetlands in agricultural areas (CAST, 1994, Berry and Buechler, 1993).

The economic demand for wetlands is derived from both the demand for wetland outputs and availability of other sources that can produce the same outputs. Wetland benefits may be grouped into conservation, direct output, indirect output, and nonuse benefits. Wetland owners, especially in agricultural areas, tend to place the highest values on direct output and conservation benefits of wetlands that impact the profitability of their farm operation (CAST, 1994). An important indirect output of wetlands that impacts profits is the effect of wetlands on crop yields in adjacent fields.

Social accounting systems have been proposed for comparing environmental and economic benefits of wetlands (Leitch 1981; Scodari 1990, Barbier, 1994). Social accounting systems have been developed and applied to economic and water quality tradeoffs of Conservation Reserve Program (CRP) lands (Ribaudo, 1990; Napier, ed. 1990). In addition, the relative merits of economic techniques (contingent valuation, hedonic pricing, damage cost and others) for valuation of wetland environmental benefits have been examined by Scodari (1990).

Crop and forage economic budgets for agricultural fields containing wetlands are the basic data used to evaluate wetland conversion decisions. Economic evaluation of wetland conversion decision in the Prairie Pothole Regions of Canada indicates the main factors favoring conversion of wetland to cropland are: crop price levels, government farm and conservation programs, owners nonuse of wetlands for hay/forage, and higher costs of field operations to farm around wetlands (VanKooten, 1993).

The agronomic, economic, and ecological performance of organic, conventional, and reduced-till farming systems has been compared over a 7-year period in northeastern South Dakota. The organic system compared favorably in net returns and depended less on government program payments than the other systems. The agronomic performance (yields) of the three farming systems varied depending on specific crop rotations and cultural practices used. Based on the distribution of nitrate in the soil profile, the potential for groundwater pollution was higher in the conventional and reduced-tillage systems (Smolik, Dobbs, and Rickerl, 1995).

Farming systems studies in South Dakota and Kansas tend to show alternative (organic) systems are more competitive in areas dominated by small grains or in the transition areas between corn and small grains and less competitive in corn-soybean areas (Smolik, et.al. 1993; Diebel et.al. 1993). The relative economic and environmental performance of farming systems in agricultural wetland areas of the Prairie Pothole regions of the Northern Plains has not been reported in the literature.

The purpose of this project was to determine key environmental and economic relationships between agricultural practices and wetlands in the PPR of eastern South Dakota. Water quality and water quantity variables are the key environmental parameters discussed in this report, while farm management economic cost and returns by agricultural management system and wetland proximity are the key economic parameters discussed.

DESCRIPTION OF STUDY SITE AND AGRICULTURAL MANAGEMENT SYSTEMS

The main criteria used to select the study sites were wetland types (temporary, seasonal, and semipermanent), wetland hydrology and agricultural management systems that were characteristic of the Prairie Pothole Region of eastern South Dakota.

Site Description

The study site, located in the Skunk Creek watershed of eastern South Dakota, is predominantly agricultural with wetlands ranging from one-fourth acre to thirteen acres in size and occupying approximately 15%-25% of the cultivated acreage. The Skunk Creek watershed overlies portions of the Big Sioux and Vermillion Aquifers and is primarily located in Lake and Minnehaha counties (Figure 1).

Soybeans and corn are the primary row-crops produced, usually in rotation, and occupy 65% of farmland acres in these two counties. Acres harvested for hay are another 7% of total farmland acres, while small grains (wheat and oats), permanent pasture and other land uses account for the remaining farmland. Crop yields in this area exceed whole-state,long term averages with corn yields averaging 84 bu/acre and soybean yields averaging 28 bu/acre.

Average growing season precipitation is 16-18 inches with the majority occurring in June. Rainfall distribution during the growing season is generally adequate for crop production and irrigation is of minor importance in the Skunk Creek watershed.

Average growing season length is 140 days, with nearly 2900 growing degree days above 50 degrees Fahrenheit. Evaporation / transpiration rates during summer months are a maximum of 0.23 inches per day. The last spring freeze usually occurs between April 30 and May 4, and the first fall frost usually occurs between October 5 and 9. Average soil frost depths range from 3-5 ft and are deepest during late February, with soils completely thawed by mid-April.

Three Agricultural Management Systems

Within the study area, three farms with distinctly different management systems were selected for this study: transitional no-till (TNT), conventional (CON), and organic (ORG) farming systems. Each farm management system differs greatly in use of crop rotations, tillage practices, and chemical inputs. However, these farms have common features that facilitate detailed agronomic and economic comparisons:

1. The three systems are located close to each other with cropland located on similar soil types (Figure 1). The TNT and ORG farms are located in southern Lake county while the CON farm, located in northwestern Minnehaha county, is less than 10 miles from the other two farms.

2. The principal crops on each farm include corn, soybeans, alfalfa and some small grains which is representative of area cropland use.

3. Each farm has semipermanent, seasonal, and temporary wetlands. The proportion of wetland acres and hydric soil acres are similar in each management system.

Cropland is the dominant land use and the cropping pattern of corn, soybeans, and alfalfa are well established in each management system. Some acres of small grains (wheat, oats, barley, or rye) are also included. The organic (ORG) system has a much greater emphasis on alfalfa production and lower emphasis on corn and soybean production, compared to the conventional (CON) or transitional no-till (TNT) system.

The TNT and CON management systems use synthetic fertilizers and chemical pesticides. The TNT system uses tillage only when herbicides fail to control weeds or during periods of excessive rainfall as in 1993. Crop residue management is a high priority in the TNT system.

The conventional (CON) management systems uses tillage as the primary weed control method. Chisel plow, tandem disks, and cultivators are the primary tillage equipment, with a moldboard plow used for breaking an established alfalfa stand. Chemical pesticides are used as the secondary weed control method with chemical input use per crop acre similar to or lower than amounts used in the TNT system.

The organic (ORG) system uses no synthetic fertilizers and generally no chemical pesticides. Strict adherence to crop rotations, which includes small grains and use of cover crops to protect the soil, is a major characteristic of the ORG system.
Tillage is the primary weed control method, with crop rotation and some hand weeding used as secondary sources of weed control. The organic system has the most tillage operations including the use of a tandem disk, chisel plow, field cultivators, harrow, rotary hoe, and row cultivators.

A corn-soybean crop rotation is used in the TNT management system. Alfalfa is an important crop in this system, but is not routinely used in an established crop rotation. The CON system uses a crop rotation of corn, soybeans, small grain interseeded with alfalfa, and three years of alfalfa for some fields. However, consecutive years of corn on corn are planted in several fields due in part to a large ASCS corn base. The organic crop rotation strictly follows this pattern:

Year 1..........small grain interseeded with alfalfa
Year 2..........alfalfa
Year 3..........alfalfa
Year 4..........soybeans
Year 5..........corn
Year 6..........soybeans

Farm size (acres operated) has varied for each management system from 1988 - 1994. During this seven year period, the TNT farm has expanded from 1200 acres to 1600 acres and the ORG farm has expanded from 1040 acres to 1275 acres. Meanwhile the CON farm has operated 480 to 720 acres. The proportion of cropland acres to total acres operated in each farm is 70% in the TNT farm and 63% in the ORG and CON farms.

The major focus of this study is on predominantly cropland tracts operated in each management system which contain wetlands selected for monitoring. These tracts have been operated by the farmer for all or most of the seven year period, and have been consistently managed according to the cultural practices discussed above. These tracts and monitored wetland sites were also used to obtain water quantity data for wetland and upland landscapes, water quality data, biomass yield and crop yield data at the field-level and by proximity to the monitored wetlands. Data in Table 1 contains a summary of the soils and wetland characteristics of these tracts.

Soil and Wetland Inventory by Management System

The three agricultural management systems have similar soil types present on their respective cropland involved in the study. The Egan and Ethan soil series are the dominant soil types of the cropland in each of the three farm management systems. The Egan soils have medium to high fertility while the Ethan soils have medium to low fertility. The Whitewood soil series, present on 9 - 12 percent of cropland acres in all three systems, is somewhat poorly drained and high in fertility.

Water and wind erosion are potential threats on all three management systems. The majority of cropland acres in all three systems are Land Capability Class 2e, 3e and 4e soils.[1] These soils are considered potential erosion hazards, therefore crop residue management is an important component of all three systems.

The soil types present on the three farms are commonly found in this area. Most soil types in this area are in land capability classes 2 and 3. Commonly cropped soil series are Egan, Ethan, and Moody silty

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[1] "Soils in Land Capability Classes 1, 2, 3, and 4 are normally considered suitable for cropland, soils in Land Capability Classes 5, 6, and 7 are suited for range and timber production, and soils in Land Capability Class 8 are considered to have little agricultural value. As the Land Capability Class numerical rating increases there are increasing limitations to crop, grass, and timber production. The four Land Capability Subclasses are **e** (erosion potential or slope), **w** (wetness), **s** (root zone)., and **c** (climate, too dry or too cold). These subclass symbols identify the limitation for crop, grass, and timber production while the numerical class value (1-8) identifies the severity of the limitation." adapted from SDSU Plant Science Pamphlet #26: Soil Productivity Ratings and Estimated Yields for Lake County, SD.

clay loams classified as Udic Haplustolls. Hydric soils in the area that are present on the farm sites include Whitewood, Worthing, Tetonka, and Lamo.

Hydric soils[2] are present on 15% of TNT cropland, 21.9% of CON cropland, and 24% of ORG cropland involved in the study area. Hydric soils have a land capability classification of 2w, 4w, 5w, or 8w which indicates its suitability for cropland use. Hydric soils with a 2w or 4w designation are likely to have some farmed through temporary wetlands. Hydric soils classified as 5w and 8w have wetlands with little cropping potential.

Wetland inventory acres were calculated using the Fish & Wildlife Service wetland maps prepared by the National Wetlands Inventory (NWI). The wetland acres enumerated in the NWI system are 6.9% of total acres in the TNT management system, 10.8% of total acres in the CON management system, and 10.6% of total acres in the ORG management system. For each farm, NWI enumerated wetland acres are about one-half of the hydric soils acreage.

It is important to remember that not all hydric soils (as defined by NRCS) are mapped as wetlands on the NWI. The criteria used for classification and the classification systems themselves are not equivalent. The NWI wetlands inventory maps and NRCS soil survey maps were both used to select monitored wetland sites that are representative of wetland hydrology in the PPR of eastern South Dakota.

ENVIRONMENTAL EFFECTS

Data Collection and Analysis Methods

Twelve wetland sites were selected for intensive monitoring of hydrological and chemical properties. Data in Table 2 summarize the characteristics of the wetlands selected. Considerations for selection included representation of each farming system, soil classification and wetland type, as well as wetlands which had been farmed through and/or altered. As much as possible, wetlands isolated from effects of practices in adjacent farming systems were selected in order to accurately assess water quality data.

Data collection began in the fall of 1993 and was expanded in 1994. The wetland sites were instrumented with sample wells (1993) on two axes extending from the wetland border to upland areas. Each axes has a well at the wetland border (wetland) and 75 ft from the wetland border (upland) locations making a total of four wells at an average depth of ten feet at each wetland site. Run-off collection weirs were placed (1994) 75 ft from the wetland border, with three

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[2] The Natural Resource Conservation Service definition of a hydric soil is " a soil that is saturated, flooded, or ponded long enought during the growing season to develop anaerobic conditions in the upper part".

weirs installed at each seasonal wetland and five weirs installed at each semipermanent wetland.

Water budgets were developed from measured and calculated data at upland and wetland sites from June 1 to August 31. The upland was defined as the watershed area for the wetland and was larger than the wetland area. The input for upland budgets was precipitation and soil water. The outputs were runoff, evapotranspiration, and seepage. In the wetland water budgets inputs included precipitation, soil water, and runon. Outputs were evapotranspiration, seepage/surface storage, and overflow.

Water quality samples were collected from the wells and surface water on a two-week cycle throughout the growing season. Upland and wetland groundwater samples were collected with a portable Masterflex sampling pump using the third 250 ml sample for analyses. Wetland surface water samples were collected at the end of each sample well axes. Water quality samples were immediately analyzed for nitrate and orthophosphate concentration using a portable Hach DR/2000 spectrophotometer. Nitrate was measured using the cadmium reduction Method 8039 and orthophosphate was measured using the Phos Ver 3 (Ascorbic Acid) Method 8048 (Hach, 1992). Surface runoff was collected from weirs following each significant rainfall event (usually > 1 in). Runoff water was analyzed for nitrate and orthophosphate concentration using the procedure described above.

Total above-ground biomass production was determined from three one foot square samples randomly collected from areas of emergent wetland vegetation (wetland), crop areas bordering the wetland vegetation (border) and each piezometer location (75, 150, and 300 ft). The samples were oven dried and weighed to determine dry matter production in each zone.

Environmental Results

Water quantity. Two significant differences in hydrologic variables, due to farming system, were measured. Soil water decreased in the CON wetland system more than in the other two and runoff in the TNT system was greater than in the other two systems. However, both of these impacts resulted from management practices to offset wet field conditions. Wetland management in the CON system included mowing and plowing the wetland borders in 1993. These practices contributed to water loss from the soil profile. Increased runoff in the TNT system reflected the percentage of unplanted acres and fall tillage in 1993 rather than an attribute unique to the farming system. Significant differences due to wetland class were not found.

Figures 2 and 3 partition inputs and outputs for upland and wetland sites. At the upland sites precipitation was 85% of the input with soil water supplying 15% of the output. The major upland output was evapotranspiration (72%). At the wetland site, runon was the major input to the water budget (60%). This indicates the potential for non-point source pollution of wetlands in agricultural areas. Overflow accounted for 36% of the wetland output. Generally, overflow from prairie potholes is minimal. The large portion of the wetland water budget partitioned to overflow indicates the effects of unusually high rainfall. Surface water storage/seepage accounted for approximately 40% of the total wetland budget. This portion of the water budget represents the potential recharge for groundwater and/or soil moisture in the area. Evapotranspiration at the wetland site was much lower than at the upland site.

Water quality. Differences in nitrate concentration between seasonal and semipermanent wetland classes were significant for the WGW samples in 1993 and for UPG, WGW, and WSW in 1994 (Table 3). Nitrate concentrations were consistently higher in the semipermanent wetland areas than the seasonal wetland areas. Denitrification is favored by wet/dry cycles typical of seasonal wetlands. It is effective in reducing nitrate concentrations in the wetland surface water with concentrations remaining low in the surrounding groundwater. In 1994, the upland groundwater nitrate concentrations exceeded drinking water standards regardless of wetland classification (seasonal 11 ppm and semipermanent 17 ppm).

Orthophosphate concentrations were not significantly different due to wetland classification in 1993, but were higher in seasonal than semipermanent wetland areas in 1994 (Table 4). The seasonal wetlands in the study have narrow vegetative borders which separate them from the managed crop area, compared to the semipermanent wetlands which have wider vegetative borders between the wetland and crop area. The wider borders help buffer the semipermanent wetlands from the effects of agricultural run-off carrying nutrients to the wetland surface water (Messmer, 1991). The data show a steady decrease in orthophosphate concentration as we move upland in the landscape. Higher concentrations in WGW than UGW may indicate that some soluble P is moving through the system and/or that the sorption capacity of the wetland soils has been exceeded. In areas where agricultural run-off carries high concentrations of P, the ability of wetland sediments to sorb P may be exceeded as it is in wetlands receiving wastewater (Bartlett et al.,1979, Broderick et al., 1988). Our data show significant differences ($p=0.05$) between wetland classification and specific nutrient concentrations in both surface water and groundwater.

Differences in water quality due to farming system are presented in Tables 5 and 6. There was a significant interaction between farming system and wetland class. Values for Fisher's Least Significant Difference at the 0.05 level of probability have been included where appropriate. Nitrate concentrations in upland groundwater samples at the semipermanent wetland sites were consistently higher in the ORG than the TNT system. The upland farm management system for the ORG has been alfalfa with manure application during the two years of the study. The addition of legume and manure N coupled with the lack of a crop in the rotation with high N uptake has probably contributed to the higher nitrate concentrations. At the seasonal wetland sites, nitrate concentrations in the WGW were higher for the TNT system than the ORG system. Differences due to farming system were not significant for nitrate concentrations in the wetland surface water, which supports the findings of others who determined that denitrification in wetland sediments was a major form of nitrate loss.

Orthophosphate concentrations were not affected by farming system in 1993. In 1994, seasonal wetland groundwater samples had higher concentrations of orthophosphate in the ORG farming system (0.68 ppm) than in the TNT system (0.20 ppm). These differences were not found in the seasonal upland or the surface water samples and are not clearly related to farm management system. However, the trend is consistent with the 1993 data.

Differences in orthophosphate concentrations due to farming system at the semipermanent wetland sites were significant for the surface water sample only. The TNT system contained 1.14 ppm orthophosphate compared to 0.14 in the ORG system. The trend was similar, although not statistically significant ($p=0.05$), in 1993. The influence of bufferstrips is evident when comparing farming systems as well as wetland class. The ORG system has a wider buffer area than the TNT system and was effective in maintaining low concentrations of orthophosphate.

Biomass. Results indicated that biomass production varied with distance from the wetland and with wetland classification (Figure 4). For the temporary and seasonal wetlands, biomass increased from the wetland to the 150 ft increment and then decreased slightly at 300 ft. These wetlands had been planted to row crops which were unproductive in the wet seasons of 1993 and 1994. In the semipermanent wetland areas, biomass production was greatest for emergent wetland vegetation. Crop biomass at the wetland edge was approximately half that of the wetland vegetation, and increased steadily toward the upland. The implication of these results, coupled with yield data and economic analyses discussed below, is that wetland management should include 75 ft buffer areas around the wetlands. These buffers can be used for hay or forage production.

The above water quantity, water quality, and biomass results were obtained under conditions where growing season (April - September) precipitation was 180% - 185% of normal (31 inches vs. 17 inches) in 1993 and near normal in 1994. Growing season days were below-normal in both years. Soil moisture conditions were above-normal at the beginning of the growing season in 1993 and 1994 (SDASS Crop Weather Reports, 1992 - 1994). The water quantity relationships and biomass production results by proximity to wetlands would likely change under growing season conditions of below-normal precipitation and above-normal temperatures.

FARM MANAGEMENT ECONOMICS - METHODS AND ASSUMPTIONS

Data Collection and Analysis Methods

On-farm interviews and field inspections were conducted each year to obtain detailed agronomic and economic information about each management system. The major characteristics of each agricultural management system were determined. This includes information on specific cultural practices and production inputs for each crop by management system and detailed data on machinery inventory and usage. A detailed cropping history, including farmer reported yields per crop per field from 1988 - 1994, was obtained and verified on a whole-farm and individual field tract basis.

Farm Management Budget Assumptions

Whole-farm and field-level enterprise budgets were developed to compare economic costs and net returns to management in each agricultural management system. The computerized farm management budget generator CARE (Cost & Return Estimator), developed by USDA - NRCS, was used in developing the whole-farm budgets and individual field budgets. A flow-chart of the budgeting process and list of key commodity price, deficiency payment, and organic premium assumptions are shown in Figure 5.

The procedures used to develop farm budgets are designed to carefully estimate the economic costs and net returns associated with the machinery, labor, and land resource base of each farm operator and each farm management system. Farmer interviews were the major information source for all cultural practices, machine operations and crop yields. Farmer interviews and ASCS offices were used to obtain the farm program parameters used in each budget.

Gross income is equal to value of production (volume of production * estimated selling price) plus government payments (including deficiency payments and disaster payments) and crop insurance payments. The organic (ORG) producer may also receive organic market premiums on a portion of corn and soybean production.

Crop prices are the marketing year average price and are used to calculate the value of crop production in each management system, regardless of amount sold, stored or fed to livestock (SDASS, 1994). Gross income in the ORG crop budgets also includes the amount of organic price premiums reported weighted by the proportion of corn and soybean production receiving the premium.

Deficiency payments used in the budgets reflect the percentage of planted acres eligible for payments. The farm operators of the TNT and CON systems plant more acres to corn than are eligible for payment, therefore the deficiency payment received per acre is the percentage of eligible acres planted to total acres planted. The organic farm (ORG) operator received deficiency payments on all acres of planted program crops. Because the ORG farmer is enrolled in the

Integrated Farm Management Program Option (IFMPO)[3] , deficiency payments are also received on resource-conserving crops as if the program crop had been planted.

Disaster payments were made on qualified 1993 corn, wheat, oats, and soybean acres. For corn, wheat and oats the disaster payment rates are $1.79, $2.60, and $0.94 per bushel which is 65% of the established target price for each crop. The soybean disaster payment is $3.52 per bushel.

Economic costs are the sum of all operating, nonland input, and land costs associated with crop production.[4] This includes all cash production costs, machinery operation and replacement costs, and opportunity costs for operating capital, family labor, and cropland. The opportunity costs represent long term resource ownership costs for land, labor, and capital. **Net return** to management is equal to gross income minus economic costs.

These budgeting procedures allow comparison of economic costs and returns by agricultural management system, regardless of each farm operator's specific financial situation and land tenure situation. These procedures were also used to compare economic costs and returns by proximity to wetlands.

ECONOMIC RESULTS BY MANAGEMENT SYSTEM AND WETLAND PROXIMITY

Crop History and Crop Yields by Management System

A review of cropping history by management system (Table 7) indicates cropland acres are 69% of total acres operated in the TNT and ORG systems 64% of total acres operated in the CON system.

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[3] The Integrated Farm Management Program Option is a "voluntary commodity program flexibility option designed to assist producers in adopting more sustainable farming systems that incorporate resource-conserving crops planted on paid acres (acres eligible for deficiency payments) and by allowing some harvesting on set-aside acres". (USDA Farm Program Options Guide, p. 3)

[4] **Operating costs** used in the crop budgets include the following items: machinery repairs, fuel, lubrication, and labor; machinery housing, insurance, depreciation, and labor; crop drying costs; and interest on operating capital. **Nonland input costs** include: seed, fertilizer, herbicides, and pesticides; crop insurance; storage charge for all crops grown; and trucking costs to point-of-first sale. **Land cost** are equivalent to gross cash rental rates of $51.75 per crop acres in the study region, which represents 9% of average cropland value of $575 per acres. Land costs include real estate taxes and net return to land ownership.

From 1988 - 1994 an average of 70% of cropland acres in the TNT system were planted to soybeans or corn for grain compared to 59% of cropland acres in the CON system and only 46% of cropland acres in the ORG system. Corn acreage harvested for grain was 43% of crop acres in the CON system, 34% in the TNT system, and only 20% of crop acres in the ORG management system. The ORG system has a much greater emphasis on alfalfa production compared to the CON or TNT system.

Crop yields for corn, soybeans, and alfalfa are usually lower in the ORG system than in the TNT or CON management systems. The seven-year average corn yield per harvested acre is 92 and 96 bushels, respectively, in the TNT and CON systems and 77.4 bushels in the ORG system. Seven year average soybean yields per harvested acre are 36.1, 31.6, and 25.1 bushels respectively in the CON, TNT, and ORG systems. Farmer reported alfalfa yields in the ORG system are an average of 0.6 tons lower than reported in the CON system and 1.5 tons per acre lower than reported in the TNT system.

Extremely wet weather conditions in 1993 had a major impact on cropping pattern and crop yields in all managment systems. For example, more than one-half of TNT and ORG cropland acres intended for corn and soybean production were prevented planting acres. Overall, one-half of TNT cropland and 32% of ORG cropland were prevented planting acres in 1993. By contrast, all of the cropland acres were planted in the CON system. The major difference was due to timeliness of planting because the topsoil on the CON farm was less saturated than on the other two farms.

The 1993 growing season resulted in much lower corn and soybean yields on harvested acres. Corn for grain and soybean yields in the CON system were, respectively, 70% and 50% of the previous five year (1988 -1992) average yields. Corn for grain and soybean yields in the TNT and ORG systems were between 10% and 25% of the previous five-year average. A majority of harvested corn acres in the TNT and CON systems were harvested for silage, compared to relatively minor amounts of silage production in other years.

The standard deviation of corn yields differed by management system, with the lowest variation (12.2 bushels) occuring in the conventional system and much higher variation (29.1 and 30.4 bushels per acre) occuring in the ORG and TNT systems. The major reason is the different management system response to the 1993 crop year. The standard deviation of soybean and alfalfa yields were similar by management system.

Economic Costs and Returns by Management System

Economic costs and returns by management system for 1992, 1993, and 1994 are summarized in Table 8. Net returns to management in all farming systems are highest in 1994, compared to 1993 and 1992. The primary reasons were corn and soybean yields considerably above long term average yields and above yields reported in 1992 and in 1993.

In each year, the relative ranking of net returns by management system are TNT > CON > ORG, unless organic premiums from soybean and corn sales are a major component of gross cash receipts. For example, 1994 net returns to management were $62.23 ($58.28) per acre in the TNT (CON) management systems. The organic (ORG) system had 1994 net returns of $26.22 per acre excluding organic premium income and net returns of $71.39 per acre including organic premium income.

A review of organic marketing information in Figure 5 indicates the volatility of organic price premiums and amount of crop production that qualifies for organic premiums each year. For example, no 1993 corn or soybeans were sold on the organic market, while all of the 1994 soybean crop and nearly 20% of the 1994 corn crop was sold on the organic market.

Production costs per acre by management system from lowest to highest are ORG < TNT < CON. The organic (ORG) system has lower reported average yields and considerably lower production costs per acre than the other management systems. The organic system also has greater reliance on a diversified crop rotation system. The TNT system generally has the least diversity of crop rotations, intermediate-level production costs, and similar yields or higher yields than reported in the CON system. The added costs of more tillage and machinery operations in the conventional (CON) system exceeds any reduction in chemical costs compared to the TNT system.

The conventional management system generates the highest gross revenue and highest total economic costs per crop acre. For example, gross income per crop acre in 1994 was $249.82 and total operating and nonland input costs were $139.79 per crop acres. Due to the large corn base, The CON system was also the most dependent on Federal deficiency payment income.

The transitional no-till (TNT) system was slightly more profitable than the conventional (CON) system, primarily due to lower operating and material costs. The TNT system has the least reliance of the three management systems on Federal deficiency payments as a percent of gross crop income.

The organic (ORG) system has considerably lower gross revenues and lower operating and material costs per acre than found in the TNT and CON systems. For example, 1994 gross income including organic premium income is $196.63 per crop acre and $151.45 per crop acre excluding organic premium income. Total operating and material input costs of $73.49 per acre are $45.20 per acre lower than in the TNT system and $66.30 per acre lower than in the CON system.

Production costs per acre in all management systems are highest for producing corn and also differ greatly between management systems. For example, total operating and material input costs for 1994 corn production by management system are: CON = $169.99 per acre, TNT = $153.27 per acre, and ORG = $104.98 per acre. Corn production costs are higher in the CON system due to more tillage operations and similar chemical use relative to the TNT system. Almost all of the reduced corn production costs in the organic system is due to no chemical fertilizer, herbicide, and pesticide costs.

Extremely wet weather conditions in 1993 resulted in drastically reduced economic returns to management in all farming systems. Economic returns to management in 1993 varied from $8.02 per acre in the TNT system to -$5.33 in the ORG system. The conventional (CON) system was the only management system with most crop acres harvested in 1993, due to early planting decisions and less saturation of the soil profile.

Disaster payments were a major factor in stabilizing farm income for the TNT and ORG systems and were the main reason that net returns in these systems were reasonably close to net returns in the CON system. Crop disaster payments were collected on 846 cropland acres on the TNT farm and 683 cropland acres on the ORG farm. Nearly one-half of gross income from cropland in the TNT and ORG system were Federal disaster and deficiency payments, with most of this income in the form of disaster payments. Value of farm production (excluding Federal payments and crop insurance) in the TNT and ORG systems were less than material and operating expenses in each system!

Overall, the **five** major reasons for differences in per crop acre net returns by management system are differences in:

(1) reported average yields per crop by management system,

(2) costs per acre of producing crops by management system,

(3) crop mix and crop rotation (proportion of corn, soybeans, alfalfa, and small grains),

(4) availability and extent of organic premiums, and

(5) the different impacts of 1993 weather conditions and disaster program provisions on each farm.

Economic Costs and Returns by Proximity to Wetlands

Two yield data collection approaches were used to estimate economic costs and returns by proximity to wetland sites:

(1) objective yields collected by SDSU agronomists at varying distances from monitored wetland sites, and

(2) farmer-reported yields for all crop fields adjacent to or including the monitored wetland sites.

Corn and soybean yields were collected from all monitored wetland sites adjacent to planted corn or soybean fields in 1992 and 1994[5]. Yields were collected from the following distances: 1st crop row out from wetland, 75' and 150' and 300' out from 1st crop row sampled. Regardless of management system, corn objective yields were lowest adjacent to the wetland site and average net returns to management were negative. Corn objective yields and net returns to management increase as distance from wetland site increases (Figure 6). The relationship of soybean objective yields and net returns to management as distance from wetland site increases was site specific and no general conclusion was made.

Crop budgets were used to estimate economic costs and returns for all fields adjacent to monitored wetland sites. These fields contain about one-fourth of crop acres in each management system. The budgets were developed and net returns were averaged for six years of farmer-reported crop yields from 1988 - 1994, excluding 1993 when most of these fields were prevented planting acres. Average annual deviations from the whole farm net crop return and the whole farm net return were calculated as another measure of variability.

The major findings from these wetland adjacent field net return comparisons were: (1) most ORG and CON fields adjacent to monitored wetland sites had below-average net returns, while (2) most TNT fields had average net returns. Average field size was larger in the TNT system, so a smaller proportion of the field contained hydric soils or was directly influenced by wetland conditions. Consequently, farmer-reported yields and net returns were similar to whole-farm average. By comparison, the six-year average net returns were negative for 5 of 13 ORG fields and below whole-farm average net returns for 12 of 13 ORG fields adjacent to monitored wetland sites.

SYNTHESIS, CONCLUSIONS AND IMPLICATIONS

Economic analysis indicates that all three agricultural management systems (TNT, ORG, and CON) are well-managed from a production standpoint and are generally profitable in the study region. Gross returns per acres are considerably lower in the organic system because ORG crop yields per acres are generally 75% - 90% of per acre crop yields reported in the CON or TNT systems. However, crop production costs in the ORG system are substantially lower than in the other management systems. The relative ranking of net returns is usually TNT > CON > ORG, unless organic premiums are an important portion of gross crop receipts. This ranking conforms with those reported from other studies indicating that organic systems are generally profitable, but may be less profitable than conventional or reduced-tillage systems in areas dominated by corn-soybean production (Smolik et.al. 1993 and Diebel et.al. 1993).

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[5] In 1993 all fields adjacent to the monitored wetland sites in the ORG and TNT were prevented plantings. Thus no yields were collected for these management systems.

Farm management systems in this study had relatively little influence on surface water quality or quantity. The most important factors were management practices in each system which reduced runoff. This was accomplished by rotation with forage legumes and buffer strips in the ORG system, reduced tillage to maintain residue in the TNT system, and terraces in the CON system. When runoff control practices failed, water quality deteriorated. The importance of runoff control was emphasized by the detection of pesticides in the organic wetlands, due to runoff of surface water or groundwater transport from an adjacent farm.

A major conclusion is that all three farming systems are profitable in the study region and, from a water quality perspective, can be managed in an environmentally sound manner. The principal surface water quality factors are the effectiveness of management practices that reduce runoff into wetlands. Grassed waterways, buffer strips around seasonal or semipermanent wetlands, crop rotations, and residue management are environmentally sound management practices that can be incorporated into numerous crop management systems. It is important to remember that "best management practices" can be adopted to reduce surface water runoff, regardless of management system. However, in the Prairie Pothole Region, surface water and groundwater are often linked and groundwater movement does not stop at field or farm boundary. Thus protection of groundwater from nonpoint source pollution, including agricultural chemicals, is more effective at a regional or watershed scale.

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Table 1: Field Tract Composition by Management System

Field Tract Composition:	Transitional No-Till Acres	Transitional No-Till Pct. of Total Acres	Conventional Acres	Conventional Pct. of Total Acres	Organic Acres	Organic Pct. of Total Acres
Total Acres	960.0	100.0%	480.0	100.0%	840.0	100.0%
Cropland Acres	767.4	79.9%	348.0	72.5%	621.7	74.0%
Wetland Acres	66.5	6.9%	52.1	10.8%	88.8	10.6%

Cropland Soil Classes:	Transitional No-Till Acres	Transitional No-Till Pct. of Cropland Acres	Conventional Acres	Conventional Pct. of Cropland Acres	Organic Acres	Organic Pct. of Cropland Acres
Land Capability Class (1-2)	641.6	83.6%	126.2	36.3%	442.6	71.2%
Land Capability Class (3)	70.9	9.2%	44.0	12.6%	41.6	6.7%
Land Capability Class (4)	25.5	3.3%	165.4	47.5%	122	19.6%
Land Capability Class (5-7)	29.4	3.9%	12.4	3.6%	15.5	2.5%
Land Capability Subclass:						
no restriction	97.1	12.6%	5.0	1.4%	44.4	7.1%
erosion (e)	529.1	69.0%	266.9	76.7%	390.1	62.8%
root zone (s)	26.5	3.4%	0.0	0.0%	38.0	6.1%
hydric/wetness (w)	114.7	15.0%	76.1	21.9%	149.2	24.0%

Table 2: Description of Project Wetlands

Wetland No.	Wetland Class	Farming System	Traditionally Farmed-Through
1	Temporary	Organic	Yes
2	Seasonal	Organic	Yes
3	Seasonal	Organic	No
4	Seasonal	Organic	No
5	Semi-Permanent	Organic	No
6	Seasonal	Transitional No-Till	No
7	Temporary	Transitional No-Till	Yes
8	Semi-Permanent	Transitional No-Till	No
9	Seasonal	Transitional No-Till	No
11	Seasonal	Conventional	Yes
12	Seasonal	Conventional	Yes
13	Semi-Permanent	Conventional	No

Table 3: Nitrate concentrations in water samples, as influenced by wetland class and landscape position.

Year	Sample*	Wetland Class: Seasonal	Semipermanent	LSD.05**
		---ppm---		
1993	UGW	1.8	6.8	NS
	WGW	0.4	10.1	3.3
	WSW	0.1	0.8	NS
1994	UGW	11.0	16.8	5.3
	WGW	1.8	8.6	1.7
	WSW	0.1	0.5	0.1

* UWG=upland groundwater, WGW=wetland groundwater, WSW=wetland surface water.
** NS=not significant at the .05 level of probability.

Table 4: Orthophosphate concentrations in water samples, as influenced by wetland class and landscape position.

Year	Sample*	Wetland Class: Seasonal	Semipermanent	LSD.05**
		---ppm---		
1993	UGW	0.47	0.47	NS
	WGW	0.54	0.45	NS
	WSW	1.70	0.75	NS
1994	UGW	0.12	0.02	0.09
	WGW	0.37	0.07	0.19
	WSW	1.17	0.64	0.13

* UWG=upland groundwater, WGW=wetland groundwater, WSW=wetland surface water.
** NS=not significant at the .05 level of probability.

Table 5: Nitrate concentrations in water samples, as influenced by wetland class and farming system.

Year	Wetland Class	Sample*	Farming System*** ORG	TNT	LSD.05**
			-----ppm-----		
1993	Seasonal	UGW	2.0	1.4	NS
		WGW	0.1	0.7	NS
		WSW	0.3	0.0	NS
	Semipermanent	UGW	13.2	0.3	7.6
		WGW	13.3	6.9	NS
		WSW	0.5	1.0	NS
1994	Seasonal	UGW	10.6	11.3	NS
		WGW	0.2	2.7	1.8
		WSW	0.1	0.1	NS
	Semipermanent	UGW	24.4	4.6	10.9
		WGW	8.2	9.1	NS
		WSW	0.5	0.5	NS

* UWG=upland groundwater, WGW=wetland groundwater, WSW=wetland surface water.
** NS=not significant at the .05 level of probability.
*** ORG=organic, TNT=transitional no-till.

Table 6: Orthophosphate concentrations in water samples, as influenced by wetland class and farming system.

			Farming System***		
Year	Wetland Class	Sample*	ORG	TNT	LSD.05**
			-----ppm-----		
1993	Seasonal	UGW	0.68	0.25	NS
		WGW	0.46	0.63	NS
		WSW	0.97	2.25	NS
	Semipermanent	UGW	0.70	0.23	NS
		WGW	0.55	0.35	NS
		WSW	0.28	1.22	NS
1994	Seasonal	UGW	0.13	0.11	NS
		WGW	0.68	0.20	0.23
		WSW	1.23	1.14	NS
	Semipermanent	UGW	0.03	0.02	NS
		WGW	0.09	0.05	NS
		WSW	0.14	1.14	0.37

* UWG=upland groundwater, WGW=wetland groundwater, WSW=wetland surface water.
** NS=not significant at the .05 level of probability.
*** ORG=organic, TNT=transitional no-till.

Table 7: Historical Crop Acreages and Yields, 1988-1994 Averages.

1. Transitional No-Till Management System

Average Cropland	1010
Average Pasture	290
Average Other*	168
Average Total Acres	1468

	Corn	Corn Silage	Soybeans	Oats Grain	Wheat	Alfalfa	Rye	Barley	Millet Hay
No. of Years Crop Planted	7	4	7	2	0	4	0	2	3
Average Crop Acres**	347.0	75.0	355.0	45.0		134.0		60.0	58.0
Average Yield	92.0	10.3	31.6	57.5		4.3		50.5	1.8
Standard Deviation	30.4	3.3	10.1	4.5		0.4		0.5	1.1
High Yield	125.0	13.0	40.0	62.0		5.0		51.0	3.0
Low Yield	22.0	5.0	8.0	53.0		4.0		50.0	0.3

2. Conventional Management System

Average Cropland	380
Average Pasture	178
Average Other*	37
Average Total Acres	594

	Corn	Corn Silage	Soybeans	Oats Grain	Wheat	Alfalfa	Rye	Barley	Millet Hay
No. of Years Crop Planted	7	7	7	4	1	7	0	0	0
Average Crop Acres	163.0	44.0	62.0	32.0	13.0	66.0			
Average Yield	96.0	14.7	36.1	65.0	40.0	3.4			
Standard Deviation	12.2	3.2	7.9	14.6	0.0	0.4			
High Yield	110.0	16.8	46.0	90.0	40.0	4.0			
Low Yield	70.0	7.0	19.0	55.0	40.0	2.8			

3. Organic Management System

Average Cropland	836
Average Pasture	186
Average Other*	189
Average Total Acres	1211

	Corn	Corn Silage	Soybeans	Oats Grain	Wheat	Alfalfa	Rye	Barley	Millet Hay
No. of Years Crop Planted	7	0	7	7	7	7	3	1	0
Average Crop Acres	168.0		216.0	112.0	51.0	197.0	27.0	106.0	
Average Yield	77.4		25.1	39.1	19.1	2.8	17.4	15.0	
Standard Deviation	29.1		8.6	19.0	9.4	0.4	6.5	0.0	
High Yield	95.0		35.0	61.0	36.8	3.3	22.0	15.0	
Low Yield	9.2		7.3	7.2	6.9	2.0	8.2	15.0	

*Includes building sites, grass waterways, non-farmed wetlands, and waterbank

**This is the average acres for those years the crop was planted

Table 8: Economic Costs and Returns by Management System, 1992-1994.

Transitional No-Till (TNT) Management System
costs and returns per acre

	1994	1993	1992
Commodity Value	$218.88	$49.98	$189.79
+ Crop Insurance	$0.00	$5.94	$0.00
+ Government Payment	$13.99	$58.09	$18.85
= Gross Income	$232.87	$114.01	$208.64
- Operating/Material Cost	$118.89	$54.19	$115.30
= Land & Mgt. Return	$113.98	$59.82	$93.34
- Land Charge	$51.75	$51.75	$51.75
= Net Return	$62.23	$8.07	$41.59

Conventional (CON) Management System
costs and returns per acre

	1994	1993	1992
Commodity Value	$220.47	$156.17	$205.56
+ Government Payment	$29.35	$11.67	$32.00
= Gross Income	$249.82	$167.84	$237.56
- Operating/Material Cost	$139.79	$112.86	$147.22
= Land & Mgt. Return	$110.02	$54.98	$90.34
- Land Charge	$51.75	$51.75	$51.75
= Net Return	$58.28	$3.23	$38.59

Organic (ORG) Management System
costs and returns per acre

	1994	1993	1992
Commodity Value	$134.64	$35.51	$123.82
+ Crop Insurance	$0.00	$15.95	$0.00
+Organic Premium	$45.17	$0.00	$8.16
+ Government Payment	$16.82	$46.77	$19.65
= Gross Income	$196.63	$98.23	$151.63
- Operating/Material Cost	$73.49	$52.01	$87.11
= Land & Mgt. Return	$121.67	$46.22	$64.52
- Land Charge	$51.75	$51.75	$51.75
= Net Return	$71.39	($5.53)	$12.77

Figure 1: Location of Study Sites

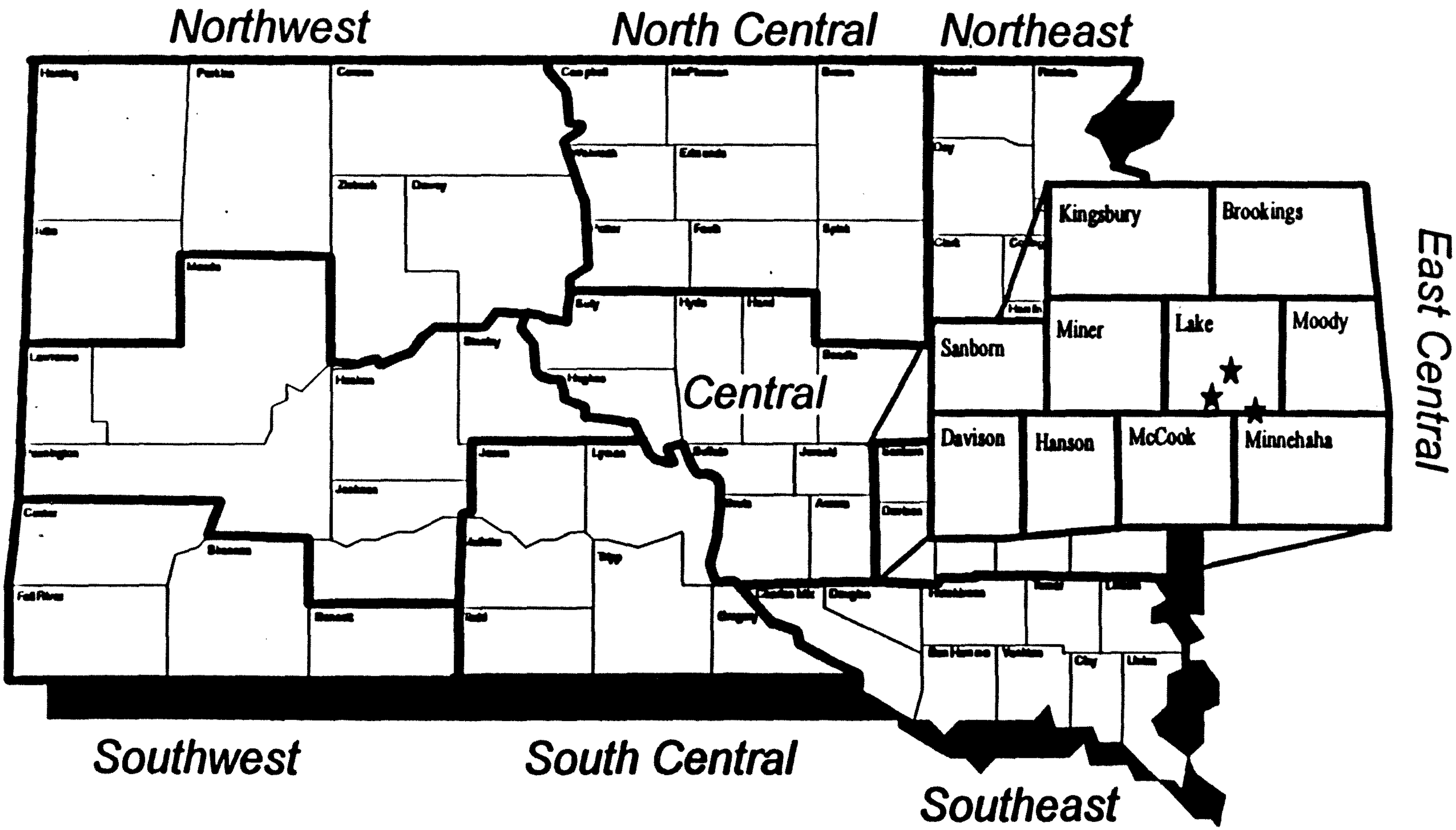

Figure 2: Upland Water Budget, June-August 1993-1994.

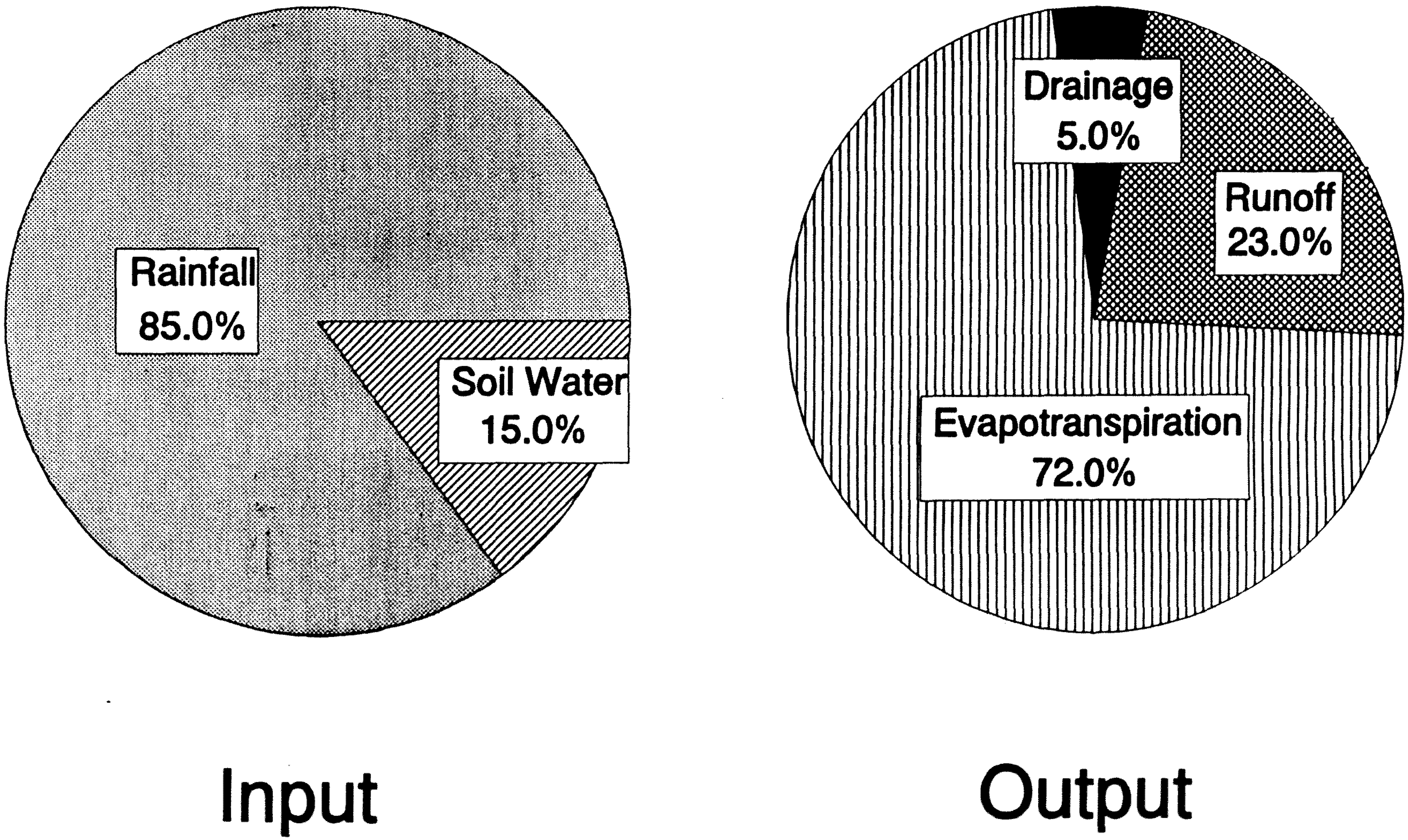

Figure 3: Wetland Water Budget, June-August 1993-1994.

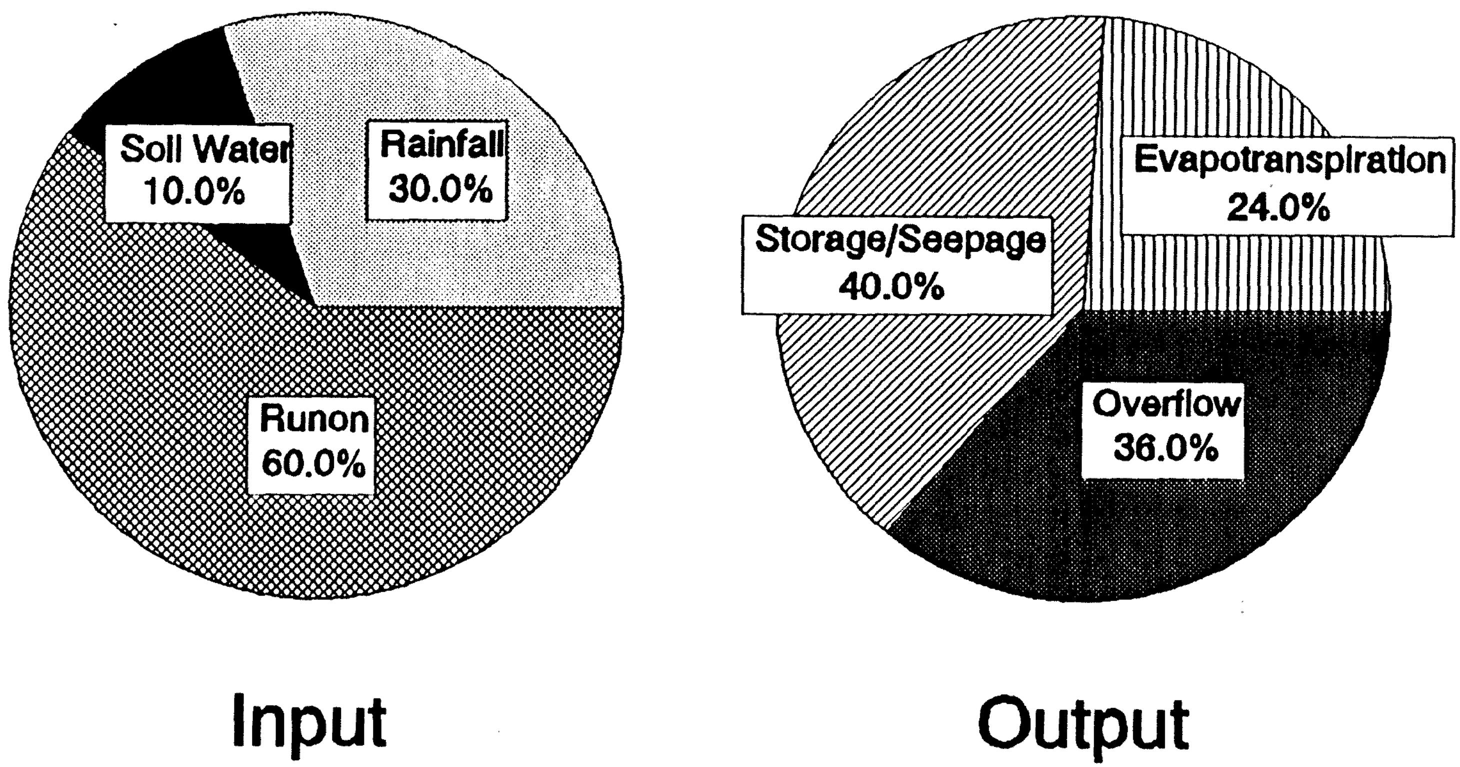

Figure 4: Above ground biomass (kg ha^{-1}) as influenced by landscape position and wetland classification. Seasonal and semipermanent wetlands have been farmed through in dry years.

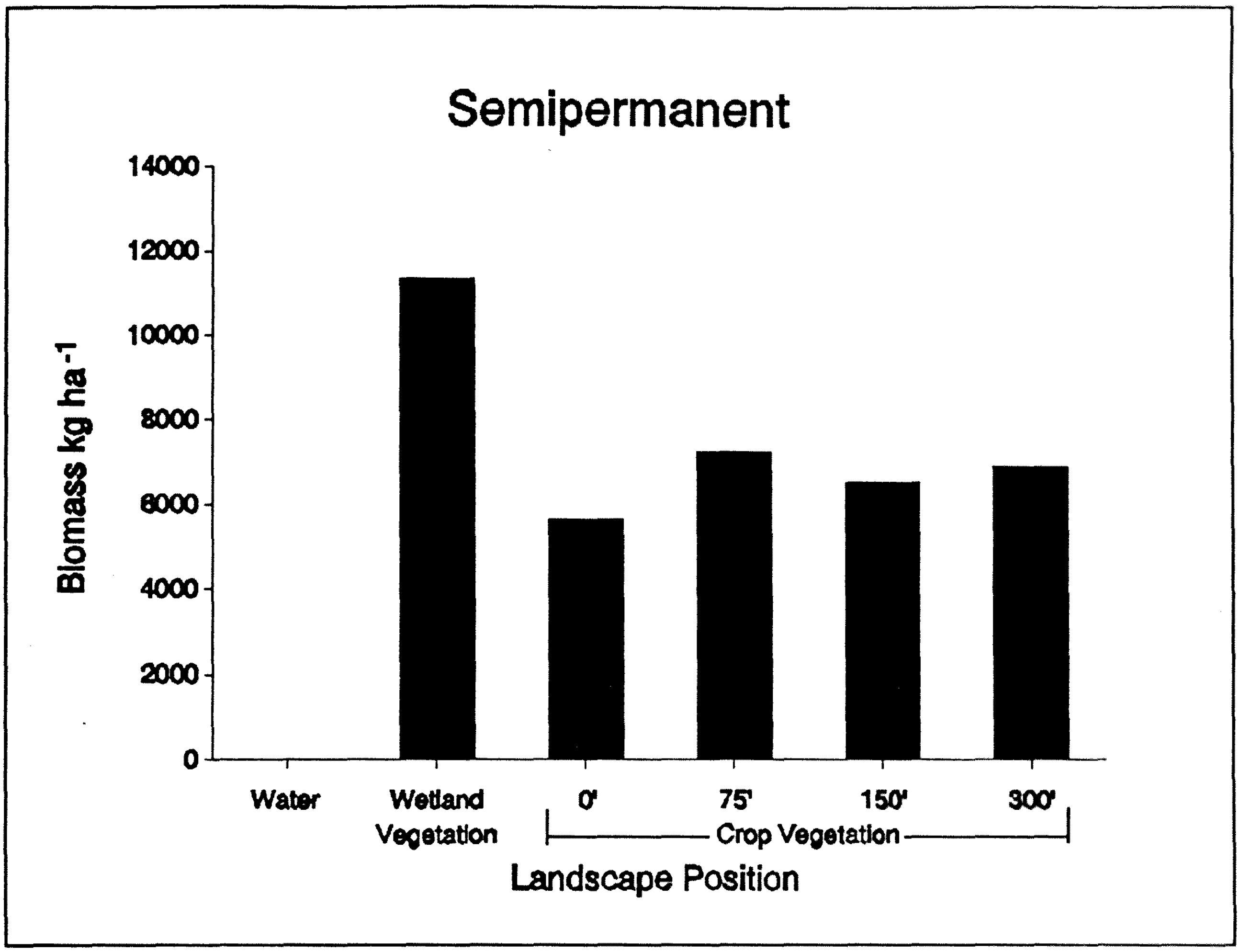

Figure 5: Economic Comparison Process

RAW DATA Farmer Interviews ORG TNT CON		BUDGETING Care Software		ECONOMIC ANALYSIS Economic Comparisons
(1) Management Practice (A) acres planted (B) cultural practices (C) production inputs (D) equipment used (2) Crop Yields (A) whole-farm yields (B) field-level yields (C) subfield-level yields (3) Government Program Participation (4) Organic Premiums	➔	(1) Input (cost) Parameters (A) machine expense (B) materials expense (C) labor expense (D) capital expense (E) land/mgt.expense (2) Output (price) Parameters (A) commodity prices (B) Gov't payments (C) crop insurance (D) organic premiums	➔	(1) Gross Revenue Comparison (A) crop revenue (B) Gov't program revenue (C) crop insurance revenue (D) organic premium revenue (2) Total Expense Comparison (3) Net Return Comparison (A) whole farm (B) field level (C) wetland-proximity

Estimated Commodity Prices, Deficiency Payments and Organic Premiums used in the CARE budgeting process.

Commodity	1994 Price	1993 Price	1992 Price
Corn	$ 2.12/bu.	$ 2.45/bu.	$ 2.00/bu.
Soybeans	$ 5.59/bu.	$ 5.75/bu.	$ 5.75/bu.
Wheat	$ 3.02/bu.	$ 3.00/bu.	$ 3.20/bu.
Barley	$ 1.75/bu.	$ 2.00/bu.	$ 2.00/bu.
Oats	$ 1.21/bu.	$ 1.35/bu.	$ 1.30/bu.
Rye	$ 1.97/bu.	$ 1.90/bu.	$ 2.05/bu.
Alfalfa	$ 50.00/ton	$ 50.00/ton	$ 50.00/ton
Millet Hay	$ 30.00/ton	$ 30.00/ton	$ 30.00/ton
Oats straw	$ 35.00/ton	$ 35.00/ton	$ 35.00/ton
Wheat straw	$ 30.00/ton	$ 30.00/ton	$ 30.00/ton
Rye straw	$ 30.00/ton	$ 30.00/ton	$ 30.00/ton
Corn silage	$ 18.50/ton	$ 21.3/ton	$ 19.50/ton
Corn Def. Payment	$ 0.63/bu.	$ 0.28/bu.	$ 0.73/bu.
Corn Org. Premium	$ .09/bu.		$ 0.16/bu.
Soybean Org. Premium	$ 8.04/bu.		$ 0.82/bu.

Figure 6: Wetland Proximity-Net Return, 1992 & 1994 Corn Yields.