Ground Water Quality Research and Demonstration Projects in Nebraska[1]

Richard B. Ferguson and Todd Peterson, Department of Agronomy, University of Nebraska-Lincoln

Abstract

Two projects were initiated in Nebraska in 1990 to address concern with increasing levels of nitrate in ground water as part of USDA's Water Quality Initiative. The Nebraska Management Systems Evaluation Area (MSEA) Water Quality Project is a joint effort of USDA Agricultural Research Service (ARS) and University of Nebraska-Lincoln scientists. One phase of the project is investigating the direct impact of four management systems on ground water quality. Another phase of the project is evaluating promising new technology for future water quality protection practices. The Mid-Nebraska Water Quality Demonstration Project is designed to encourage adoption by producers of practices which can protect ground water quality while maintaining productivity. The project is conducted in a 15 county area of south-central Nebraska, and is jointly administered by the University of Nebraska Extension and the Soil Conservation Service. Both projects will be conducted over a five year period.

Introduction

In July, 1989, USDA released a Water Quality Program Plan in support of the Presidential Water Quality Initiative, announced in February, 1989. The USDA Water Quality Program Plan outlines objectives and procedures to implement the plan over a five year period, 1990-1994. The primary goal of USDA's Water Quality Program is to *"Provide farmers, ranchers, and foresters the knowledge and technical means to respond independently and voluntarily in addressing on-farm environmental concerns and relate State water quality requirements. The Department plans to achieve this goal in a way that reduces the need for restrictive regulation, and in a manner that maintains agricultural productivity, avoids economic hardship, and sustains an economical and safe supply of food and fiber."*

The University of Nebraska-Lincoln is involved with the implementation of several water quality projects which are components of USDA's Water Quality Initiative. The two largest projects in the state, in terms of scope and funding,

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are the Nebraska Management Systems Evaluation Area (MSEA) Water Quality Project, and the Mid-Nebraska Water Quality Demonstration Project. Both projects have as a primary objective addressing the trend of increasing concentrations of nitrate in ground water, particularly in areas of the state with intensive irrigation. Figure 1 illustrates trends in average nitrate-N concentrations in ground water in three counties in Nebraska. In a recent survey, over 20% of all wells sampled had nitrate-N levels that exceeded the 10 ppm drinking water standard (Exner and Spalding, 1990). The MSEA project is one of five research and demonstration projects funded in the Midwest, with the goal of evaluating the impact of common agricultural management practices on ground water quality, and investigating the potential for new practices to protect ground water quality. The Mid-Nebraska Project is one of 16 demonstration projects nationwide. The primary goal of the project is to encourage adoption by producers of proven, cost-effective practices that can reduce agri-chemical loading in the environment, while sustaining profitable production levels and ultimately reduce the movement of agri-chemicals to ground water.

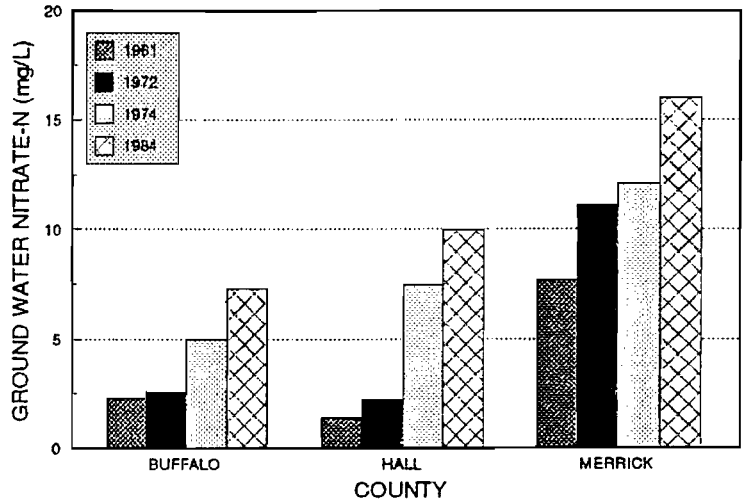

Figure 1. Trends in ground water nitrate-N concentrations in three Nebraska counties, 1961-1984.

Mid-Nebraska Water Quality Demonstration Project

The Mid-Nebraska Project is located in a 15 county area of south-central Nebraska south of the Platte river (Figure 2). Soils in this area are primarily loess-derived silt loams, overlying ground water 50-150 ft deep. Much of the area is cropped to continuous irrigated corn. There are 3.4 million acres of cultivated land in the project area. Irrigated corn, soybeans, and grain sorghum account for 1.9 million of these acres. Irrigation has existed in the area for more than 60 years. The area comprises some of the most productive acres in Nebraska. Containing less than a quarter of the cultivated acres in the state, it produces over a third of the corn raised in Nebraska. Thirty percent of Nebraska's irrigation wells are in the area, and 30 percent of the nitrogen fertilizer used in the state is in the project area.

There is no widespread ground water nitrate problem in the project area. However, the intensive, irrigated agriculture in the area poses the potential for

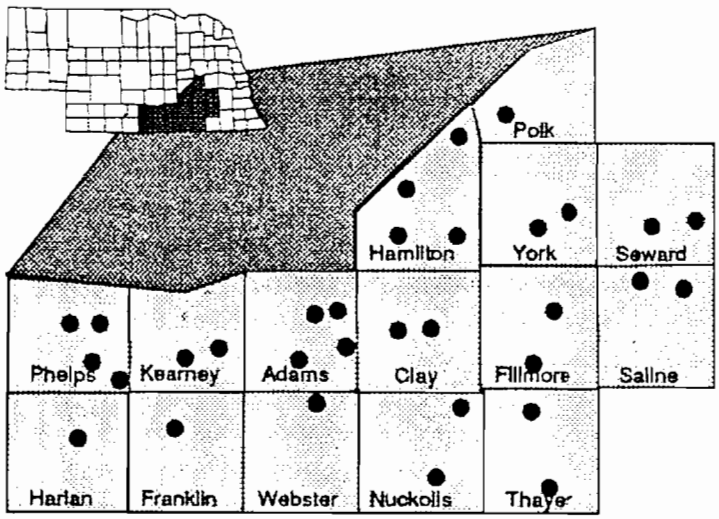

Figure 2. Mid-Nebraska Water Quality Demonstration Project area.

water quality problems. There is evidence that ground water nitrate concentrations are increasing in the area, as well as evidence of significant nitrate in the vadose zone. One study (Spalding and Kitchen, 1988) showed the movement of nitrate 60 ft deep over a 15 year period under furrow-irrigated, excessively fertilized plots. Vadose zone soil nitrate load has been documented at several sites in the project area, with substantial amounts of nitrate at depths below crop retrieval (Figure 3).

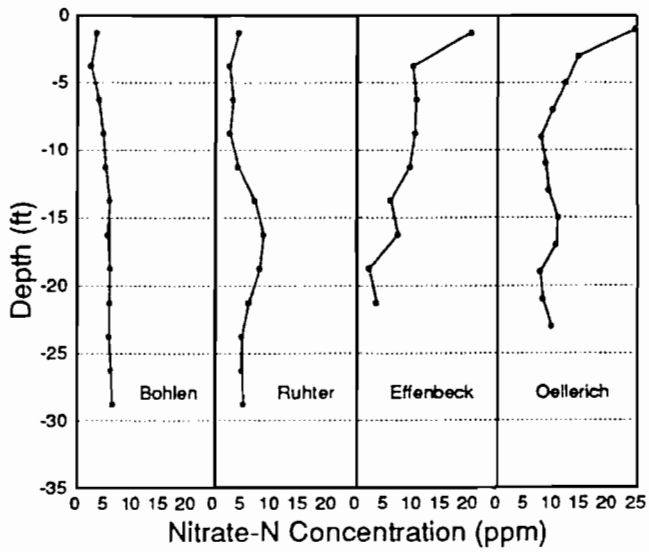

Figure 3. Vadose zone nitrate-N concentrations at 4 Mid-Nebraska Project demonstration sites, spring, 1991.

The Mid-Nebraska Project is jointly administered by the University of Nebraska Extension and the Soil Conservation Service (SCS). Both agencies have a Project Coordinator who work closely together to coordinate all project activities. The project is directed by an interagency committee, composed of representatives from University of Nebraska Extension, SCS, ASCS, ARS, Tri-Basin Natural Resources District (NRD), Upper Big Blue NRD, Lower Republican NRD, Little Blue NRD, Nebraska Department of Environmental Control, University of Nebraska Conservation and Survey Division, and the Blue River Association of Ground Water Districts. A Local Coordinating Committee in each county directs demonstration activities in that county. The committee is composed of farmers, agri-business, fertilizer dealers, bankers, and agency representatives. An Advisory Committee, composed of representatives from 14 organizations and agencies with an interest in water quality issues provides ideas for the project, as well as facilitating transferral of project information to

these groups. A Technical Committee, composed of subject matter specialists from UNL and SCS, provides scientific direction on practices to demonstrate and interpretation of demonstration results. An Information/Education Committee, with representatives from various media, Natural Resources Districts, Extension and SCS conducts the information dissemination aspects of the project.

Thirty-three demonstration sites were conducted in 1991. Demonstrated practices focused in three areas: nitrogen management, irrigation management, and pest management. A total of 16 practices in those three areas were demonstrated across the project, although any one site usually demonstrated 3-7 of the practices. Demonstrated practices included deep soil sampling for nitrate-N, irrigation water testing for nitrate-N, selection of realistic yield goals, use of irrigation flow meters, use of irrigation surge valves, irrigation scheduling according to crop water use, N credits for legumes and manures, integrated pest management and scouting for economic thresholds of pests, as well as several other practices. Most sites had replicated N rate strips, with N fertilizer applied at the recommended rate, as well as 50 lb/acre above and below the recommended rate.

Nebraska's Management Systems Evaluation Area (MSEA) Water Quality Project

At each of the five MSEA sites in the Midwest, researchers are taking currently available technologies and integrating them into production systems on a field scale. They are evaluating the assumption that following USDA and University-recommended production practices will protect and maintain ground water quality. In parallel with field studies, researchers at each of the MSEA sites are also studying the social and economic impediments to adoption of practices that protect ground water.

The Nebraska MSEA site is located near Shelton, Nebraska, in the central Platte river valley. At the Nebraska MSEA site (Figure 4) scientists are applying a series of production practices on four 35 acre management blocks to determine the impact of the management practices on ground water. A conventional block has been established as a control, with the cooperating producer continuing to irrigate and fertilize as is typical for the area. A second block utilizes improved surface irrigation practices including surge irrigation and runoff collection on laser graded land. A third block uses sprinkler irrigation including fertigation as needed to supply N to the crop. The two "improved" management blocks are managed to maintain crop yield while reducing fertilizer and irrigation water inputs. A fourth block uses alfalfa as a nitrogen scavenger crop to capture and remove nitrogen from soil and irrigation water. (Irrigation water nitrate-N concentrations in the area are approximately 30 ppm NO_3-N). A network of multi-level sampling wells are located in and around each management block to directly monitor the impact of management systems on ground water. The site is located on silt loam soils overlying a sand and gravel aquifer between 15 and

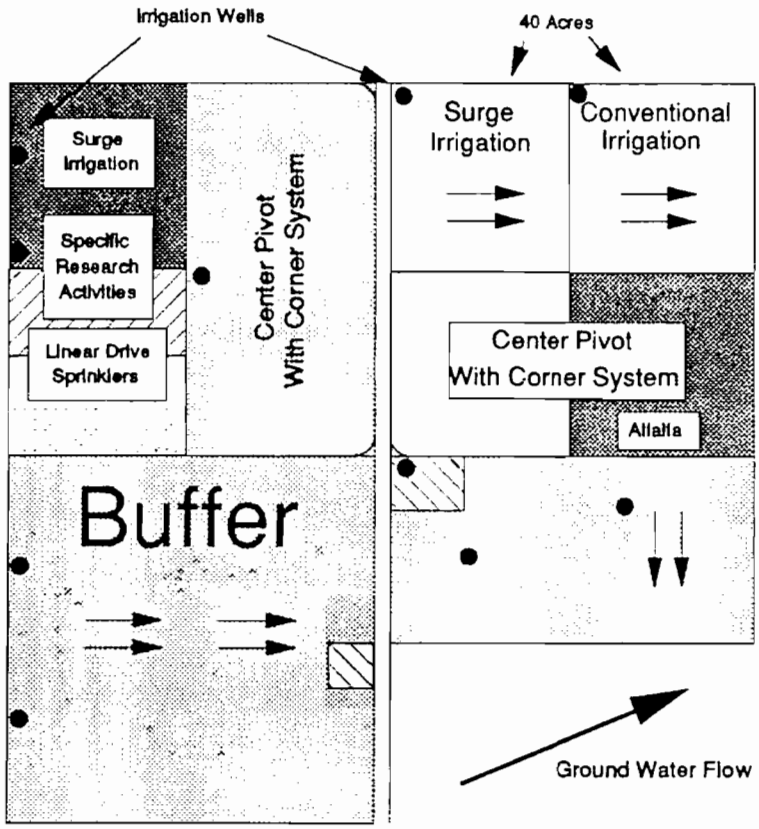

Figure 4. Nebraska MSEA Project Site near Shelton, NE.

20 ft below the surface. Soil and water samples are periodically analyzed for N and approximately 17 pesticides. The shallow nature of the aquifer, coupled with frequent measurements of N and pesticides in various levels of the aquifer, provides the potential to directly measure the impact of management variables on ground water quality in a short time frame.

Developing Management Systems for the Future

The four management blocks described above take present practices off the shelf and combine them into production systems. Research to develop the components for improved management systems for the future is conducted on adjacent fields (Figure 4).

Nitrogen Management Research: The use of chlorophyll meters to monitor the N status of corn throughout the growing season is proving to be a highly effective tool for reducing the amount of preplant fertilizer required. This technique allows us to schedule N applications as needed to meet crop requirements, yet reduce the total amount of fertilizer applied. Fertilizer not utilized by the plant is susceptible to leaching, so reducing the amount applied can result in less nitrate leaching. We are utilizing the chlorophyll meter to determine the relative difference between several preplant-fertilized strips in the field and the rest of the field. A developing N deficiency can be detected through weekly monitoring and comparing the fully fertilized and bulk field areas. This allows ample time to correct developing N deficiencies through fertigation before they become serious enough to reduce yield.

Other ongoing research projects include the use of crop rotations to reduce potential nitrate leaching, fertigation through sprinkler and surface irrigation systems, utilization of organic sources of N, improving fertilizer use efficiency through the use of super granules formulated for the slow release of N, evaluation of starter fertilizers containing the nitrification inhibitor dicyandiamide (DCD), and using forage crops to scavenge or remove N from soil and irrigation water.

Irrigation Management Research: Surge flow irrigation can reduce water application and improve the uniformity of water distribution. Much of the irrigation research underway deals with surge irrigation management and other ways to reduce deep percolation losses and associated nitrate leaching. Researchers are studying ways to improve scheduling through feedback control, blocked furrow ends versus tailwater reuse, improved methods of sprinkler irrigation, modifying tillage practices to improve water distribution, and other ways to better manage conventional surface, surge, and sprinkler irrigation.

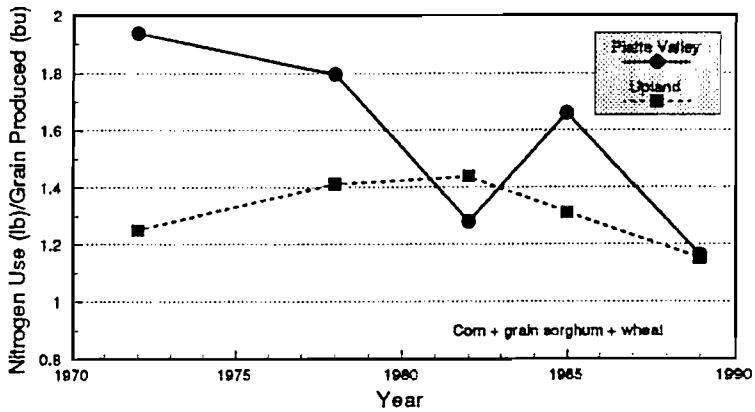

Figure 5. Trends in nitrogen use efficiency in Platte valley and upland counties in Nebraska.

Social and Economic Research: Scientists are examining alternatives to current public policies that influence ground water pollution from irrigated agriculture. University scientists need to understand the challenges faced by producers and what motivates them to make changes in their production systems. Researchers are working closely with the Central Platte Natural Resources District in structuring the NRD's Ground Water Management Plan. The goal is to identify management systems that not only protect ground water quality but are also practical and economically viable.

Summary

Recent trends of fertilizer N sales coupled with grain production in south-central Nebraska (Figure 5) suggest that producers are using nitrogen more efficiently now than they were 10 or 20 years ago. Nitrogen fertilizer use per bushel of grain produced peaked in the Platte Valley in the mid-1970's, then declined as

producers raised more grain per lb of N in the 1980's. Producers away from the Platte River Valley, with less current problem with nitrate contamination of ground water, have been slower to increase N use efficiency than producers in the valley, although they were more efficient than producers in the valley to start with.

Both the Mid-Nebraska Project and the MSEA Project seek to encourage producers to adopt production practices which efficiently use nitrogen and irrigation water, building on the increasing awareness of the interrelationships of agriculture and environmental quality.

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Randy Killorn

Department of Agronomy
Department of Agronomy
Iowa State University
Ames, IA 50011