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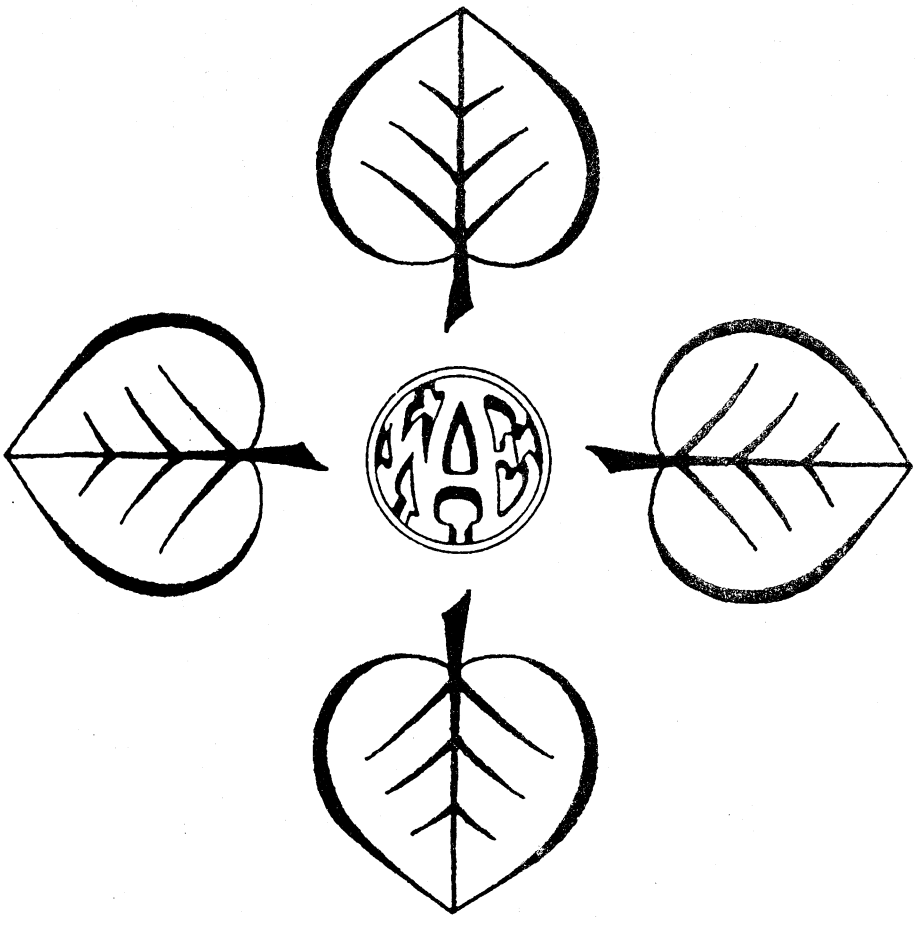

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Level of Environmental Concern, Technical Knowledge, and Nitrogen Management Practices of Irrigated Corn Producers

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Abstract

Survey results from 445 irrigated corn producers in central Nebraska were analyzed concerning their water quality-related knowledge, attitudes, and practices. Producers expressed agreement that water quality was a problem and that they need to consider the environment in selecting production practices. However, some producers still significantly over-apply nitrogen.

Introduction

The Central Platte Natural Resource District (NRD) in Nebraska has been working on nitrate contamination of groundwater since 1961. In 1978, a study by the University of Nebraska Conservation and Survey Division, sponsored by the district, identified commercial fertilizers applied to irrigated crop lands as the major (but not the only) source of groundwater nitrates in the Central Platte Valley (Central Platte NRD, 1992).

Nitrates in groundwater continue to increase in this area. Some wells that had tested at over 10 ppm in 1978 tested at over 20 ppm in 1990. The U.S. Environmental Protection Agency has set the lifetime health advisory level for nitrates in drinking water at 10 ppm. It has been proposed that this level of 10 ppm 'advisory level' be upgraded to a maximum contaminant level (MCL) (Exner and Spalding, 1990). A MCL is an enforceable limit that would apply to community water systems with at least 15 service connections and noncommunity water systems that regularly serve at least 25 people 60 or more days a year.

The Central Platte Valley, the Central Platte NRD has developed a management program involving three phases of regulation (Central Platte NRD, 1992). These phases are defined by test results from groundwater samples taken from wells. The Phase I area has an average groundwater nitrogen level below 12.5 ppm and producers in that area are required to attend educational meetings on water quality management. Phase II has an average groundwater nitrogen level of between 12.6 and 20.0 ppm and producers in that area are required, in addition, to monitor their soil and water nitrogen. Phase III has an average groundwater nitrogen level of 20.1 ppm or greater. Fall application of anhydrous ammonia is prohibited in the Phase III area and spring application requires the use of a nitrification inhibitor. Phase III producers will also be required to measure water pumped.

Concern over nitrate contamination has led to considerable interest in current production practices, in differences between current production practices and "best" management practices, and the receptivity of producers to different approaches for solving the problem. This interest and need was addressed in part by a survey of producer attitudes and practices in central Nebraska. Results of this survey were then matched with management reports that producers must submit to the Central Platte NRD. This data source included nitrogen recommended, nitrogen applied, and yield by field.

Producer Survey

In the spring of 1991 a survey was mailed to all 780 producers in the Phase II area of the Central Platte NRD. The objective of the survey was to identify producer characteristics and practices as a basis for understanding current behavior in regard to nitrogen and water management. Questions were asked concerning:

- demographic characteristics
- producer knowledge of selected practices
- farm characteristics
- production practices related to nitrogen fertilization and irrigation
- decision making criteria
- environmental attitudes
- receptivity to adoption of selected nitrogen and water management practices
- opinions concerning the profitability of nitrogen and water management practices

Nearly 45 percent of the initial mailing was returned within two weeks. A second mailing was sent to those who had not responded by mid-April. The responses to the survey totaled 60 percent. The survey responses were matched with actual field practice reports that had been submitted to the NRD. Twelve percent of the surveys could not be matched with the NRD's data.

Survey Results

Survey questions have been grouped by topic and ranked by mean response (Tables 1 through 6). The frequency distribution and mean response were determined for each question. A Kolmogorov-Smirnov two-sample test was used to help test whether the distribution of responses was significantly different between questions within each group (Siegel, 1956). The hypothesis of whether the responses were drawn from the same population was tested at the 5 percent level.

Groundwater Concerns

The first set of questions addressed the level of concern for groundwater quality. Nearly 90 percent of the respondents agreed that farmers should consider the impact of their farming practices upon the environment and over 75 percent agreed that groundwater contamination is an important environmental problem in their area. Significantly less agreement was shown on whether groundwater contamination threatens human health in their area (Table 1). Also more than one third of the respondents disagreed with the statement that nitrate levels in the groundwater seems to be increasing. A similar number felt groundwater contamination was a problem in their area but not on their farm.

Production Practices

Views on specific "best" management production practices were varied (Table 2). Over 60 percent of the respondents agreed that following NRD recommended N rates would probably lead to improved groundwater quality and over 40 percent felt that these rates would not reduce yields. Respondents were less positive about improved water management practices and made no statistically significant distinction between scheduling, reducing water applied, or making adjustments to reduce the time required to get water through to the end of the row (Table 2).

Respondents placed most emphasis upon crop characteristics, rainfall, and temperatures in irrigation management and ranked recommended irrigation management practices relatively low in importance (Table 3). However, 50 percent of the respondents did indicate that use of the soil probe was important in irrigation management.

In contrast to irrigation management, "best" management practices for nitrogen management received strong support. The components of the NRD N rate recommendation (soil test, water N test, yield goal, and previous crop) were at the top of the producer's nitrogen management factors with no statistically significant difference in importance (Table 4). The responses suggest, however, that these factors may not necessarily be used as recommended since the NRD recommendations were scored significantly less important by respondents.

Adoption of Practices

Respondents considered several factors of equal importance in adopting new practices. See Table 5. However, protecting groundwater is notably at the bottom of the list in Table 5 with significantly different responses. Perhaps protecting groundwater was given less importance by respondents since the question did not specifically refer to practices that would affect groundwater contamination.

Respondents were also asked their likelihood of adopting water quality related practices during the next 5 years. Fertilizer and chemical related practices were at the top of the list (Table 6). In fact, over 40 percent of the respondents reported already adopting the top three practices. Water management practices were given the least attention by respondents.

Nitrogen Management

The availability of data on actual nitrogen applied and NRD recommended rates made it possible to compare producer knowledge and attitudes with actual performance. Performance was measured as the difference between nitrogen applied less nitrogen recommended, averaged over all irrigated corn fields for each respondent. Applying less than 25 lbs more than the recommended amount was defined as good management because of the difficulty of calibrating equipment and achieving uniform applications. It was found that approximately 40 percent over applied N by 25 pounds or more per acre and 20 percent over applied by 50 pounds or more (Table 7). These results are consistent with the finding that approximately 60 percent of the producers had not adopted the NRD fertilizer recommendations. They are also consistent with the finding that one third of the respondents felt groundwater contamination was a problem in their area but not on their farm.

To test the hypothesis that producer behavior is consistent with their level of environmental concern and groundwater knowledge, a factor analysis of the survey data was conducted and an attempt was made to correlate indices of environmental concern and knowledge with over application of N (Johnson and Wickens, 1982). An "environmental concern" variable was developed from preliminary results of the factor analysis that combined four questions, two of which were reported in Table 1: 1) groundwater contamination is an important environmental problem in my area and 2) groundwater contamination is an important health problem in my area. The two additional survey questions used were: 1) nitrogen fertilizers have contaminated groundwater to the point that human health is threatened, and 2) agricultural pesticides have contaminated groundwater to the point that human health is threatened. A "water quality knowledge" variable was developed from the factor analysis that

combined the first four questions reported in Table 2. The following regression equation was then estimated (t levels are reported in parenthesis under each coefficient):

$$\underset{\substack{(17.2)\quad(18.6)\quad(2.9)\quad(0.96)}}{NDIF = 115.4 - 0.64\,NR - 1.31\,EC - 0.49WQK} \qquad R^2 = .48$$

Total degrees of freedom = 381

where

NDIF = average difference between per acre nitrogen applied and per acre NRD nitrogen recommendation for all fields in Phase II for that farmer
NR = NRD nitrogen recommendation
EC = environmental concern index
WQK = water quality knowledge index

Both the NRD recommendations and the environmental concern index are statistically significant at the one percent level in explaining the difference in N applied and recommended. The signs of the coefficients for all variables are in the direction expected. The significance of the recommended N levels is further illustrated by the data reported in Table 8. The nitrogen applied by producers who over applied by 50 pounds or more is only 6 pounds above the level applied by all other producers, while there is 65 pounds difference in the recommended levels, 77 pounds versus 132 pounds.

Conclusions

Although producers surveyed expressed general agreement that water quality is an environmental problem and that producers should recognize environmental concerns in selecting production practices, they were in less agreement on what to do about the problem. Over application of nitrogen is correlated with level of environmental concern, but appears to be more related to the level of N recommended. No significant correlation was found between performance and water quality knowledge. These preliminary findings suggest the hypothesis that producers apply the recommended level of N as long as the recommended level isn't "too low." Plans are being made to investigate this hypothesis in more detail with producers to see if it is true and, if so, why producers do not respond to the low recommended rates.

References

Central Platte NRD's Groundwater Quality Management Program, Central Platte Natural Resource District, Grand Island, Nebraska, January, 1992.

Exner, Mary E., and Spalding, Roy F. *Occurrence of Pesticides and Nitrates in Nebraska's Ground Water.* Water Center, Institute of Agriculture and Natural Resources, The University of Nebraska, Lincoln, 1990.

Johnson, Richard A. and Dean W. Wicken. *Applied Multivariate Statistical Analysis,* Prentice Hall, Englewood Cliffs, New Jersey, 1982.

Siegel, Sidney, *Nonparametric Statistics for the Behavioral Sciences,* McGraw-Hill, New York, 1956.

Table 1. Farmer views concerning groundwater quality.

	Mean Response[1]
Farmers should consider environmental impacts of practices	1.9 a[2]
Groundwater contamination is an important environmental problem	2.1 b
Groundwater contamination is an important health problem	2.7 c
Groundwater contamination is an area problem not on my farm	3.0 d
Nitrate in groundwater is increasing	3.0 d

[1] Responses: 1= strongly agree, 2= agree, 4=disagree, 5= strongly disagree
[2] Questions follows by the same letter did not have statistically significant different distributions of responses at the 5% level based on the Kolmogorov-Smirnov two-sample test.

Table 2. Farmer views concerning recommended practices.

	Mean Response[1]
Following NRD recommended N rates will improve groundwater	2.4 a[2]
Irrigation scheduling will improve groundwater quality	2.8 b
Reducing total water applied will improve groundwater quality	2.8 b
Getting irrigation water through to the row end faster will improve groundwater quality	2.8 b
Following NRD recommended N rates would (or has) reduce(d) my yields	3.2 c

[1] Responses: 1= strongly agree, 2= agree, 4=disagree, 5= strongly disagree
[2] See Table 1 footnote.

Table 3. Farmer views concerning factors important in irrigation management.

	Mean Response[1]
Crop growth stage	8.4 a[2]
Rainfall since last irrigation	8.2 a
Temperatures	7.4 a
Crop appearance	7.2 a
Days since last irrigation	6.8 ab
Soil probe	6.4 b
Crop water use	4.8 cd
Moisture blocks	4.8 cde
Crop consultant	4.4 de
Water balance	4.2 e
Neighbors' irrigations	1.9 f

[1] Responses: 0=not important to 10= very important.
[2] See Table 1 footnote.

Table 4. Farmer views concerning factors important in nitrogen management.

	Mean Response[1]
Soil test	8.5 a[2]
Water N test	7.7 a
Yield goal	7.4 a
Crop last year	7.2 a
Last year's yields	6.8 ab
NRD recommendations	6.1 bc
Crop color	5.7 cd
Fertilizer price	5.5 cd
Fertilizer dealer recommendations	5.3 de
Crop consultant recommendations	5.1 e
Landlord expectations	4.9 e
Neighbors' rates	3.3 f

[1] Responses: 1=not important to 10= very important.
[2] See Table 1 footnote.

Table 5. Farmer views concerning importance of factors in adopting new practices.

	Mean Response[1]
Expected impact on yields	8.4 a[2]
Size of investment	8.1 a
Potential yield sacrifice	8.0 ab
Expected profitability	7.6 ab
Labor requirements	7.6 ab
Information access on use	7.1 ab
Management skills/knowledge needed	7.0 ab
Protects ground water	6.4 b

[1] Responses:0=not important to 10=very important
[2] See Table 1 footnote.

Table 6. Practices farmer is likely to adopt in next 5 years.

	% Already Adopted	Mean Response[1]
Banding herbicides	52.6	8.3 a
NRD fertilizer recommendations	43.5	8.0 a
Mix spray chemicals away from well	40.2	7.4 a
Nitrification inhibitor	21.1	6.0 b
Time shut-off on irrigation pumps	23.5	5.6 c
Water reuse system	19.6	5.4 c
Anhydrous flow meter	21.2	5.2 c
Measure well output	13.1	5.1 c
Surge valves	9.9	4.8 c
Furrow packing	6.9	3.9 d
Convert gravity to sprinkler irrigation	7.5	3.5 e
Laser leveling	6.3	3.2 e

[1] Responses: 0=highly unlikely to 10= already adopted.

Table 7. Distribution of respondents by nitrogen applied versus nitrogen recommended.

N DIF[1] (lbs/acre)	Respondents	
	Number	Percent
125 to 150	1	0.3
100 to 125	8	2.1
75 to 100	20	5.2
50 to 75	53	13.7
25 to 50	84	21.6
-25 to 25	192	49.5
-50 to -125	30	7.8
	388	100.0

[1] N Difference = average difference between per acre nitrogen applied and per acre nitrogen recommended by the NRD for all fields in Phase II for that farmer.

Table 8. Selected characteristics of producers over applying nitrogen compared to other producers.

	N DIF[1] over 50 lbs/ac	N DIF[1] under 50 lbs/ac
Total acres	401	379
Acres owned	336	293
Operator age	51	47
N recommended, lbs/ac	77	132
N applied, lbs/ac	148	142
Actual yield, bu/ac	156	154
Number of producers	82	306

[1] N DIF = See Footnote 1, Table 7.