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A FOUR YEAR SUMMARY OF MAQUOKETA WATERSHED PHOSPHORUS, NITROGEN AND MANURE MANAGEMENT FIELD DEMONSTRATIONS

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Beginning in crop year 2000, 56 producers in the Maquoketa River, Elk River and Mud Creek watersheds of eastern Iowa hosted 74 on-farm nutrient management field demonstrations. Producers participated by hosting demonstrations that evaluated the effectiveness of manure as a source of nitrogen (N) and phosphorus (P), and compared several rates of N and P in a corn following soybeans rotation.

Field demonstrations were conducted to provide the cooperating farmers with information produced on their own farms to make confident decisions relating to crop nutrient inputs. Computer modeling scenarios developed for the Maquoketa Headwaters watershed suggest that watershed producers could save $7-9.50 per acre by refining manure and N use and up to $18 per acre by eliminating P fertilizer applications on high or very high testing soils. Past field demonstration results have confirmed that manure does have a high economic value and that commercial N and P applications can be reduced while maintaining corn yields and increasing net farm income.

Growing conditions resulting in exceptional corn yields the past three seasons provided a unique opportunity to measure the effectiveness of refined nutrient use. Host producers compared yield data, soil sampling results and end-of-season cornstalk nitrate-N analyses from their own farms with to results produced at similar multiple-nutrient-treatment demonstrations conducted at other local field sites.

Results from a wide area of eastern Iowa are included in the Maquoketa Watershed Summary of Demonstration Results that can be obtained by contacting the Maquoketa Watershed Project at (563) 425-3233 or visit http://extension.agron.iastate.edu/waterquality/projects/maquoketa.html

Phosphorus Management

Awareness of the potential for P to negatively impact the environment has increased each of the past four growing seasons causing producers to question the need for fall application of P fertilizer. Producers are encouraged to review a recent soil test to assess the crop available P in the soil resource in order to know if additional P is needed. Iowa State University recommends fertilizing with P when soil tests fall below the high range (< 21 ppm P), with an option to use a low rate of P in starter fertilizer when P tests are in the high soil test range.
To demonstrate that University recommendations provide an adequate cushion to protect net income while maintaining yield, twenty-two producers hosted P management demonstrations to study the impact of one- and two-year crop removal applications of P on corn yield. As part of each demonstration a baseline soil sample is collected to measure the available soil P. Through sampling, 87 percent of field sites were found to be testing high or very high for P, with an average P test of 53 parts per million (ppm).

One- and two-year crop removal rates of P are fall-applied to each demonstration site with each treatment also receiving a spring application of 120 lbs N/acre. Resulting corn yields showed a small yield response to the one- and two-year crop removal rates of added P when soil P tests were less than 21 ppm, as shown in figure 1. The cost of added P was significantly greater than the income from the additional corn yields, as shown in figure 2.

Figure 1. Twenty-two on-farm P management demonstrations comparing corn yield by soil test level. 2000-2003. 5 sites <21 ppm P (range 9-20). 5 sites 21-45 ppm P. 12 sites >45 ppm P (range 47-168).

Figure 2. Twenty-two on-farm P management demonstrations comparing return to P fertilizer investment by soil test level. Corn valued at $2.00/bushel. Cost of phosphorus is $0.23/lb.
Nitrogen Management

Between 1995 and 2000, the number of acres planted to soybeans in the eight counties that the Maquoketa River flows through increased from 389,000 acres to 668,000 acres. Growers have added soybeans to their rotation in response to the farm program and commodity prices, and some use the rotation to break weed, insect and disease cycles associated with continuous corn production. An added benefit is the reduced amount of nitrogen needed for corn following soybeans in the rotation.

During the last four crop seasons eastern Iowa corn growers hosted 35 corn following soybean N management demonstrations on their farms. The field sites were fertilized with either five or six N rates ranging from zero to 200 pounds per acre. During three high yield growing seasons, corn yields increased slightly with additional N, as shown in figure 3; however, economic response to additional N was minimal when more than 90 lbs per acre is applied as shown in figure 4.

Figure 3. Average corn yield from 19 corn following soybean N management demonstrations comparing six application rates, crop years 2000-2003.
Small-plot results, like those above, show that applying N at rates near 120 pounds per acre provide the best economic return to N; however, many producers are reluctant to recognize the results because they are produced in small areas. To evaluate N rates on a larger scale, thirteen producers, with support from the Iowa Corn Growers Association, hosted field-scale demonstrations during crop years 2002-03 to measure the impact of N rates on corn yield using field-width treatments.

Field-scale results, developed from nearly 600 acres of data show yields that are very comparable to small-plot demonstrations, typically within 1 or 2 bushels at each N rate, as shown in figure 5. The largest economic return to N fertilizer at these demonstrations was the 90 pounds N per acre rate due to the increasing total cost of N and declining yield response with additional N input shown in figure 6.
Figure 5. Average corn yield from 13 corn following soybean, field-scale N management demonstrations comparing five application rates, crop years 2002-2003.

Figure 6. Return to additional N from 13 corn following soybean demonstrations. Corn is valued at $2.40/bushel (black line), $2.00/bushel (gray line) and N is estimated at $0.20/pound.

End-of-season cornstalk nitrate-N analysis is an important part of each demonstration conducted through the Maquoketa project. Residual N in the cornstalks following maturity was measured for all field-scale N treatments, as shown in figure 7. The check and 60 pounds N per acre treatments did not have enough N available to optimize corn production. Stalk nitrate results from the 90 and 120 pounds N per acre rates were within the 700 to 2,000 ppm optimum range, while the 150 pounds N per acre rate resulted in excess nitrate-N remaining in the corn plant at maturity.
Eastern Iowa farmers are using information produced from 22 local on-farm manure management field demonstrations to better understand how livestock manure use can be incorporated into an efficient crop production program. Producers hosting these demonstrations utilized mostly solid manure from swine, dairy and beef feeding operations to evaluate the effectiveness of manure for corn production. About 25 percent of the demonstrations involved the use of liquid swine manure.

Cooperating producers applied manure at their historic application rates with replicated treatments of zero, 50 and 100 pounds N per acre added to the manure application at planting. Additional treatments included a zero check with no manure, 100/150 pounds of N per acre and the first-year crop-available manure N rate applied as commercial fertilizer. The resulting yields are shown in figure 8.

The average first-year crop-available N credit from manure was 133 pounds per acre for the 19 demonstrations. The manure N contribution at each location was calculated using adjustment factors of field manure history, N loss from surface application versus manure incorporation and first year nutrient availability.

The average corn income when manure was the only nitrogen (N) and phosphorus (P) fertilizer source, compared with the zero check, resulted in increased gross corn income of $55 per acre when corn was valued at $2.00 a bushel and N at 20 cents a pound. At $2.40 per bushel corn, the improved yields from manure application resulted in $66 per acre increased gross income.

On average, yield was highest when 100 pounds of N was added to the manure application; however, it was only one bushel higher than the 50 pounds per acre additional commercial N treatment, not enough to pay for the additional N, as shown in figure 9.

Figure 7. Average end-of-season cornstalk nitrate-N analysis for 13 field-scale N demonstrations, crop years 2002-03.
Figure 8. Average corn yield from 19 corn following soybean, manure management demonstrations comparing, crop years 2000-2003. Average calculated manure N contribution was 133 lbs N/acre. N* = 100 N/a on corn following soybean or 150 N/a on second year corn. MN rate = calculated manure N credit applied as commercial fertilizer.

Figure 9. Return to additional N from 19 manure management demonstrations. Corn is valued at $2.40/bushel (black line), $2.00/bushel (gray line) and N is estimated at $0.20/pound.