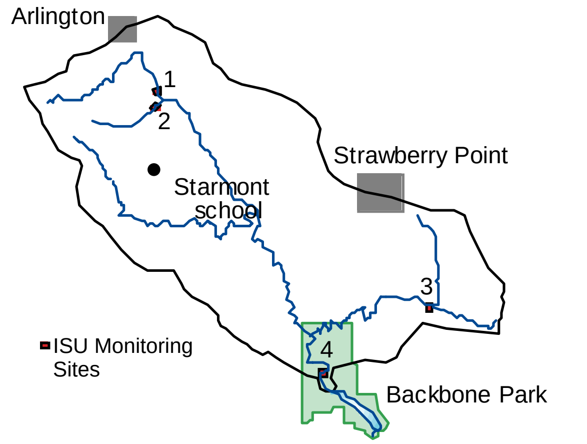
Maquoketa Headwaters Watershed
Field Demonstrations
Crop Year 2000

IOWA STATE UNIVERSITY
University Extension



In March 1999, two public meetings held in the Maquoketa Headwaters Watershed led to the formation of a citizen council of towns-people and farmers. The council's role is to lead discussion of water quality issues in the watershed and promote changes to improve water quality. A systematic approach was also underway using automated monitoring stations at 4 sites in the head-waters (see map at right). The monitoring started in the fall of 1998, before the Headwaters project began, in order to gather baseline data.

The Goal of the Council

Early on, the council reviewed water monitoring data and computer modeling scenarios for management of crop and livestock production in the Headwaters. Using this information, the council established a long-term goal of reducing by 50% the amount of nitrate, phosphate, and sediment leaving the 40,000-acre watershed. The council chose field demonstrations as one approach to help producers to evaluate and refine certain management practices while maximizing net returns and reducing potential nutrient and soil loss, especially during spring rainfall events. These practices included:

- timing, placement and amount of nutrients applied to their fields
- tillage methods
- crop response to nutrients from manure

Field Demonstrations

Field demonstrations on cooperating farms were initiated in the fall of 1999. The goals of the demonstrations were to evaluate:

- crop response to manure nitrogen (N) and phosphorous (P)
- crop response to various rates of N and P fertilizer in corn-soybean rotations
- crop response to various rates of N and P with deep band placement of fertilizer
- crop response from strip-till, no-till, and spring tillage

Results of Field Demonstrations

Field demonstration treatments were replicated 3 times (except for strip-till trials). This is standard for research plots, however, conclusions drawn from these trials should be treated as demonstrations rather than research, at least until more than one year of data is acquired. The responses to various fertility and tillage practices for crop year 2000 are reported on the following pages.

N and P Fertilization in Corn-Soybean Rotations

Water monitoring data from the station in Backbone Park for calendar year 1999 indicated an average nitrate concentration of 9.9 mg/L (health advisory level is 10 mg/l) and soluble P concentration of 0.154 mg/L. Algae growth accelerates as soluble P levels increase above 0.05 mg/L in flowing water and 0.025 mg/L in impounded water.

Fall broadcast application of phosphorus at annual crop removal rates is a common practice in the watershed, and nearly 90% of the fields test high or very high for plant-available P. Three field demonstrations were conducted on corn following soybeans. The corn was fertilized with N at rates of 0, 30, 60, 90, 120, and 150 lbs/acre. These sites were also fertilized with P_20_5 at 0, 46 (crop removal) and 92 (twice crop removal) lbs/acre. Figures 1 and 2 show yields and economic response to N fertilizer, respectively.

Figure 1. Yields at 3 demonstration sites to different rates of N fertilizer.

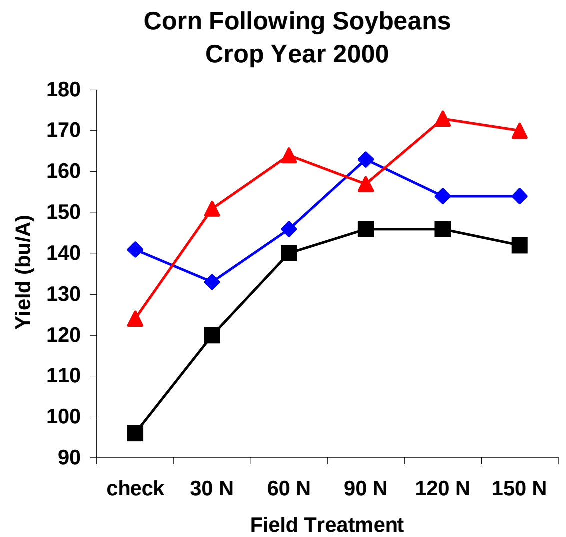
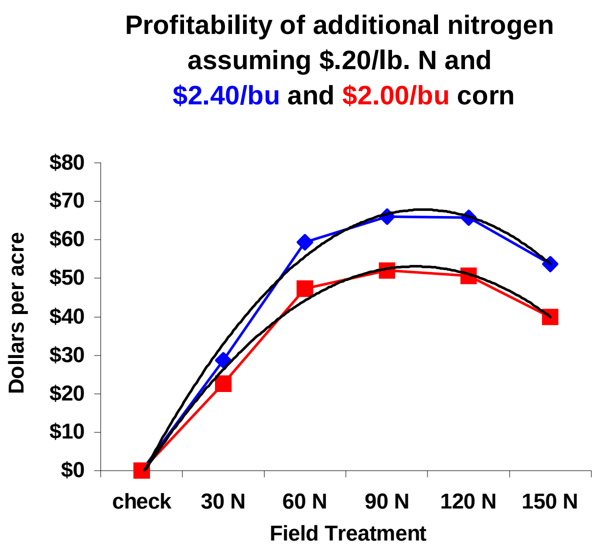


Figure 2. Average returns to dollars spent on N fertilizer for the 3 demonstrations.



Figures 3 and 4 show the yield and economic response of these same demonstration sites to P fertilizer. Soil tests for the 3 sites were 54 ppm (VH), 47 ppm (VH), and 14 ppm (L). Even though one site had a low P soil test, yield responses were similar for all 3 sites so data is shown as the average of all 3 sites.

Figure 3. Average yields for the 3 phosphorus fertilizer demonstrations.

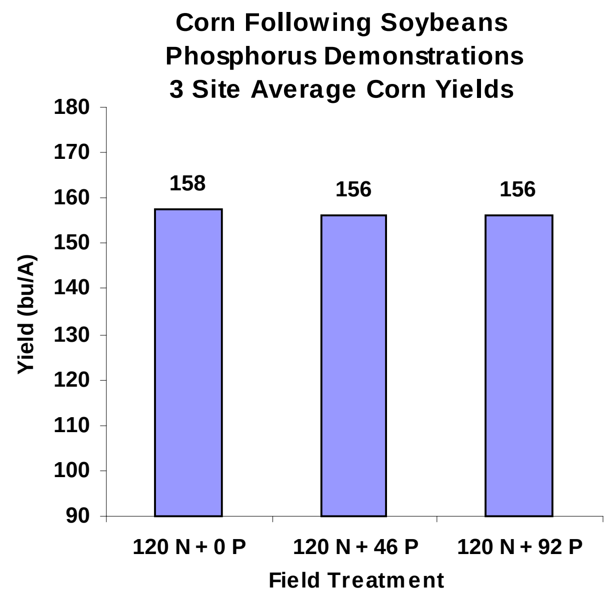
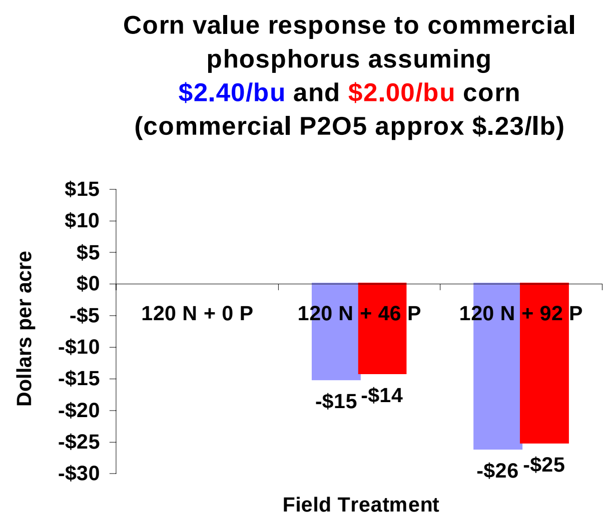


Figure 4. Average returns to dollars spent on phosphorus fertilizer for the 3 demonstrations.



Summary

- The trend line for maximum profitability peaked between 90 and 120 lbs/acre N in the corn-soybean rotations (Fig. 2).
- Additional P fertilizer resulted in a net negative return (Fig. 4). ISU 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 soil tests are in the high range.

Nitrogen and P Management Using Manure

In January 1999 ISU Extension conducted a survey of livestock producers in the Maquoketa Headwaters Watershed. Results indicated that livestock in the watershed annually excrete approximately 118,000 tons of manure containing approximately 1,341,000 pounds of nitrogen and 805,000 pounds of P_2O_5. If all of these nutrients were collected and uniformly spread on the 15,800 acres of corn grown in the watershed, it would result in about 85 lbs/acre N and 50 lbs/acre P.

Eight farmers cooperated with manure nutrient management demonstrations. These trials began with manure spreader calibration of the producers usual spreading rate, and an analysis of the nutrient content of the manure applied to the demonstration site (Table 1). Other treatments included a check (no manure), and commercial fertilizer applied at the estimated equivalent manure contribution of available N and P. One plot was confounded with compaction from semi-truck traffic during last falls harvest and was not included in the results.

Results of Manure & P Demonstrations

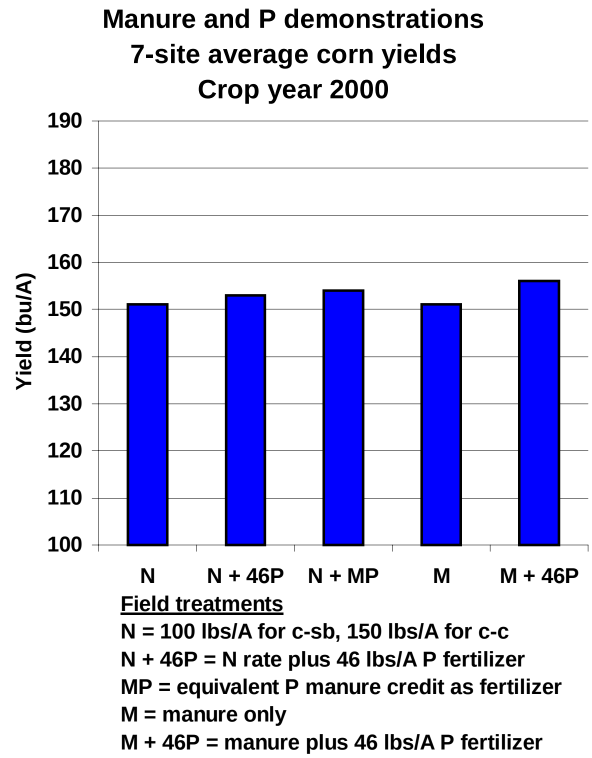
Soil tests showed that all fields ranged high (H) to very high (VH) in P (Table 1). Typical ISU recommendations would be to not apply any additional P nutrients for the 2000 crop year with the exception of the option of applying a low rate of starter fertilizer for the H test soils.

Table 1. Farmers "usual" manure rates (ton/acre) for corn-corn (c-c) & corn-soybean (c-sb) rotations.

Study no.	Crop rotation	Soil test P, ppm	Farmers manure rate	Calculated available N-P-K*
1	c-c	22 (H)	22.5	229-175-172
2	c-c	22 (H)	9.3	106-214-324
3	c-c	43 (VH)	37.5	226-117-184
4	c-sb	67 (VH)	14.6	61-60-157
5	c-sb	116 (VH)	25.2	115-207-403
6	c-sb	64 (VH)	25.2	175-287-736
7	c-sb	52 (VH)	35.0	176-147-350

*calculated N-P-K credits is dependant on manure source, application method, and field history.

Figure 5. Yield comparisons of plots treated with no P, fertilizer P, P from manure, and fertilizer P plus P from manure.



Summary:

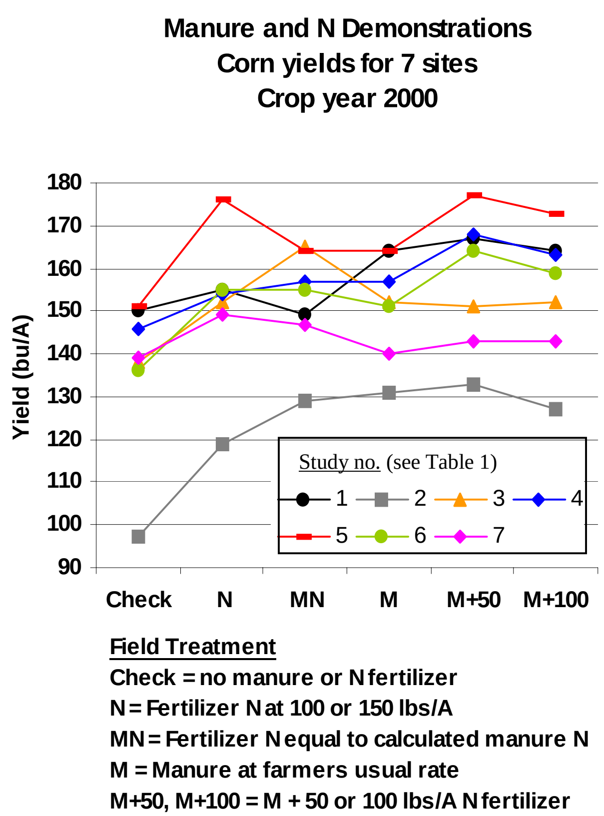
- Adding additional P fertilizer to manure treatments did not increase crop yield in any of the demonstrations (Fig. 5).
- This result was expected due to the H to VH soil tests. Thus, adding P fertilizer to these fields resulted in a net loss of income.

Results of Manure & N Demonstrations

The farmer in Study no. 2 did not apply enough manure to meet "typical" N recommendations for corn in a corn-corn rotation, however no additional yield response was achieved with increased N applications. This was due to other problems in the field (root rot, etc.) resulting from unfavorable environmental conditions. Under better growing conditions, the crop may have responded to additional N.

The farmers in Study no. 4 and 5 did not apply enough manure to meet "typical" N recommendations for corn in a corn-soybean rotation (Table 1), and an additional 50 lbs/A N significantly increased yields (Fig. 6). The other 4 farmers manure rates met or exceeded "typical" N recommendations. Only Study 6 responded to an additional 50 lbs/A N. This may have been in part due to plot error. One of the "manure only" treatments in the far corner of the study was at least 13 bu/ac. lower than for the same treatment in the other 2 replications. This lower yield response reduced the average of the 3 replications by 6 bu/ac.

Figure 6. Yield comparisons of 7 studies treated with manure and/or N fertilizer.



The economic return from manure treatments compared to the check is illustrated in Fig. 7 for $2.00 corn and Fig. 8 for $2.40 corn. Applying an additional 50 pounds of N fertilizer to the manure application produced increased profits for only 2 of the 7 studies. For these 2 studies (Study 4 and 5), the usual farmer's manure rate was below typical ISU recommendations for available N, thus the need for additional N was not surprising.

Figure 7. Profitability of manure and manure plus additional N fertilizer compared to the check (corn selling price = $2.00/bu).

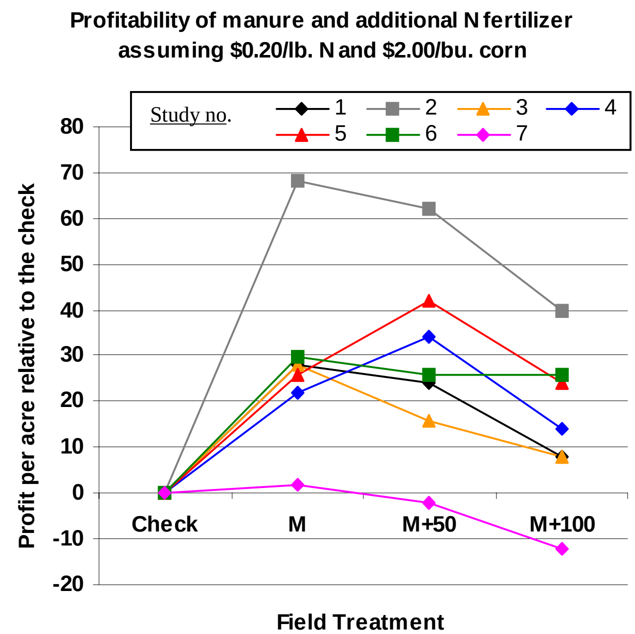
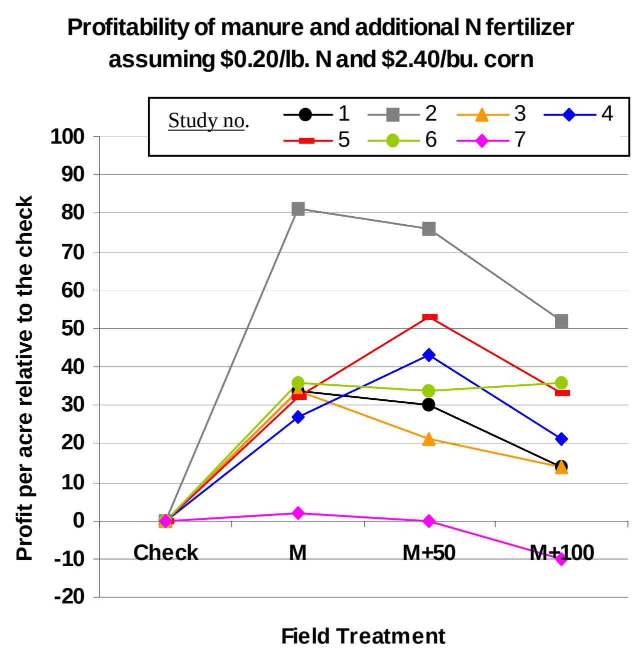


Figure 8. Profitability of manure and manure plus additional N fertilizer compared to the check (corn selling price = $2.40/bu).

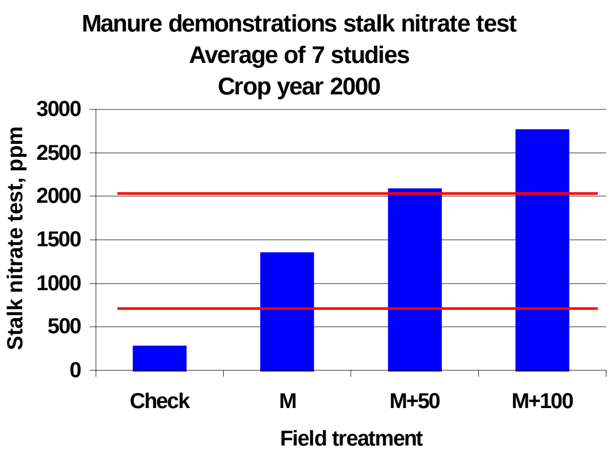


The other study (Study 2) who's manure rate provided available N credits below typical ISU recommendations to meet optimal corn crop needs, did not respond to additional fertilizer N. This was probably because of problematic environmental conditions (high rainfall, slow drainage, root rot, etc.) influencing the crop resulting in below normal yields for the entire study. For the rest of the studies, added N fertilizer did not increase profitability, and in most cases decreased profitability (Fig. 7 & 8).

To help explain the potential available N (insufficient to excess) in the crop system, the fall Stalk Nitrate Test (SNT) was sampled for these 7 studies. Figure 9 shows the average analysis for these studies. The SNT is interpreted as follows:

- < 700 ppm = possibly insufficient N
- 700-2,000 ppm = optimum N
- 2,000 ppm = excess N

Figure 9. Fall Stalk Nitrate Test for manure and manure + N fertilizer treatments.



The excess nitrate remaining in the manure + 100 N treatment indicates a potential environmental concern which can result from any excessive N application (manure or fertilizer).

Summary:

The results of these studies supported ISU recommendations on available N credits from manure, and the need for adequate addition N from fertilizer when insufficient amounts of manure are applied for a given yield goal.

Strip Tillage & Deep Placement of Fertilizer

Tillage practices that expose soil during winter, and rainfall in spring is a concern for the long-term profitability of crop production in the watershed. The watershed council has given priority to conservation practices that producers would likely adopt to help meet the goal of 50% reduction for soil leaving the watershed.

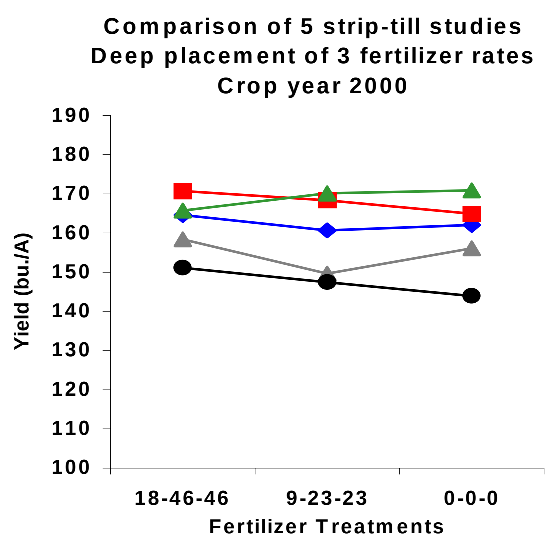
Strip-tillage demonstration equipment used in the studies had the option to place a fertilizer band six inches deep into the soil and build a ridge over the knife slot for earlier soil warm-up for the spring planting zone. There is minimal residue disturbance during the fall strip tillage pass and no additional tillage is used in the spring. The deep placement of fertilizer avoids nutrient loss due to soil erosion, minimizing environmental concerns.

Five studies compared fall strip-tillage and different rates of deep band fertilizer placement. Three studies compared fall strip-placement. Three studies compared fall strip-tillage, no-till, and conventional spring tillage.

Results of Strip-till Deep Band Fertilizer

Figure 10 shows yields of the 5 studies treated with 18-46-46, half that rate, and no fertilizer. Yields were similar across all treatments, with the average results shown in Figure 11.

Figure 10. Deep band placement of P & K at 3 fertilizer rates for 5 studies.



The response to nutrients added on these high and very high P testing soils showed a loss in profitability largely in proportion to the cost of the fertilizer.

Figure 11. Average yield of the 5 strip-till deep band fertilizer studies.

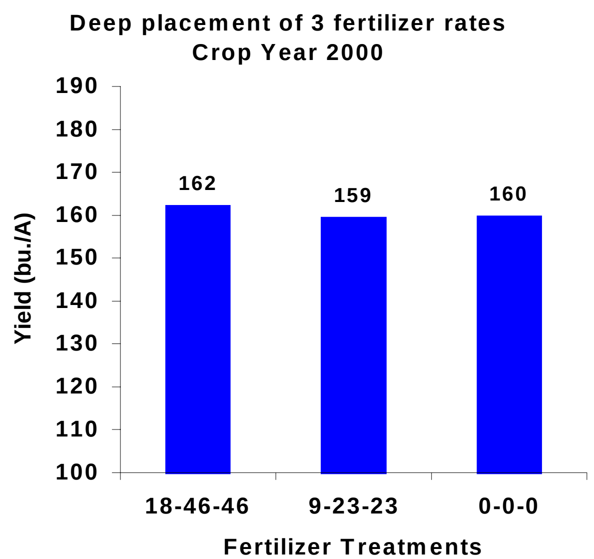
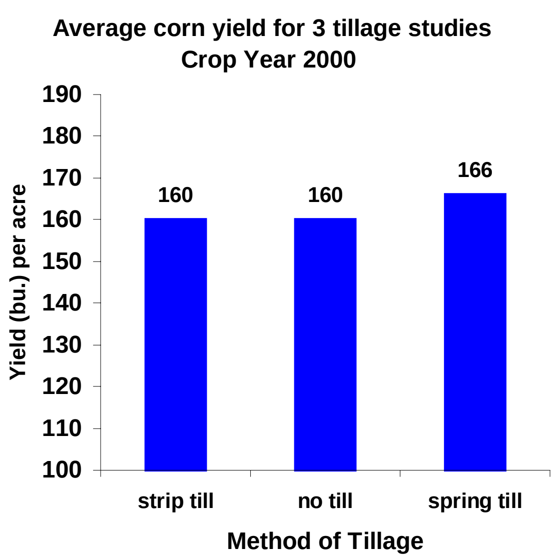


Figure 12 shows the average yield comparisons of 3 tillage studies comparing fall strip-till, no-till, and conventional spring tillage. Yields were similar for all three methods. Economic comparisons would have to include comparing the costs of the different tillage methods.

Figure 12. Comparison of 3 tillage methods.



Fall vs. Spring Anhydrous Ammonia Applications

Four strip trials compared fall vs. spring anhydrous ammonia application (Figure 13). One study had significant growth and development problems due to poor environment. Results of the other 3 studies showed a small yield advantage to spring-applied anhydrous. Economic analysis would have to weigh the purchase cost of fall vs. spring fertilizer and labor availability.

Figure 13. Three studies comparing fall vs. spring anhydrous ammonia application.

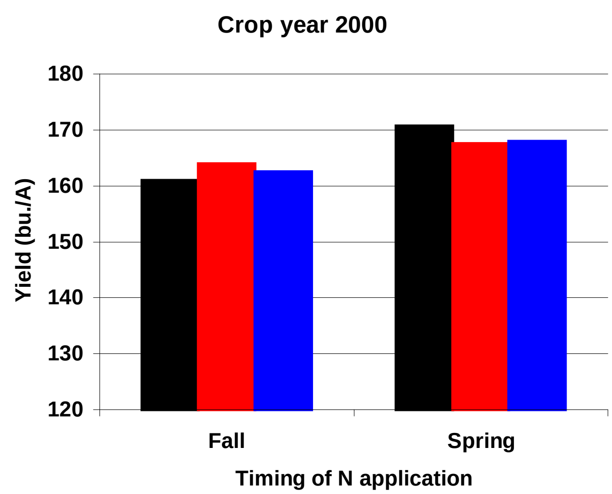


Table 3 shows the fall stalk nitrate tests (SNT) for these studies. Even though yield differences were small, the amount of N potentially available to the crop was significantly greater for the spring applied N.

Table 3. Fall stalk nitrate tests for fall vs spring anhydrous ammonia application studies.

	Study 1	Study 2	Study 3
	----------------- ppm nitrate N		---------------
Fall	202	1,320	235
Spring	930	2,150	2,100

*ppm levels between 700 & 2000 are considered optimal.