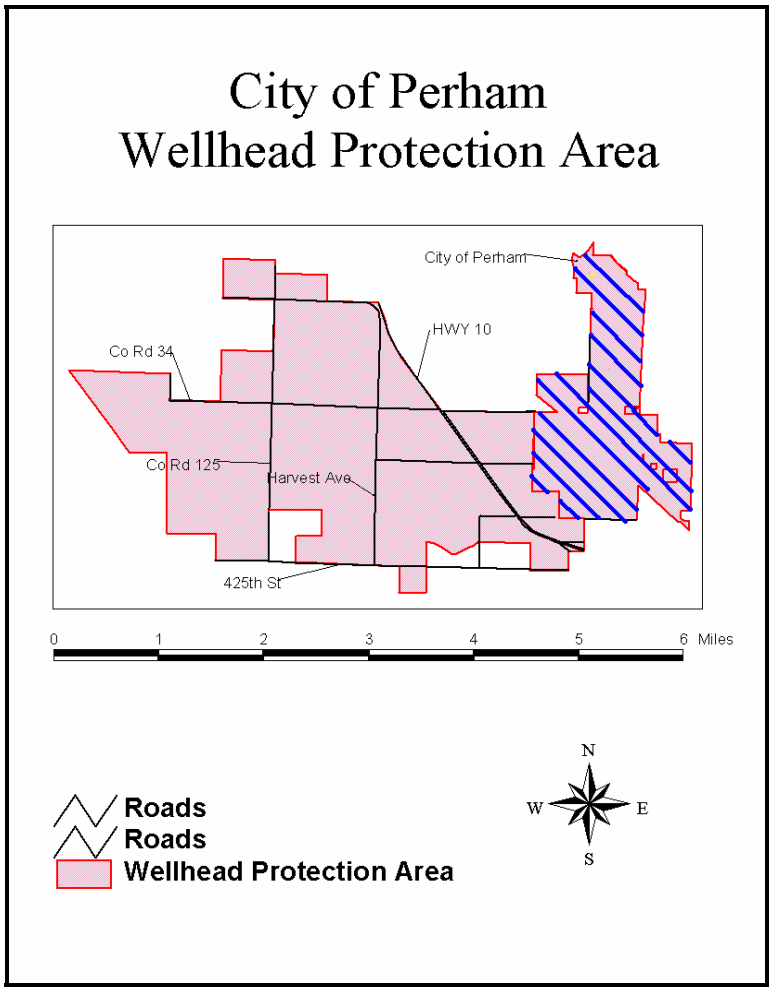
# 1999 Nutrient Management Assessment of Producers Perham Wellhead Protection Area




**For additional information, contact:**
**Denton Bruening at 651-297-4400**
**Minnesota Department of Agriculture**

**Interviews conducted by:**
**Don Sirucek at 218-894-0086**
**Minnesota Department of Agriculture**

## General information:
## Farmers in the Perham Wellhead Protection Area.

Farmers in the Perham Wellhead Protection Area (P-WPA) were originally interviewed for the 1998 crop year and subsequently for the 1999 crop year. The combined interviews resulted in an inventory of crops and nitrogen fertilizer practices within the P-WPA. This report details inventory results for the 1999 growing season and compares them with results of the 1998 growing season.

Water quality in the P-WPA is a concern due to the health risk associated with elevated nitrates in drinking water. The Perham water supply is obtained from four wells ranging in depth from 90 feet to 125 feet. The P-WPA boundaries are established by the Minnesota Department of Health and encompass an area where the wells could be affected by contamination from surface and subsurface activities. This study focuses on the farming activities associated with the P-WPA and reports the results of farm assessments conducted throughout the P-WPA for the 1998 and 1999 cropping season.

A list of farmers/operators in the P-WPA was obtained from the Ottertail Farm Service Agency. Minnesota Extension Service Educators, Perham wellhead protection committee members, Natural Resources Conservation Service (NRCS) personnel and Soil and Water Conservation District (SWCD) personnel were contacted to inform them of the specifics of the project and overall goals. Introduction letters describing the project were mailed from the NRCS to the farmers in December of 1999. The letter's intent was to identify: 1) the overall project; 2) the purpose of the nutrient assessment; 3) why individual farmers were selected, and; 4) what types of information and amount of time would be necessary to successfully complete the project. Letters were sent to 18 operators and a total of 12 operators were interviewed. Approximately 70% of the farmland in the P-WPA was included in the inventory. Letters were also sent to all people with acreage enrolled in the federal Conservation Reserve Program (CRP) in the area. Although owners of CRP land were not interviewed, CRP acres registered with the local NRCS office are included in the tabulation of land-use percentages in the inventory results.

The Minnesota Department of Agriculture used a data gathering tool and analysis system called the Farm Nutrient Management Assessment Program (FANMAP). FANMAP was developed seven years ago to provide an understanding of current farm practices regarding agricultural inputs. This information is used to design effective water quality educational programs and provides baseline data to determine program effectiveness over time. In the past seven years, over 500 farmers throughout Minnesota have volunteered two to four hours of their time to share information about their farming operations. Previous FANMAP surveys have been conducted as a result of funding through the Legislative Commission on Minnesota Resources or Clean Water Partnership programs and from the fertilizer account at the MDA.

## Nutrient Information of the Selected Farms in the Perham Wellhead Protection Area

Inventory forms and database design were patterned after a previous successful project[1]. Timing, rates, and method of applications were collected for all nitrogen (N), phosphate ($P_2O_5$), and potassium ($K_2O$) inputs (fertilizers, manures, and legumes) on **a field-by-field basis for all inventoried acres (approximately 70% of the acres within the P-WPA)**. Soil and manure testing results were also collected if available. Nutrient inputs and yields were specific for the 1999 cropping season. Crop types and manure applications (starting in the fall of 1998) were also collected for the 1998 season for purposes of 1999 nitrogen crediting. Long-term yield data generally reflected the past three to five years. Livestock census and other specifics for the entire farm (i.e. types of manure storage systems, total farm sizes) were also recorded. Information was gathered from the farmer or from the fertilizer dealer if the dealer kept the farmer's records.

## Farm Size, Crop and Livestock Characteristics of the Selected Farms in Perham Wellhead Protection Area

Twelve farmers were interviewed in February 2000. Some of the "farmers" were actually a combination of farmers such as a father and son who farmed together. Only one farming operation applied any manure to crop acres.

A total of 1,864 cropped acres of were inventoried in the P-WPA study for the 1999 crop season. A total of 2,085 cropped acres of were inventoried in the P-WPA for the 1998 growing season. Operators were not questioned directly about their CRP acres during the 1999 inventory, but CRP acreage totals were obtained from the local NRCS office and incorporated into the inventory analysis. A total of 837 acres of CRP were in the P-WPA in 1999 compared to 386 acres in 1998. Farm interviews covered approximately 70% of all agricultural acres in the P-WPA. Livestock appears to play a limited role in the P-WPA for the 1999 growing season. One operation broadcast manure on a total of 32 acres. The manure broadcast was not incorporated immediately after application. Approximately 1,000 lb N was applied through manure broadcast and was available as a first year manure N credit. The manure was spread on 32 acres of corn. For 1998, approximately 250 acres of cropland were spread with 10,000 lb of first-year-available manure N. A greater number of farmers participating in the inventory in 1998 had livestock than did in 1999, so it is difficult to draw conclusions about manure use in the P-WPA with time for the two years in question. Several farmers with livestock did not participate in FANMAP. It also appears liquid hog manure and turkey manure will be applied in the future.

Table 1 lists each type of crop grown and the corresponding acres. Irrigated agriculture accounts for 58% of the all inventoried acres included in the P-WPA land use analysis and 84% of non-CRP land. Irrigation has been increasing in the area with over 700

[1] Effective Nitrogen and Water Management for Water Quality Sensitive Regions of Minnesota, LCMR 1991-93

(45%) inventoried acres converted from non-irrigated to irrigated status during the 1990s.

**Table 1. 1999 Crop Type and Acres in the P-WPA. (Numbers Based on 12 Participating Farms)**

| Crop | Total Acres | Irrigated Acres | Non-irrigated Acres |
|---|---|---|---|
| Corn | 450 | 387 | 63 |
| Edible Beans | 368 | 323 | 45 |
| Alfalfa | 294 | 194 | 100 |
| Small Grain | 72 | 0 | 72 |
| Potato | 558 | 558 | 0 |
| Soybeans | 110 | 110 | 0 |
| Other | 12 | 0 | 12 |
| CRP | 837 | 0 | 837 |
| Total Acres | 2,701 | 1,572 | 1,129 |

## Commercial Fertilizer Use Characteristics on Select Farms: Perham Wellhead Protection Area

Potatoes, corn and edible bean production accounts for virtually all of the N fertilizer use within the P-WPA. Field corn accounted for 23% of the total N commercial fertilizer use. All corn acreage received commercial N fertilizer (Table 2). Average fertilizer N rate on corn acres with commercial fertilizer was 127 lb/A. This rate is calculated as the mean across all commercially N fertilized corn acres regardless of past manure or legume N credits. Total N inputs will be discussed later in the "Nitrogen Balances and Economic Considerations" section of this report.

**Table 2. Distribution Of Commercial Nitrogen Applications On Inventoried Cropland - 1999.**

| Crop | Acres Receiving N Fertilizer | Total N Applied | Average Rate of Non Fertilized Acres |
|---|---|---|---|
| Corn | 450 | 57,088 | 127 |
| Edible Beans | 368 | 42,118 | 115 |
| Potatoes | 558 | 147,378 | 264 |
| **TOTALS** | **1,376** | **246,584** | **-----** |

Irrigated acres received 241,000 lb of N or 98% of all N used on inventoried acres. A total of 247,000 lb of N was applied to inventoried acres in 1999. Applications of N to potatoes accounted for 60% of all N applied (Figure 1).

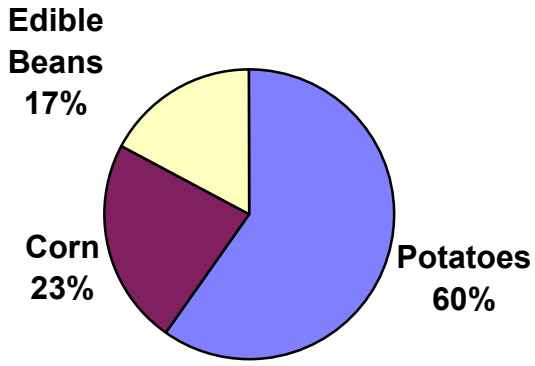



Figure 1. Distribution of 1999 N across all inventoried crop acres fertilized with N. Distribution was similar to 1998 crop year.

Best Management Practices (BMPs) for nitrogen have been developed for irrigated and non-irrigated soils in central Minnesota. Timing of N fertilizer applications is an important consideration in maximizing fertilizer use efficiency and minimizing environmental effects on the sandy, coarse soils in the P-WPA.

Fall application of N is not recommended on the soils in the P_-WPA and there was no fall application of N (Figure 2.

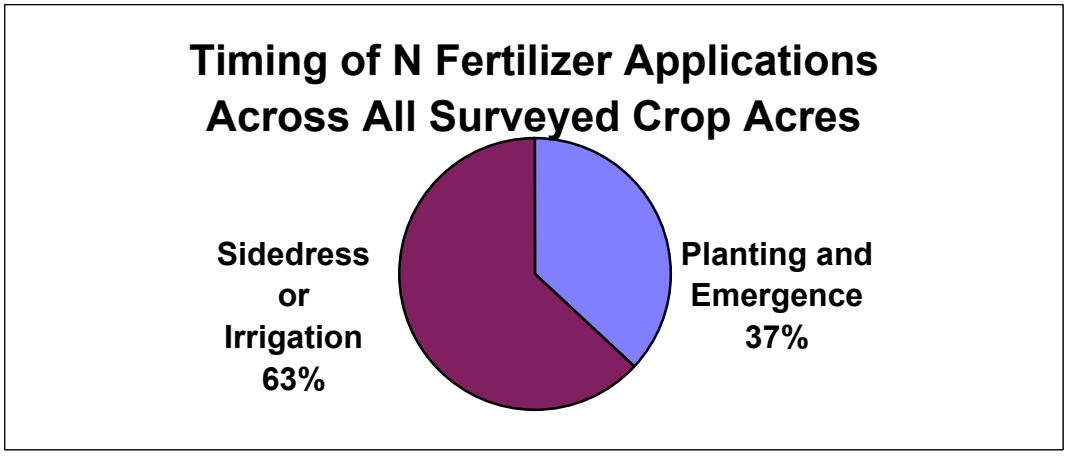



Figure 2. Timing of 1999 N fertilizer applications across all inventoried crop acres. Timing of N applications in 1999 were similar to the 1998 N applications.

Sidedress or split applications of N are preferred for crops in the P-WPA. Sixty-three percent of all nitrogen was applied in a sidedress application or through the irrigator on all crops.

A small amount of N in the starter is recommended in most situations: Ten to twenty pounds per acre of N for irrigated corn and 20 to 40 pounds per acre of N for potatoes. Starter N applications to edible beans are optional, with any starter amounts factored into a maximum 120 lb/N/A for the entire growing season. Fertilizer recommendations and BMPs for edible beans from the University of Minnesota are currently under review and are being updated[2].

Farmers applied 20 lb/A to 45 lb/A of N as a starter on corn with an average of 33 lb/A of N and an average planting date of May 3 across all 387 irrigated corn acres. A blended mix of urea and ammonium phosphate was used on most acres as sources of N in the starter applications. Starter rates averaged 19/lb/A of N over all 63 non-irrigated corn acres. Urea or ammonium phosphate was the source of N for non-irrigated corn starter applications.

Sidedress applications of N were applied on all 387 inventoried acres of irrigated corn. Sidedress applications of N ranged from 40 lb/A to 125 lb/A. Urea was used on 354 acres and UAN solutions were used on 33 acres. Sidedress applications of N were used on 45 of 63 acres of non-irrigated corn. Rates of N applied as a sidedress ranged from 30 lb/A to 40 lb/A.

Nitrogen was applied through the irrigation system on 282 acres of irrigated corn. Average rate per application was 30 lb/A. Nitrogen through the irrigation system should not account for more than one-third of the required N and should only be applied prior to the “silking” stage of plant growth. Farmers applied 19% of all N for corn though irrigation systems (Figure 3).

Farmers applied 20 lb/A to 30 lb/A of N as a starter with an average of 21 lb/A of N on 263 acres of irrigated edible beans (60 acres of irrigated edible beans received no N). Urea was the source of N in the starter on 42 acres and ammonium phosphate was used on the other 221 acres. Starter rates averaged 30 lb/A of N over all 45 dryland bean acres. Urea was the source of N for dryland bean starter applications.

Sidedress applications of N varied widely. Farmers applied between zero to three sidedress applications of N on irrigated edible bean acres at rates between 30 lb/A and 100 lb/A of N per sidedress application. Urea was the only source of N in sidedress applications and urea ammonium nitrate (UAN) solutions were the only source of N in irrigation applications on edible beans. Nitrogen was applied through irrigation on 221 edible bean acres. Fifty percent of N was applied as a sidedress application (Figure 4).

[2] New N recommendations for edible beans are being developed. Contact Dr. George Rehm, University of Minnesota.

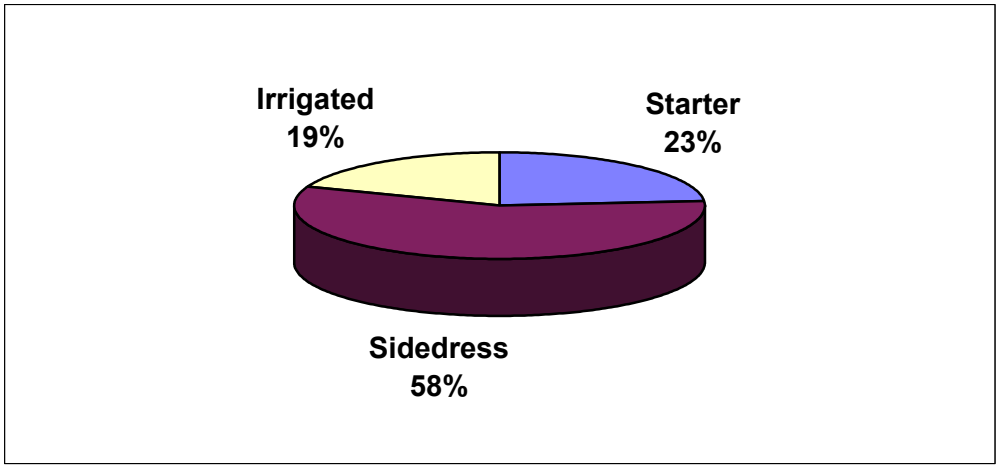



Figure 3. Timing of N applications on inventoried irrigated corn acres.

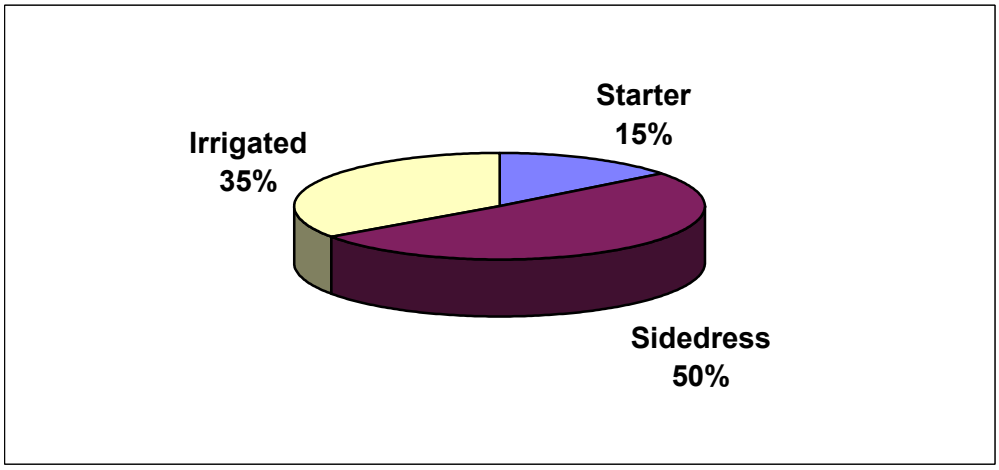



Figure 4. Timing of N applications on inventoried irrigated edible bean acres.

Potato growers applied between 30 and 67 lb/A of N, with a 57 lb/A average, as a starter application across all 558 inventoried acres of potatoes. Ammonium phosphate was the source of N in starter applications.

All potato acres received N at hilling, with most potato acres having a single hilling operation (only one field in the P-WPA had two hilling operations and two corresponding N applications). Rates of N at hilling ranged from 51 lb/A to 88 lb/A. UAN solutions were used for all hilling operations, except one in which urea was used.

For potatoes, N not applied as starter or at hilling was applied through the irrigation system. Rates of N through the irrigator ranged from 14 to 31 lb/A. Applications of N per field though irrigation ranged from 0 to 9 times over the growing season. Approximately 50% of the N was applied through irrigation (Figure 5).

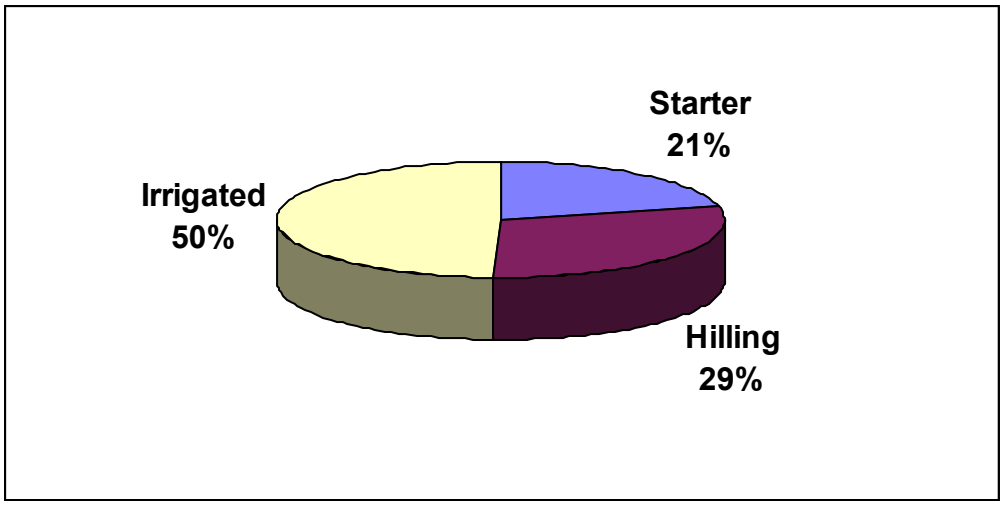



Figure 5. N applied on inventoried potato acres.

Liquid N (UAN solutions) supplied 56% of the total amount of commercial N applied to all crops (Figure 6). Anhydrous ammonia was not a source of N in the P-WPA.

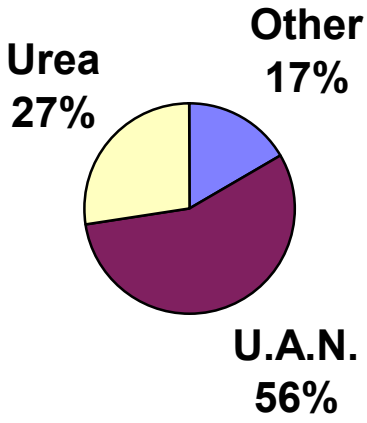



Figure 6. Sources of commercial N used on all inventoried crop acres.

## Relative Importance of N Sources on the Selected Farms: Perham Wellhead Protection Area

The University of Minnesota recommends legume crops be credited for their N contributions to subsequent crops. Alfalfa was assumed to have 2-3 plants per square foot when tilled for the following corn crop. Based on these stands, first-year alfalfa provides a 75 lb/A N credit, and second year alfalfa provides a 50 lb/A N credit. Edible

beans supply a 20 lb/A N credit, but only when corn follows the edible bean crop[3]. The general crop rotation for non-irrigated acres is corn -small grain - alfalfa. The general crop rotation for irrigated acres is corn - edible beans – potatoes. Alfalfa was the most important source of legume N, supplying approximately 95% of all legume N.

Commercial fertilizers (94%), manures (1%), and legumes (5%) contributed a total of 260,000 lb of "first-year available N" to all inventoried acres in 1999 (Figure 7). For comparison, commercial fertilizer accounted for 94% of nitrogen applied to acres inventoried in 1998.

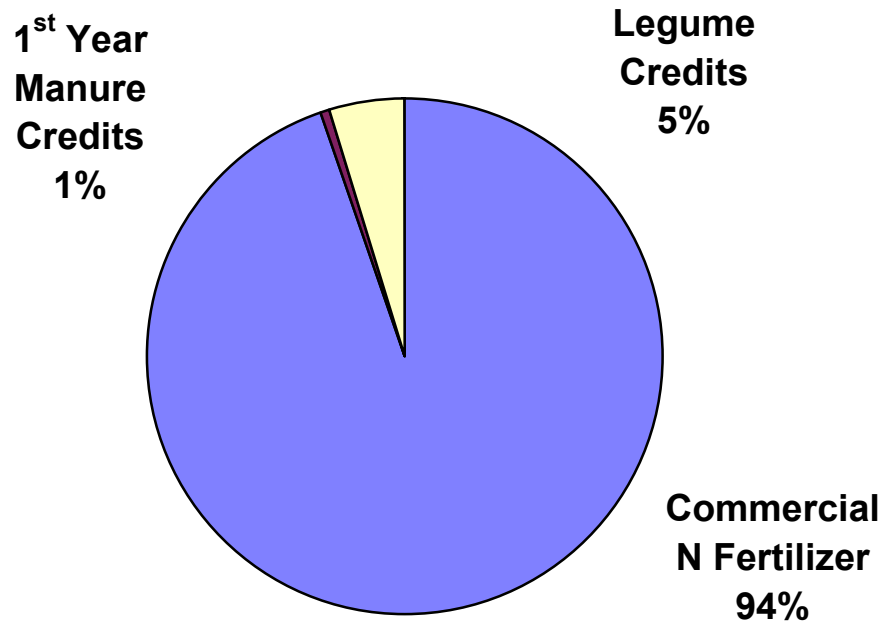



Figure 7. Relative N contributions from fertilizers, manures and legumes across all crop acres inventoried in 1999. Nitrogen inputs totaled 260,000 lb for all sources across the 12 participating farms.

## Nitrogen Balances and Economic Considerations: Perham Wellhead Protection Area

Contributions of N to inventoried corn acres totaled 57,000 lb. Irrigated corn received 54,000 lb of N and non-irrigated corn received 3,000 lb of N. The irrigated corn yield goal across all farms averaged 156 Bu/A while historic yields averaged 154 Bu/A. The non-irrigated corn yield goal averaged 70 Bu/A, which was identical to historic yields. Yield goals for both irrigated and non-irrigated corn were, therefore, equal to or slightly

[3] According to the University of Minnesota, edible bean credits should not be used in calculating N needs for a subsequent potato crop.

greater than historic yields. It appears farmers are using realistic yield goals for both irrigated and non-irrigated corn acres.

University of Minnesota N recommendations (based on yield goal, crop history and soil organic matter level) were compared to actual amounts of fertilizer and manure applied to each field. Approximately 1,300 inventoried acres had soil tests with organic matter data and 98% of those acres were considered low in organic matter (<3% organic matter).

University of Minnesota N recommendations for irrigated corn averaged 163 lb/A (Figure 8). Actual amounts of N applied from fertilizer and manure averaged 140 lb/A across all irrigated corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an under-application rate of 23 lb/N/A. Only 50 acres of corn received fertilizer rates above the University of Minnesota recommendations. Those 50 acres averaged 25 lb/N/A over University of Minnesota recommendations.

Yields and yield goals for irrigated corn in the P-WPA increased on average by 20 to 30 Bu/A from 1998 to 1999. A possible reason may be due to the fact that farmers raising corn rotate their fields with other farmers in a three-year rotation of corn, edible beans and potatoes. The 1999 corn crop may have been planted on land that is more productive. If this is true, farmer-established yield goals would be higher, and the University of Minnesota N recommendations associated with those goals would explain the additional 25-lb/N/A increase in fertilizer applications compared to those of 1998. The observed increase in corn yields for 1999 may be explained by these factors.

Only 63 acres of dryland corn were planted. Non-irrigated corn acres received either manure or legume credits from previous alfalfa crops, and these credits supplied most non-irrigated corn N requirements.

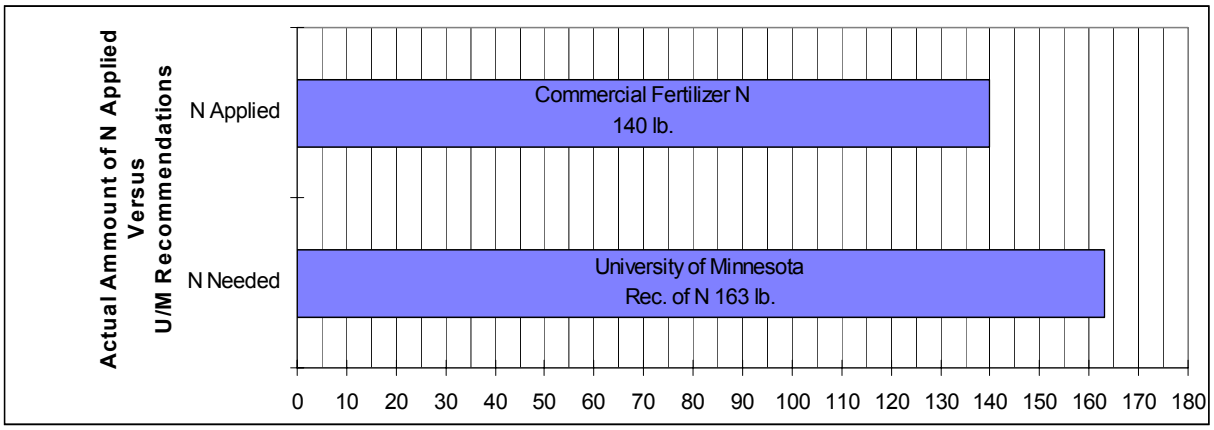



Figure 8. 1999 crop N requirements based on University of Minnesota N recommendations in comparison to actual N inputs (fertilizer and manure) for **irrigated corn acres** in the inventory area.

All bean acres were irrigated except for 45 dryland acres. Irrigated beans received 39,000 lb of N and non-irrigated beans received 3,000 lb of N. The edible bean yield goal across all farms averaged 2,000 lb/A. Yield goals for edible beans were 10% greater than historic yields (1800 lb/A). University of Minnesota N recommendations (based on yield goal, crop history, and soil organic matter level) were compared to actual amounts of fertilizer and manure applied to each field. University of Minnesota N recommendations for edible beans averaged 118 lb/N/A (Figure 9). Actual amounts of N fertilizer applied (no manure was applied to edible beans) averaged 115 lb/A respectively across all edible bean acres. There was an under-application rate of 3 lb/N/A across all edible bean acres.

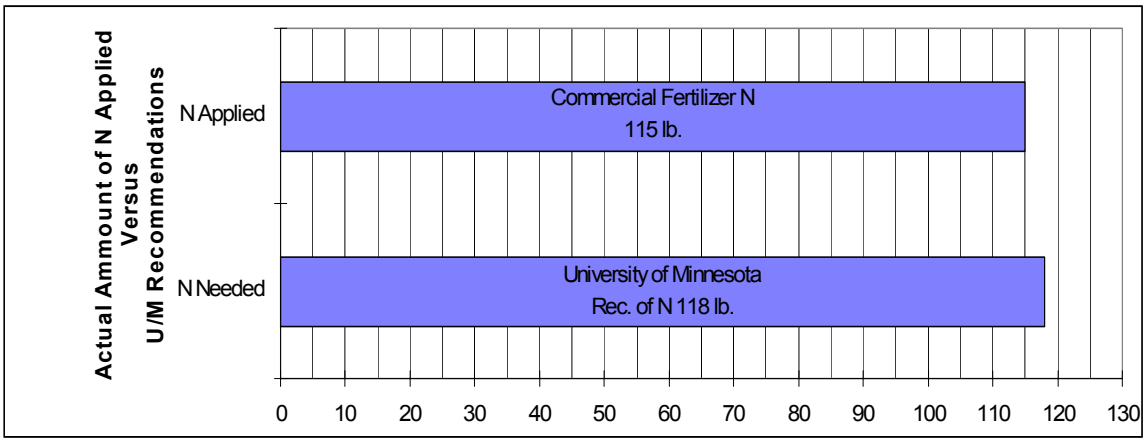



Figure 9. Crop N requirements for **edible bean acres** based on University of Minnesota N recommendations in comparison to actual N inputs.

There were no significant changes in crop production planning, practices and total acres for edible beans within the P-WPA from 1998 to 1999.

It appears farmer N applications to edible beans are very close to University of Minnesota recommendations. It may be possible to adjust the timing of the N applications to obtain better economic and environmental management of N. Current demonstrations in the Perham area and related research at the Central Lakes Ag Center in Staples will eventually provide improved recommendations related to the timing of N applications on edible beans.

The potato yield goal across all farms averaged 452 hundred weight/A. All potato acres were irrigated. Historic yields averaged 441 hundred weight/A. University of Minnesota N recommendations (based on yield goal, crop history, and soil organic matter level) were compared to actual amounts of fertilizer applied to each field. University of Minnesota N recommendations for potatoes averaged 218 lb/N/A (Figure 10) based on yield goals selected by the producers. However, the actual amounts of fertilizer N applied averaged 264 lb/A across all potato acres. Thus, there was an over-application rate, on average, of 46 lb/N/A.

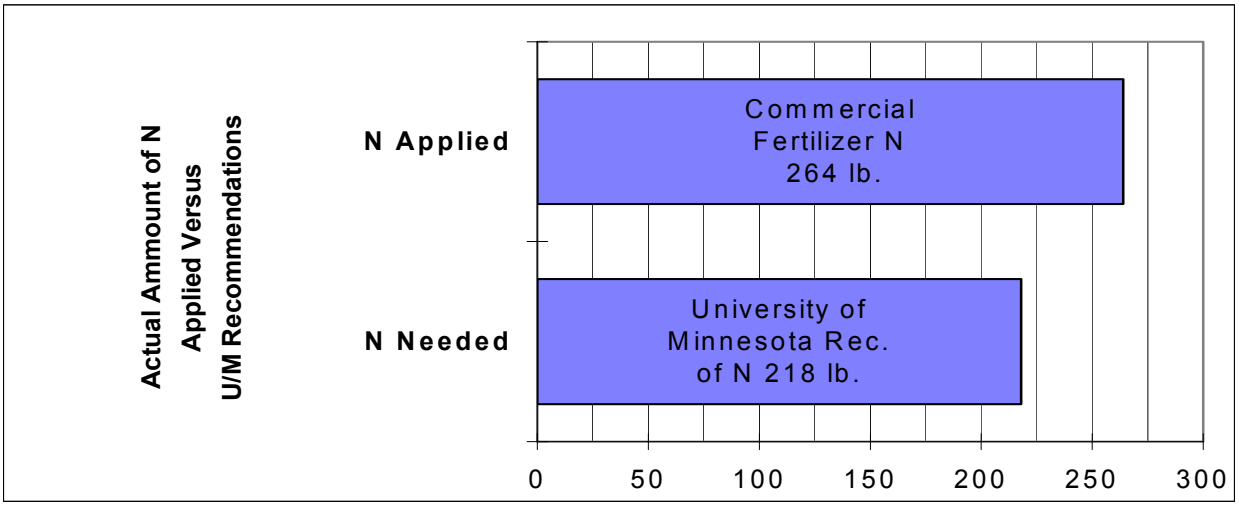



Figure 10. Crop N requirements based on University of Minnesota N recommendations in comparison to actual N inputs across all potato acres. Total area planted to potatoes in this analysis was 558 acres.

Assessment results indicate that potato fertilization and production practices on inventoried acres do not typically follow practices anticipated in the published potato BMPs. For example, the University of Minnesota recommends 20 to 40 lb/N/A starter fertilizer for potato production. Current practices, according to this assessment, are to apply an average of 59 lb/N/A. Additionally, the University of Minnesota recommendations anticipate two hilling operations, with a portion of post-emergence fertilizer needs split between the two hilling events and applied as an injected or incorporated sidedress. Production practices documented during the assessment

confirm the elimination of a hilling event. Applications of N normally linked to the second hilling event (up to 40 lb/N/A) must therefore shift to the first hilling event or to applications elsewhere in the growing season.

Another BMP for potato production is the petiole analysis test (a type of plant tissue test), which provides information on plant nitrogen health after hilling operations. The test was designed to be conducted on plants from each field, with the next anticipated nitrogen application rate based on test results. If petiole analysis results are not factored into the next available fertigation event, there could be an over-application of nitrogen during that event.

Finally, potato BMPs recommend testing irrigation well water to account for the nitrogen contribution from nitrate-contaminated groundwater. For example, groundwater contaminated with 10 parts per million nitrate and applied through irrigation pivots (1 inch per week for six weeks) could provide up to 14 lb/N/A. Failure to account for nitrogen in irrigation water can lead to over-application of N.

Annual over-application of N (relative to University of Minnesota recommendations), and potential leaching losses, on potato acres (a combined 25,000 lb excess N on inventoried acres within the P-WPA) might be the result of several factors, including:

1) Over-application of pre-emergent N;
2) Lack of information about when to apply necessary N in the absence of a second hilling event;
3) The application of N through irrigation pivots (fertigation) prior to complete canopy cover;
4) Lack of proper crediting of irrigation waters containing dissolved nitrate; and/or
5) Disagreement between producers and the University of Minnesota regarding BMPs, N fertilizer rate and source recommendations and the calculation of yield goals.

## Conclusions and Summary of the Current Nutrient Management Practices for the Perham Wellhead Protection Area.

The Perham Wellhead Protection Area (P-WPA) consists of coarse soils on the central outwash plains. During the past 25 years agriculture in the P-WPA has converted from dryland farming and average N inputs of up to 60 lb/A per year to intense irrigated production with average annual N inputs of 180 lb/A. Currently 50% to 60% of crop production in the P-WPA is irrigated, with 45% of irrigated acres converted from dryland to irrigated acres in the last 10 years. Twelve farms, covering 2,000 acres, participated in the FArm Nutrient Management Assessment Program (FANMAP) with staff from the Minnesota Department of Agriculture. Producers volunteered two to four hours of their time to share information about their farming operations. The overall purpose of the program was to develop a clear understanding of current farm practices regarding agricultural nutrients and to utilize this knowledge for future water quality educational programs.

Of the 2,085 cropped acres inventoried for the 1998 growing year, 1,344 acres received 216,000 lb of commercial N. Of that N, 61% was applied to 545 irrigated potato acres, 19% to 426 corn acres, 19% to 328 edible bean acres, and 1% to small grain acres. Alfalfa, CRP and pasture acres did not receive N fertilizer.

Of the 1,864 cropped acres inventoried for the 1999 growing year, 1,376 received 247,000 lb of commercial N. Of that N, 60% was applied to 558 irrigated potato acres, 23% to 450 corn acres, and 17% to 368 edible bean acres. Alfalfa, soybean, CRP and pasture acres did not receive N fertilizer.

Anhydrous ammonia was not a source of N and no fall application of N occurred.

An adjustment to N application rates on potato acres in the starter application and during the growing season could reduce total N applied to levels in conformance with University of Minnesota recommendations. Side dress timing could be adjusted in certain cases for corn acres. The amount of starter N used for edible bean production could be adjusted as well as the timing of side dress applications. Current on-farm demonstrations in the Perham area, and research at the Central Lakes Ag Center focusing on these issues, will provide data needed to verify N management decisions.

Manure (first-year available) accounted for 4% of N on inventoried acres, while legumes and commercial N accounted for 2% and 94%, respectively, in 1998. In 1999 commercial N accounted for 94% of all N applied to inventoried acres, with alfalfa being the dominant source of legume N credits. Producers appeared to be applying N at rates very close to the University of Minnesota N recommendations for most crops. Timing of N generally appears to follow University of Minnesota recommendations, although several adjustments could be made to better match application timing to crop uptake, N availability and plant tissue analysis (for potatoes).

In the past two years manure has not been a significant N source in the P-WPA. Farmers appear to be planning an increase in manure use in 2000. Soybean acres also appear to be increasing in the Perham area.

There were some very positive findings from this study. There is strong evidence that corn and edible bean producers are voluntarily adopting the educational materials and recommended N management strategies developed by the University of Minnesota. However, N management on irrigated potatoes varies from University of Minnesota recommendations, resulting in over application of N at rates of 40 lb/A to 50 lb/A. The specific reasons for these departures from recommendations are unclear. The lack of agreement between practices and recommendations will likely require a re-evaluation of potato production in the P-WPA in relation to BMPs and N fertilizer management. Additional surveys with potato growers may help resolve perceived differences and refine educational programs. It is also evident that BMP promotional activities need to continue and be specifically targeted to deliver the most recent advances in production technology, N management and irrigation recommendations.