Improving Predictability and Adoption of Alfalfa Nitrogen Credits for Corn
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According to nitrogen (N) management surveys in Minnesota, the most extreme cases of excessive N fertilization in corn occur when fertilizer N and manure are applied to corn (Zea mays L.) following legumes (Bierman et al., 2011). Growers and their consultants often do not allow sufficient credit for the N contribution of legumes and manure, and the resulting excessive soil N can contribute to nitrate pollution of water (Shepard, 2000). The majority of research studies support the conclusion that on medium-textured soils, alfalfa (Medicago sativa L.) typically provides most or the entire N needed to maximize grain yield of the following corn crop (Lawrence et al., 2008; Schmitt and Randall, 1994; Bundy and Andraski, 1993; Morris et al., 1993). This reduction in fertilizer N requirement for corn after alfalfa is known as the N credit or fertilizer N replacement value. Although it is more common for first-year corn to require additional fertilizer N on sandy and fine-textured soils, no reliable methods exist across soil types to predict which fields need to be fertilized. This uncertainty, in combination with the concern that alfalfa will not provide sufficient N to support the high corn yields common today, may contribute to low adoption of alfalfa N credits on Minnesota farms, and the resulting increase in water contamination.

Research was conducted from 2009 to 2010 on 16 farms in Minnesota to assess corn response to fertilizer N after alfalfa (Yost et al., 2012) and results from this work show that corn grain yield increased with fertilizer N at only one farm. This research not only confirmed current Minnesota fertilizer N guidelines for first-year corn after alfalfa (Kaiser et al., 2011), but suggests that the N credit should be raised. At the responsive site, there were no pre-season indications that a substantial fertilizer N rate (~90 kg N ha⁻¹) would be needed to optimize grain yield. Ultimately, the average response may not reduce a grower’s risk as much as knowing the response that is likely in a specific field during a specific growing season. More accurate forecasting of fertilizer N response in these situations would likely improve N credit adoption, increase net returns to the grower, and reduce nitrate losses.

My research is an integrated effort with five parts focused on determining agronomic and environmental factors that affect the fertilizer N response of corn following alfalfa and sociological factors that influence the adoption of alfalfa N credits to corn. The first effort involves two field experiments on 16 Minnesota and Wisconsin farms that will help determine the effects of manure and no-tillage on the fertilizer N requirement of first-year corn after alfalfa. These field experiments should help growers more accurately credit N from alfalfa to first-year corn to improve their net returns to fertilizer N and reduce the amount of excess N susceptible to loss to the environment, but alone they will likely not increase widespread adoption of alfalfa N credits.

Second, there are over 400 site-years of published data in the U.S. and Canada on the response to fertilizer N in first-year corn after alfalfa. This large body of research covers a much wider range of soil and crop management and weather conditions than any single study, and may contain clues for predicting fertilizer N response that have been missed by others. This database will be developed and mined for predictors of fertilizer N response using logistic multiple regression. The variables that appear to predict fertilizer N response in first-year corn will be
validated against the independent set of data from 31 recent site-years (2009-2011) of on-farm research in Minnesota and Wisconsin.

Third, in order to help farmers utilize the full N benefit from alfalfa to second-year corn, experiments were conducted at 11 farms in 2010-2012 to determine the effects of first-year corn residue or stover removal on the fertilizer N requirements of second-year corn after alfalfa, and whether a combination of soil and plant tests will accurately predict fertilizer N requirements of second-year corn after alfalfa.

Fourth, to improve the adoption of alfalfa N credits in Minnesota, a survey of Minnesota growers who have at least 40 hectares of alfalfa and 20 hectares of corn \( (n = 2,196) \) was conducted to learn their N management practices in alfalfa-corn rotations and the determinants of adoption or non- adoption of alfalfa N credits to first- and second-year corn. The results will clarify the extent of adoption, inform development of effective education interventions, and identify particular audiences that should be targeted (e.g., grower characteristics, geographic distribution).

Fifth, high resolution maps of cropping patterns in Minnesota since 2006 will be analyzed to provide the first quantitative, geographically-specific estimates of first-year corn following alfalfa acreage in the state. Trends longevity of alfalfa stands production, the alfalfa acreage rotated each year, and which crops follow alfalfa in the rotation also will be determined in this geographic analysis.

These five integrated efforts should improve the prediction and adoption of alfalfa N credits to first- and second-year corn, improve net returns for growers, and reduce the amount of excess fertilizer N applied for corn following alfalfa. These integrative efforts will form the basis for updated alfalfa N credit recommendations that will be more accurate and site specific while addressing grower concerns and considerations, thereby improving grower adoption of alfalfa N credits to corn.

References: