Advancing Nitrogen Use Efficiency on Ontario Livestock Farms

(Interim Report)

Purpose:

One of the challenges for livestock producers in utilizing manure for crop production is accurately estimating the nitrogen credit that should be given to manure applied the previous fall. Estimates of the amount of nitrogen available to a succeeding corn crop are available (OMAFRA Agronomy Guide to Field Crops, Pub. 811); however these figures may over or underestimate the amount actually present in the spring when the corn crop requires nitrogen. A series of on-farm demonstration sites were established to assess the overall nitrogen use efficiency on livestock farms and to evaluate technologies such as the soil nitrate-N test and lower stalk N-test as tools to advance this nitrogen use efficiency and to accurately predict corn fertilizer N requirements on fields where manure had been applied in the fall. The 2005 growing season was the final year of a 3 year Greenhouse Gas Mitigation Program project.

Accurate estimation of corn fertilizer nitrogen requirements is essential to maintain profitable yields while at the same time minimizing the amount of soil N not utilized by the corn crop. Non-utilized N is subject to environmental losses; including the possibility for conversion to Greenhouse Gasses.

Methods:

Ten on-farm demonstration sites were established across the corn producing regions of Ontario in 2005 (Table 1). On nine of the sites, manure had been uniformly applied across the whole experimental area during the late summer and fall of the previous year (2004), on the other site liquid hog manure was sidedress applied into corn in mid-June at a rate of 190 kg-N/ha of available N. The fertilizer response portion of the tenth site did not receive manure within the last year.

Corn was planted in early to Mid-May of 2005 at each of the sites using the normal production practices of the co-operating farmer; except for fertilizer N application. Four rates of fertilizer N (0, 50, 100, and 150 lb-N/ha) were established by side-dressing the appropriate rate of U.A.N (28%) sometime during the latter part of June. Two replications of the N rates occurred at each site. The yields from the various fertilizer N strips were used to estimate the maximum economic N rate (MERN).

Results:

Corn yields at all the sites were relatively high ranging from 146 to 200 bu/ac (9100 – 13,000 kg/ha) at the maximum economic rate for nitrogen (Table 2). Yields across all nitrogen rates ranged from a low of 97 bu/ac (6085 kg/ha) to a high of 200 bu/ac (12,548 kg/ha). The estimated maximum economic nitrogen rate (MERN) ranged from 0 to 128 kg-N/ha (0 – 114 lb-N/ac). Four of the nine sites actually did not require any sidedress fertilizer N to achieve the most economic yields (a planter application of 30 kg-N/ha would have been sufficient to ensure adequate N fertilization for corn).

Spring soil nitrate concentrations in the surface 30 cm (1 foot) in the period June 5 – 20th ranged from 15 to 41 ppm. Unfortunately when presidedress soil N test recommendations (PSNT) are compared to actual corn fertilizer requirements, the soil N test often significantly underestimated N requirements.

Over the 3 years of the project the average PSNT recommendation was 25 kg-N/ha, compared to an OMAFRA recommendation of 46 kg-N/ha, and MERN of 59 kg-N/ha. This indicates that there may be a need for further calibration of the PSNT N test (eg. inclusion of spring weather variables such as accumulated temperature and (or) rainfall) to account for potential year to year variability in the relationship between MERN and PSNT soil nitrate-N concentrations.

Table 1. 2005 Livestock Manure N Demonstration Sites

Site Code	County	Manure Type	Last Applied	Application Rate
L2AS	Stormont, Dundas and Glengarry	Liquid Beef	Fall 2004	6,000 gal/ac
L2CW	Huron	Solid Broiler	Fall 2004	4 T/ac
L2DC	Stormont, Dundas and Glengarry	Liquid Dairy	Fall 2004	8,000 gal/ac
L2HV	Huron	Liquid Swine	Late Summer 2004	5,000 gal/ac
L2GV	Perth	Liquid Swine	Fall 2004	6,000 gal/ac
L2KB	Perth	Liquid Dairy	Fall 2004	5,500 gal/ac
L2LH	Wellington	Solid Broiler	Fall 2004	3 t/ac
L2SE	Wellington	Liquid Swine	Spring 2005	3,900 gal/ac
L2WJ	Durham	Liquid Dairy	Fall 2004	6,000 gal/ac
L2DS	Perth	Liquid Swine	Side-dress 2005	4,000 gal/ac

Table 2. An overview of the 2005 sites and recommended N rates associated with general recommendations, manure credits and soil N test (PSNT).

SITE CODE	(A) OMAFRA N REC'D[1]	(B) Manure Nitrogen Credit[1]	(A-B) OMAFRA Credit Rec'd[1]	Pre-Sidedres N Rec'd	Most Economic Nitrogen Rate	2005 CORN YIELD (economic)
	kg - N/ha					kg/ha
L3CW	134	78.0	56.0	0	81	12387
L3KB	136	56.0	80.4	0	39	11117
L3LH	77	56.0	21.2	0	0	9827
L3SE	75	65.5	9.5	0	35	10244
L3GV	106	40.0	65.9	3	102	9513
L3HV	91	30.0	61.3	24	128	9914
L3DS	93	0.0	93.0	30	149	10145
L3WJ	105	56.0	49.0	44	0	9111

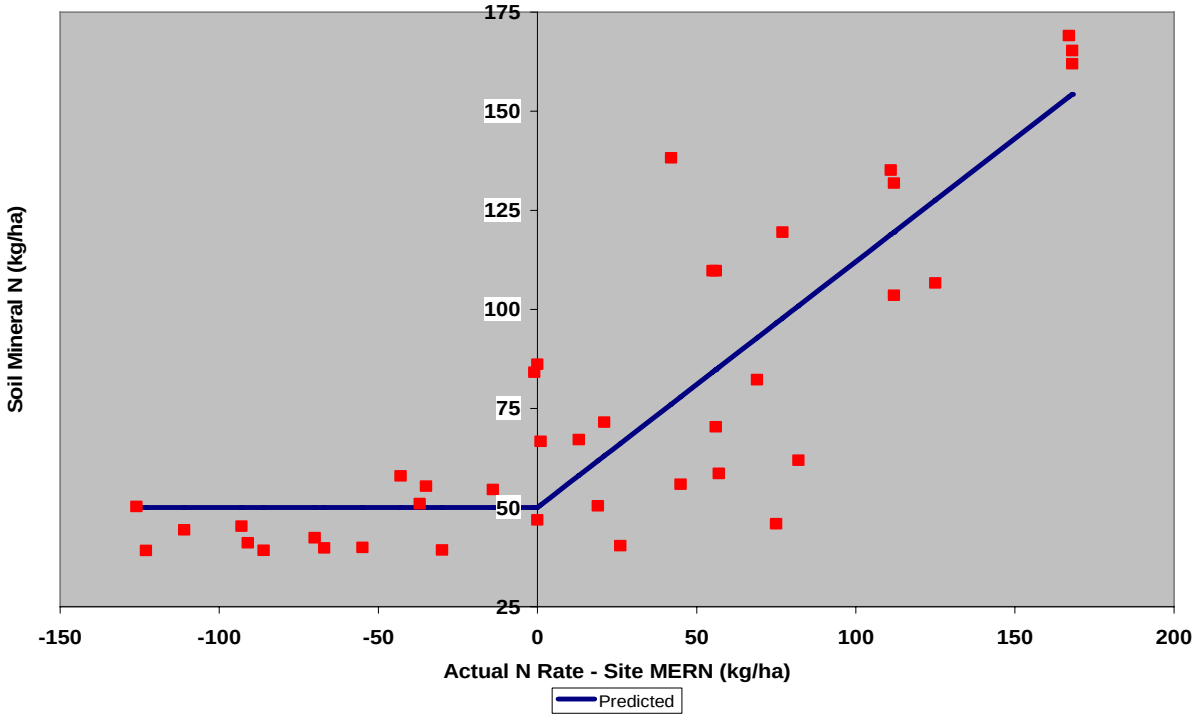
[1] OMAFRA N recommendation is based on the new N rate calculator utilizing a corn price of $110 /tonne and nitrogen cost of $1.10 /kg (0.50 /lb).

Application of fertilizer N in excess of crop requirements can lead to higher soil N concentrations at the end of the growing season. Figure 1 illustrates the trend in post-harvest soil N concentrations as the fertilizer rate applied exceeds requirements for the 2003 -2004 project years. On the fertilizer rate strips where fertilizer N rate applied was less than the economic requirement (the negative rate applied values), soil mineral N concentrations remained relatively constant, averaging about 50 kg/ha (45 lb-N/ac) of mineral N in the surface 30cm. On strips where fertilizer application exceeded economic requirements, the average mineral N content in the surface 30cm increased from 50 kg/ha (45 lb-N/ac) to 150 kg-N/ha (135 lb-N/ac). Clearly, application of fertilizer N in excess of economic requirements contributes to greater soil N concentrations at the end of the growing season; soil N which is subject to environmental losses, including conversion to Greenhouse Gasses.

Summary:

Both years of this study clearly demonstrated that applying fertilizer nitrogen in excess of economic crop requirements will result in significantly higher soil mineral N levels at the end of the growing season. The majority of nitrogen left over in the soil at the end of the growing season is susceptible to environmental losses, including conversion to greenhouse gases. Using OMAFRA general recommendations including a credit for manure did a good job of predicting N requirements and reducing potential environmental contamination.

Figure 1. End of season soil mineral N in the surface 30cm in relation to the amount of fertilizer nitrogen applied. A negative value indicates that the fertilizer N rate applied was less than the fertilizer N rate required to economically optimize yield. A positive value on the x-axis indicate a fertilizer N rate that was more than required to economically optimize yield.



Next Steps:

This project is forming an important part of a larger effort to re-evaluate OMAFRA recommendations for determining manure credits in a crop sequence. This work will continue over the next 18 months with the goal of improving the process by which livestock producers assess manure N credits on their farms.

Acknowledgements:

Farm co-operators from across Ontario are gratefully acknowledged for their contributions to this project. Funding for the project has been provided by the Greenhouse Gas Mitigation Project for Canadian Agriculture supported by AAFC in conjunction with OSCIA, Ontario Pork, IFAO and others.

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