Assessment of General Nitrogen Recommendations for Corn

Purpose:

This project was designed to assess the effectiveness of the revised General N Recommendations for Corn at predicting the Maximum Economic Rate of Nitrogen (MERN) for a particular field. Improving the confidence of Ontario growers in the recommendations will reduce the application of "insurance" rates of N, thereby improving the economic returns from growing corn, and reducing the environmental impact from over-application of nitrogen. Other studies have shown that reducing N rates below crop requirements has not reduced the environmental impact, while matching N applications to crop requirements maximizes both the environmental and economic benefits.

Methods:

The Ontario Corn N Database (OCNDB) includes the yield response data from 1024 site-years of research trials with three or more rates of nitrogen fertilizer. This data spans the 41 year period from 1962 to 2002. The new general nitrogen recommendations for corn were derived from this data by defining the relationship that best predicted the optimum rate of nitrogen for a particular field. This assessment uses the data to determine how close the recommendations came to the optimum economic rate of nitrogen for each field, and how often a grower would gain or lose economically by applying a different amount of nitrogen from the recommended rate.

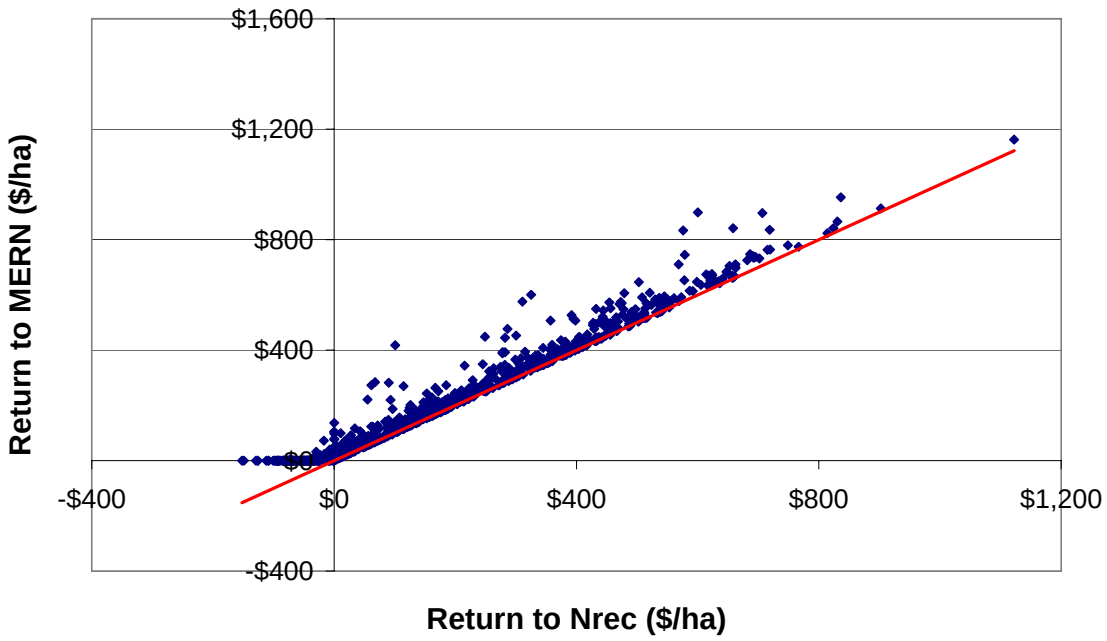
A number of assumptions were made in the analysis of this data:

- The range of nitrogen responses observed in the OCNDB is similar to the range found in grower's fields across Ontario.
- N responses followed a curved pattern where the response to added nitrogen gradually rose to a maximum and there was no yield decrease from applying nitrogen rates above the rate that produced maximum yield (i.e. a quadratic-plateau response).
- Economic responses were based on an N:corn price ratio of 7.67 (i.e. it took 7.67 pounds of corn yield increase to pay for a pound of nitrogen, which would be the case for corn at $2.80/bu, and urea at $388/t)

Results:

To assess how well the new N recommendations predicted the optimum rates of nitrogen for a range of field conditions, we first compared the return to nitrogen (value of yield increase minus the cost of added nitrogen fertilizer) at the recommended N rate to the return at MERN (maximum possible return) as shown in Figure 1. The solid line indicates where the recommendations exactly equal the MERN value for the site. If the new N recommendation perfectly predicted the MERN for each field, all the dots would fall on the solid line. Although few of the points fall exactly on the line, most fall close to the line. There is no trend to a greater difference at higher returns to nitrogen, indicating that the recommendations predict the N requirements at highly responsive sites as well as sites with low levels of response.

Figure 1: Return to Nitrogen at MERN vs. Nrec



The next step was to calculate the probability of attaining a particular return to nitrogen for each site at the recommended rate of N for that site. This was expressed as a cumulative probability, as shown in Figure 2. At each point along the curve, the vertical distance (shown as percent on the Y-axis) shows the probability of earning the dollar return shown directly below it on the horizontal axis, or less. From 0 to about 17%, the values indicate a negative return. These are the sites that were not responsive to nitrogen, but where N was recommended. Roughly 60% of the sites had a return to nitrogen of $200/ha ($80/acre) or less, which means that 40% of the sites had a return to nitrogen at recommended rates of greater than this value. A very few sites had returns to nitrogen of over $800/ha ($360/ac).

The next step was to compare what impact there would be on yield by applying more or less than the recommended rate of nitrogen. The probability of a change in yield with different N rates is shown in Figure 3. Adding an extra 20 kg/ha (18 lb/ac) of nitrogen over the recommendations (the diamonds or right-hand line of the graph) would not increase yield at all about 35% of the time, and half the time the increase in yield would be less than 80 kg/ha (1.25 bu/ac). A large yield response (>500 kg/ha or 446lb/ac) would only occur rarely (<5% of the time). Adding higher rates of nitrogen (not shown) resulted in greater increases in yield at the highly responsive sites, but did not increase the probability that a yield increase would occur.

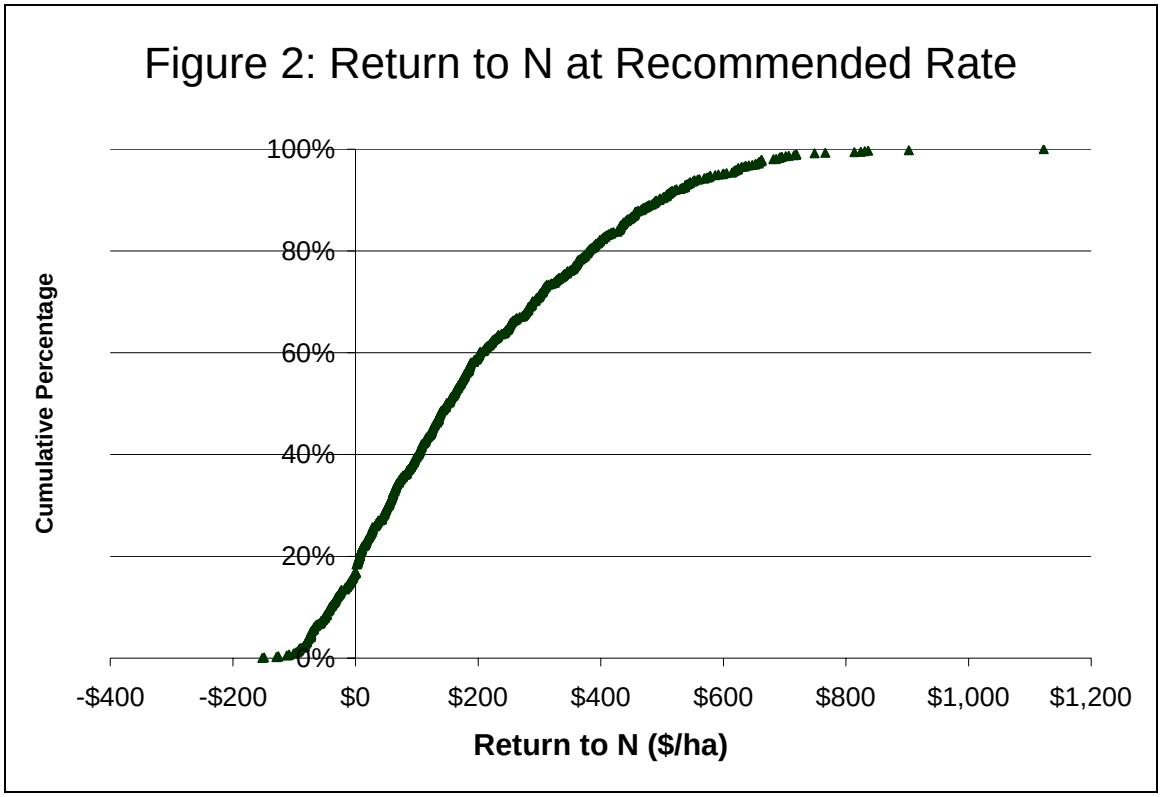


Figure 2: Return to N at Recommended Rate
Cumulative Percentage
100%
80%
60%
40%
20%
0%
-$400
-$200
$0
$200
$400
$600
$800
$1,000
$1,200
Return to N ($/ha)

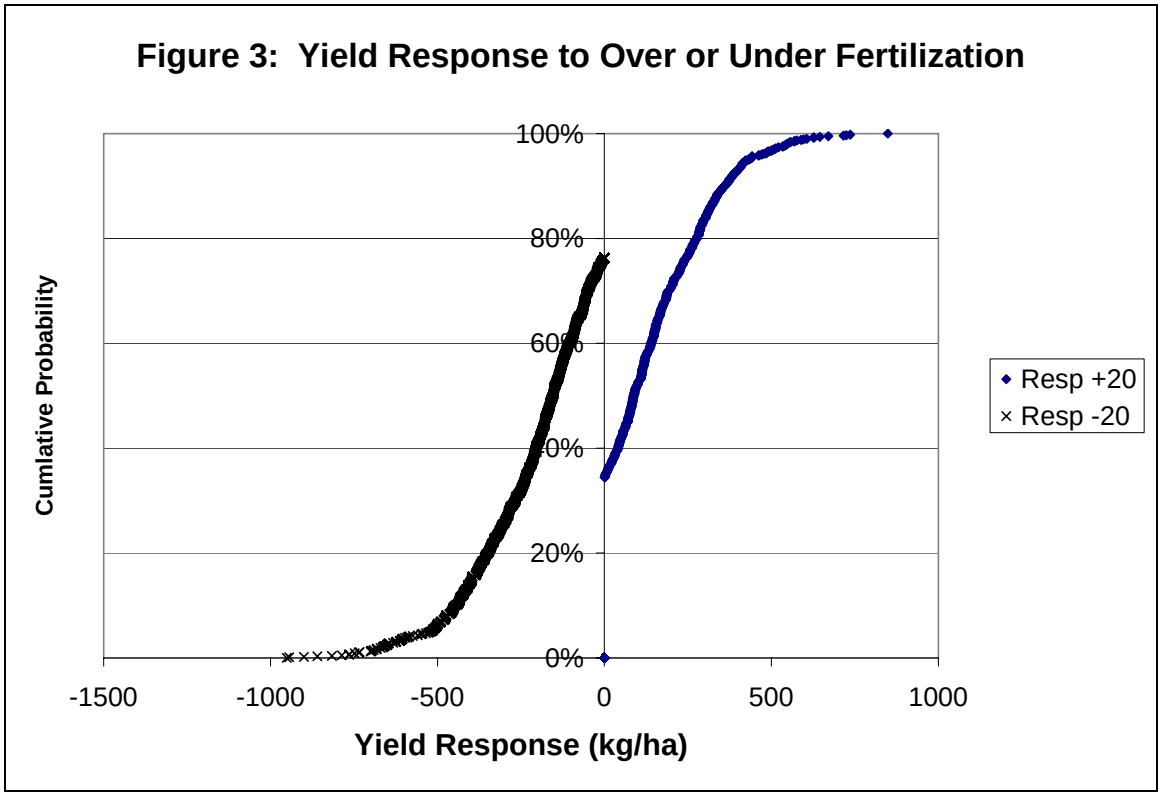


Figure 3: Yield Response to Over or Under Fertilization
Cumlative Probability
100%
80%
60%
40%
20%
0%
-1500
-1000
-500
0
500
1000
Yield Response (kg/ha)
Resp +20
Resp -20

Cutting rates by 20 kg/ha (18 lb/ac) below the recommendations would reduce yields about three-quarters of the time, as shown by the black “x” symbols on the left side of the graph. The remaining 25% of the time, the recommendations are already more than 20 kg/ha above the point of producing maximum yield at the site, and so there is no change in the yield.

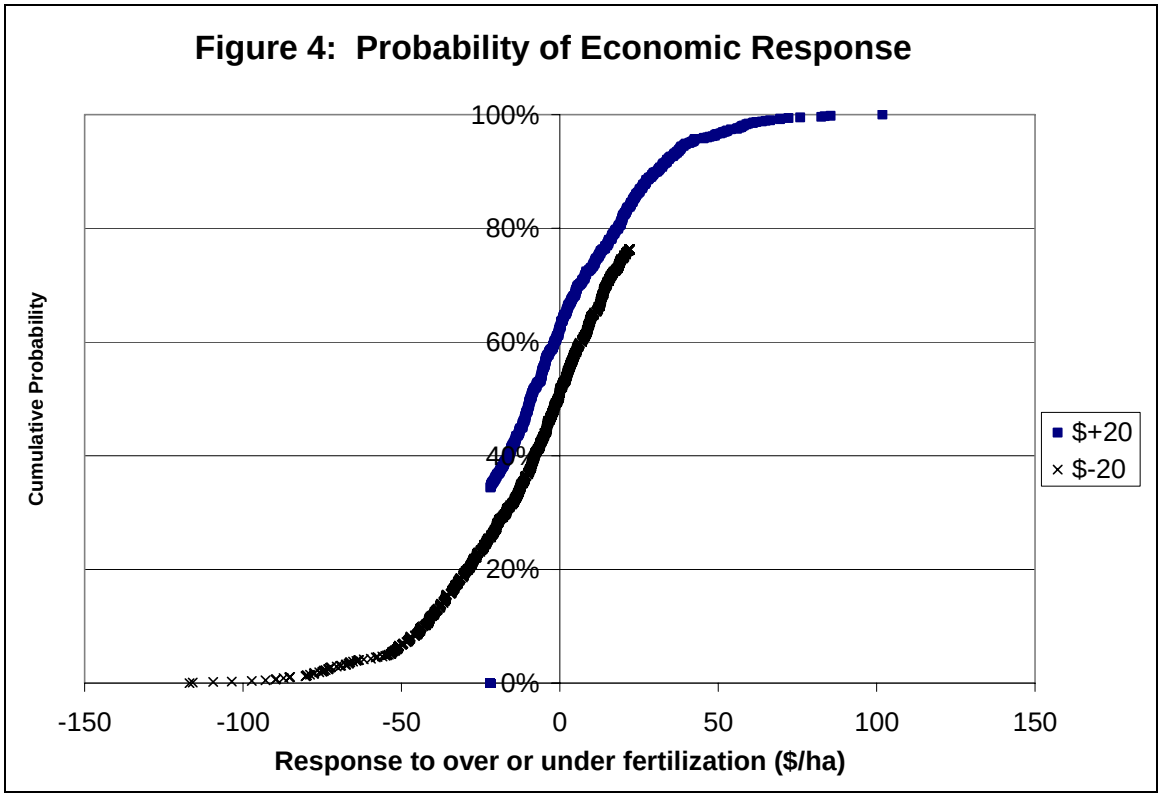
The final step in the analysis examined the economic impact from applying more or less nitrogen than was recommended. This takes into account the change in the cost of the fertilizer as well as the value of the yield increase or shortfall compared to applying the recommended rate of N. The probability of a dollar response to changing the nitrogen rate is shown in Figure 4. There is a net loss in income approximately 50% of the time from cutting rates by 20 kg/ha (18 lb/ac), and the maximum benefit to cutting rates below recommendations is the cost of the fertilizer. Adding an extra 20 kg/ha (18 lb/ac) resulted in a net loss of income about 60% of the time, There were a few highly responsive sites where adding extra nitrogen generated significant returns, but without some way of predicting what conditions led to those responses, it would be gambling rather than investing, to apply extra fertilizer in hopes of extra profit.

Summary:

The new general N recommendations for corn appear to provide good predictions of the optimum rates of nitrogen for Ontario corn growers. There does not appear to be an advantage to applying more N than is recommended often enough to justify this practice.

Next Steps:

Initial evaluation of data collected in the N Benchmark project and from other trials at the University of Guelph, which were not included in the initial database, showed a similar pattern to what was shown here. Continuing evaluation of optimum N rates achieved in field trials relative to the recommended rates is needed to ensure that OMAFRA recommendations are relevant to Ontario growers. This type of information will also help to uncover any relationships between weather conditions and N requirements.



Acknowledgements:

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