Environmentally Sustainable Utilization of Nitrogen on Corn 2015

Purpose:

To improve nitrogen use efficiency for sustainable corn production, while enhancing the environment. This project will evaluate the yield response to comparable nitrogen (N) rates applied at various timings, including a late application (Y-Drop) applied at the 10 to 14 corn leaf stage to planting broadcast or side-dressed applied nitrogen.

Background:

Recent research has shown that hybrids of today's era use more nitrogen (29%) post tassel than hybrids of the 1990's and earlier. Modern day hybrid's take up seven lbs. more nitrogen. Up to 37% of the total N is taken up post tassel.

N uptake prior to flowering supports critical ear shoot development, kernel number and potential kernel size. Corn growers have traditionally targeted N availability to this period, and considered post-flowering application to be of little value.

Given the variability in soil type and environmental conditions from year to year, nitrogen use efficiency may be improved by applying a portion of the required nitrogen closer to when the corn plant will take up the nitrogen.

Recently new equipment (Image 1) has become available to allow growers to apply N (Image 2) at later growth stages. Research work in the United States has shown favorable yield increases and improved nitrogen utilization while minimizing potential water quality concerns. However, no research work has been conducted to date in Ontario assessing these corn nitrogen management changes.

Image 1: Y Drop units attached to sprayer for late N Application

Image 2: Y Drop units attached to sprayer for late N Application

Image 3: Y Drop liquid N stream of late N beside the corn row.

Methods:

10 farm locations in the Ottawa-Carleton, Lanark and Dundas counties, applied the 6 treatments (see Table 1), with 3 randomized replications of each treatments. Note: actual N rates at each site varied depending on the Grower Rate of each location.

Table 1: An example of the six treatments.

Treatments:	Starter N	Sidedress N	Late N (Y-Drop)	Total N
1. Starter N at Planting Only (N up to 40 lbs/ac)	30			**30**
2. GR[a] Reduced rate by 25 to 30 (lbs/ac) - 2/3[b], 1/3[c]	30	50	25	**105**
3. GR[a]	30	100		**130**
4. GR[a] - split approximately - 2/3[b], 1/3[c]	30	60	40	**130**
5. GR[a] - increased rate, split approximately - 2/3[b], 1/3[c]	30	100	50	**180**
6. GR[a] - increased rate by 30 to 50 lbs/ac	30	150		**180**

[a]GR = Grower's Current N Rate; [b]sidedress;
[c] late applied (V10 to V14 corn stage) pounds per acre (lbs/ac)

VERIS was used at several location to measure CEC, pH and Organic Matter to characterize the soils into management zones while enhancing our understanding of soil/nitrogen relationships (Figure 1). *UAV* (unmanned aerial vehicle) (Image 4-5) maps were taken at 3 stages during the growing season to look for differences in treatments and field management zones. Note the starter N only strips in the field shown in Image 6. Pre-side-dress nitrogen test (PSNT) soil samples were taken from the *Starter N at Planting Only* (treatment 1) strips within the treatments at each site. At harvest, yield monitors were used to collect continuous side-by-side yield data to compare different N rates and application timings across the field management zones.

Figure 1: Example of VERIS map in management zones.

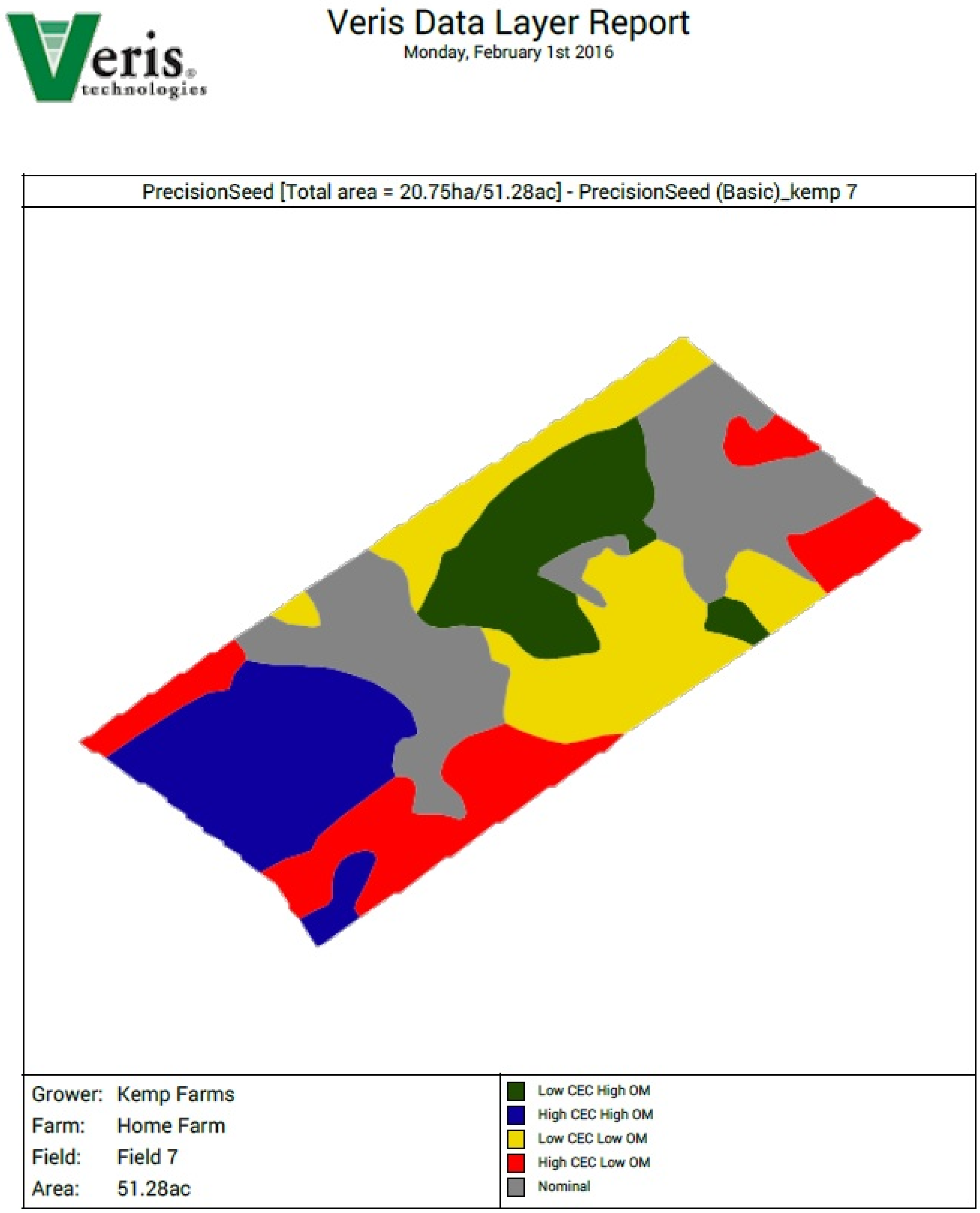
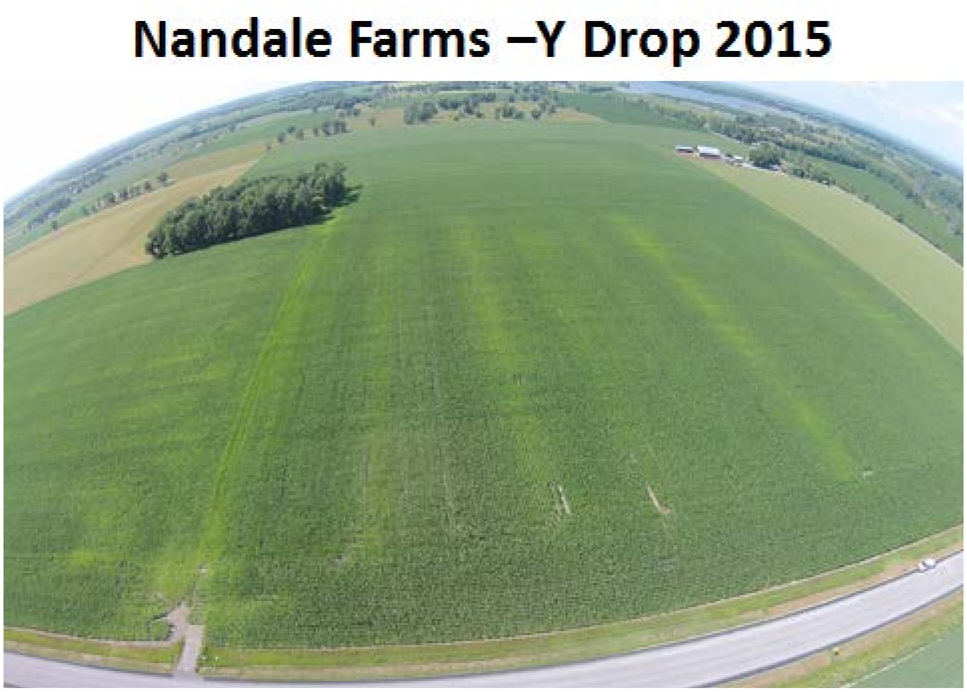


Image 4: ***UAV*** **(unmanned aerial vehicle) Brugline Farms location**

Image 5: ***UAV*** **(unmanned aerial vehicle) Nandale Farms location**



Results:

Table 2a: Summary of 10 locations Yield and N Rates, PSNT results, Soil Texture and Previous Crop.

Location	**Jockbrae**		**Panmure**	
Summary of Plots	**Total N**	**Yield (bu/ac)**	**Total N**	**Yield (bu/ac)**
No side dress	34	173	48	221.7
Grower Split with 75 %	103	198	84	224.0
Grower Rate	**109**	207	**113**	222.8
Grower Split with YD	118	208	117	226.0
125 % of grower rate with YD	154	215	141	226.5
125 % of grower rate	149	208	141	226.0
Average PSNT-June 5 (range)	**20**	**(19-22)**	**39**	**(22-56)**
Average PSNT-June 17 (range)	14	(7-21)	34	(21-46)
Soil Texture Previous Crop	Sandy Loam Soybean		Silt loam to loam Winter wheat	

Location	**Nandale**		**VVF**	
Summary of Plots	**Total N**	**Yield (bu/ac)**	**Total N**	**Yield (bu/ac)**
No side dress	11	131	45	185
Grower Split with 75 %	65	156	120	209
Grower Rate	**126**	167	**145**	209
Grower Split with YD	126	167	145	212
125 % of grower rate with YD	171	172	195	212
125 % of grower rate	171	174	195	211
Average PSNT-June 5 (range)	**N/A**		**26**	**(17-32)**
Average PSNT-June 17 (range)	11		20	(13-24)
Soil Texture Previous Crop	Silt loam to silt-clay loam Mixed Grain		Loam to silt loam Soybean	

Table 2b: Summary of 10 locations Yield and N Rates, PSNT results, Soil Texture and Previous Crop. (Continued)

Location	**Brugman**		**Vanden Bosch**	
Summary of Plots	**Total N**	**Yield (bu/ac)**	**Total N**	**Yield (bu/ac)**
No side dress	84	204	40	119.8
Grower Split with 75 %	114	205	130	186.3
Grower Rate	**144**	209	**160**	193.6
Grower Split with YD	144	208	160	185.3
125 % of grower rate with YD	184	216	200	197.1
125 % of grower rate	184	214	200	194.9
Average PSNT-June 5 (range) Average PSNT-June 17 (range)	**34**	**(30-42)**	**12**	**(11-14)**
Soil Texture Previous Crop	Silt loam Soybean		Loam to silt loam Soybean	

Location	**AGD**		**Hilltone**	
Summary of Plots	**Total N**	**Yield (bu/ac)**	**Total N**	**Yield (bu/ac)**
No side dress	51	168.6	47	110
Grower Split with 75 %	141	239.3	145	155
Grower Rate	**171**	242.8	**179**	165
Grower Split with YD	171	244.0	177	163
125 % of grower rate with YD	211	241.7	219	169
125 % of grower rate	211	226.0	217	169
Average	159.3	227.1	164.0	155.2
Average PSNT-June 5 (range)	**19**	**(13-26)**	**12**	**(10-13)**
Average PSNT-June 17 (range)	11	(4-16)	13	13
Soil Texture Previous Crop	Sandy loam to loam Soybean		Silt loam Soybean	

Table 2c: Summary of 10 locations Yield and N Rates, PSNT results, Soil Texture and Previous Crop. (Continued)

Location	Kemp Farms		Cederlodge Farms	
Summary of Plots	**Total N**	**Yield (bu/ac)**	**Total N**	**Yield (bu/ac)**
No side dress	34	157	60	172
Grower Split with 75 %	154	191	145	192
Grower Rate	**204**	196	**145**	183
Grower Split with YD	204	195	145	191
125 % of grower rate with YD	244	191	180	185
125 % of grower rate	244	203	180	189
Average PSNT-June 5 (range)	**13**	**(10-15)**		
Average PSNT-June 17 (range)	**33**	**(26-47)**	33	(26-47)
Soil Texture Previous Crop	Sandy loam to silt loam Corn		Clay-loam Corn	

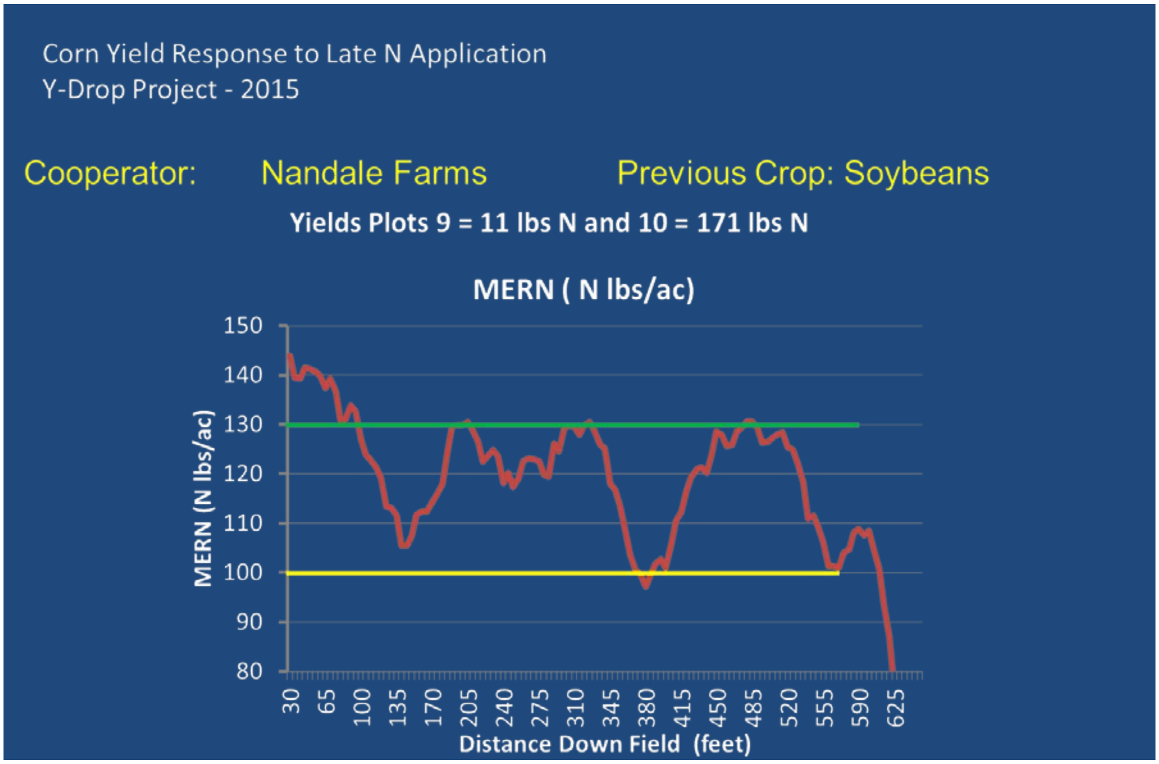
Table 3: Yield and Economics at 2015 Nandale Farms location:

Treatment	Planter N	Broadcast N	Y Drop N	Total N	Yield (bu/ac)	Net ($/ac)
O	11	0		11	131	
Reduced	11	65	25	101	161	$56
Standard	11	115		126	167	$13
Std. Y Drop	11	75	40	126	167	-$3
N High	11	160		171	174	-$8
High Y Drop	11	110	50	171	172	-$17

Net = additional corn bushels at $4.50 per bushel, additional nitrogen at $0.70 per pound of nitrogen plus the cost of Y Drop at $15.00 per acre where applicable.

Image 6: Field view of Nandale Farms –Y Drop 2015 location.

Figure 2. Yield Monitor Delta Yield calculation of the Most Economic Rate of Nitrogen 2015 Nandale Farms



Summary:
2015 is only one year's data and is the first of a three project. In 2015, there was no benefit to the split, late applied (Y-Drop) nitrogen at most of the sites. Yield response to higher N rates did not pay for the additional N costs. Example Nandale location Table 3, the Grower Rate provided the most return. Using the Grower Rate split applied with the Y Drop had an additional cost of $15 per acre for Y Drop application costs.

The lack of response to Y Drop and higher N rates can be practically explained by the favorable growing season (adequate rainfall, moderate temperatures and higher crop heat units) and the high available soil nitrate (NO_3) levels as shown by the PSNT (Pre-Sidedress Nitrogen Test) results taken on June 5th and again on June 17th. From Table 2, Pre-Sidedress Nitrogen Soil Test (PSNT) fertilizer N recommendations (OMAFRA), the N recommendation was 100 down to 0 pounds per acre. Other factors that will need to be considered are hybrid response, crop rotation, planting timing and fungicide use.

However, there does appear to be a potential opportunity to variable rate apply N as shown in graph 1; the Most Economical Rate of Nitrogen (MERN) for the Nandale Farm location. The field would appear to be very uniform; Image 6. At the Grower Rate of 126 pounds per acre (lbs/ac) was adequate for most points along the length of the field, but with there were also points that the N could be reduced to about 100 lbs N /ac that could save up to $18/ac (26 lbs N at $0.70/lb N) in zones within the field. The yield, Veris and UAV maps will be analyzed to determine which is the best correlation to these zones.

Table 4: Pre-Sidedress Nitrogen Soil Test (PSNT) fertilizer N recommendations based on soil nitrate concentration (PPM) and expected yield (bu/acre).

Soil Nitrate (PPM)	Expected Yield (bu/ac)					
	120	143	167	191	215	239
	Sidedress Nitrogen Fertilizer Recommendation (lb N/acre)					
0	176	197	218	240	261	282
2.5	163	184	205	225	246	267
5	151	171	191	211	231	252
7.5	138	158	177	197	216	236
10	126	144	163	182	201	221
12.5	113	131	149	168	187	206
15	99	117	135	153	172	190
17.5	83	102	120	138	156	175
20	57	86	105	123	141	159
22.5	0	60	88	107	126	144
25	0	0	63	90	110	128
27.5	0	0	0	66	92	111
30	0	0	0	0	68	93
32.5	0	0	0	0	0	69
35	0	0	0	0	0	0

Next Steps:

2015 was the first of a three project. Plots are planned to be setup, monitored and harvested again in 2016 and 2017. Further analysis of the 2015 yield monitor harvest data is underway such as MERNs for each location. Data from the VERIS measurements of CEC, pH and Organic Matter soil characteristics and the *UAV* (unmanned aerial vehicle) maps will be over-laid with the yield data to evaluate the correlation between these information layers to see if this can be used to explain the soil/nitrogen relationship and potential management zones. These results will be added to the report when available. Results to date have been presented at several local Soil & Crop Improvement Association – Annual Meetings in eastern Ontario and will be at the 2016 Eastern Ontario Crop Conference.

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Location of Project Final Report:

Crop Advances, Ontario Soil & Crop Improvement Association at:
http://www.ontariosoilcrop.org/