Managing Manure

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Optical sensors for corn silage production

Sensors provide a way to check crop status and evaluate if more N is needed.

In the past 50 to 60 years there has been a steady increase in corn grain and silage yields, reflecting great improvements in corn hybrid performance and in crop management. There is also a growing awareness that excess nitrogen can cause environmental issues that could greatly impact the sustainability of the agricultural industry.

In the past, nitrogen management decisions, whether for manure or fertilizer application, were often set at one single rate across a field. All farmers recognize that crop yields are not uniform across most fields but the use of grain yield monitors really helps to illustrate the differences in bushels from place to place as well as how the yield changes, often with just a few feet of travel. Some of this variation is due to soil conditions: texture, parent material, how the soil was formed, drainage, water holding capacity and so on. While we recognize that not all of the yield variation is due to nitrogen, it is an appropriate area of emphasis. This is because N is needed in such large quantities by corn, and is often a major limiting factor in yield. Yields will vary across a field as a reflection of micro-conditions (Fig 1). Apart from the spatial (within-field) variability, temporal variability (from one year to another), which is greatly impacted by weather conditions during the growing season, is a main issue in agricultural systems making yield prediction and selecting the right N rate from year to year, difficult tasks. So, how to account for nitrogen-related, in-field spatial and temporal, variability?

Some years ago, researchers realized that it would be ideal to let the plant tell us how it is doing. Optical sensors are the result of this idea. Optical sensors to determine crop nitrogen status and to variable-apply nitrogen fertilizer have received a lot of attention in corn grain production and now increasingly also for corn silage production. There are several optical sensors used for in-field sensing and for on-the-go applications in agricultural systems and they all are based on the same principles: measuring certain wavelengths (red or visible and near infrared) of light that reflect off of plant leaves. Thus, several vegetation indices can be calculated such as NDVI (Normalized Difference Vegetation Index) which varies from zero to one and provides an estimate of the "greenness" of a crop (Fig 2).

Optical sensors can be hand-held or mounted on a sidedress fertilizer applicator. For corn, sensors and interpretations are calibrated to evaluate the crop when it is in the V7-V10 stage (when 7 to 10 leaf collars are visible). Sensor readings reveal how the crop has responded to the combination of factors in that part of the field up to that point. Mathematical equations are then used to interpret the readings and convert them to an application rate that is adjusted on the go as the sensors detect changes in crop conditions. If the crop needs more N, for whatever reason, sensors can offer a simple way to make that determination, and to select the right rate. There are opportunities to put this technology to use on dairy farms for fields that do not receive manure but also as a way to check on how well a nutrient management plan and its implementation are working even where manure is the main N source.

When used correctly, optical sensors are able to detect how well the crop is doing, since the areas with NDVI values approaching 1 are greener and thus the plants are healthier and more vigorous compared to the areas with lower NDVI. While this information is somewhat useful in and of itself, things really come in to focus when there are both a heavily fertilized area (N rich strip) and N deficient area (zero-N strip) in the same field for the sensors to compare. With these strips in place, the sensor unit can compare a high fertility location with zero N and the rest of the field, and convert this information to an appropriate on the go N application rate.

Figure 1.

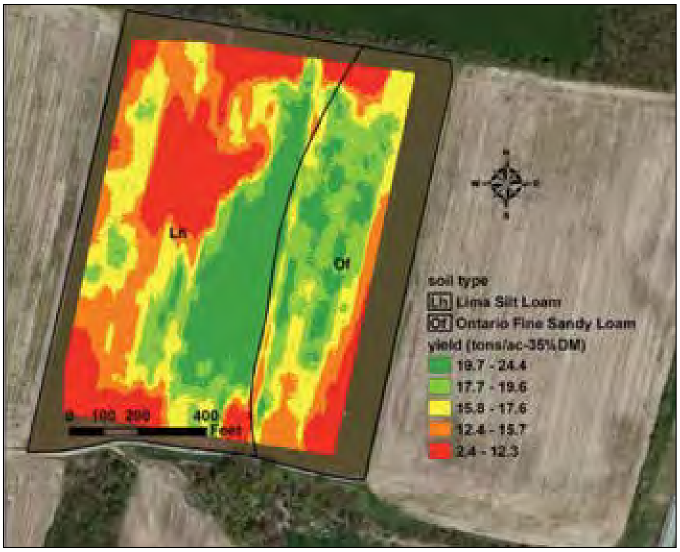
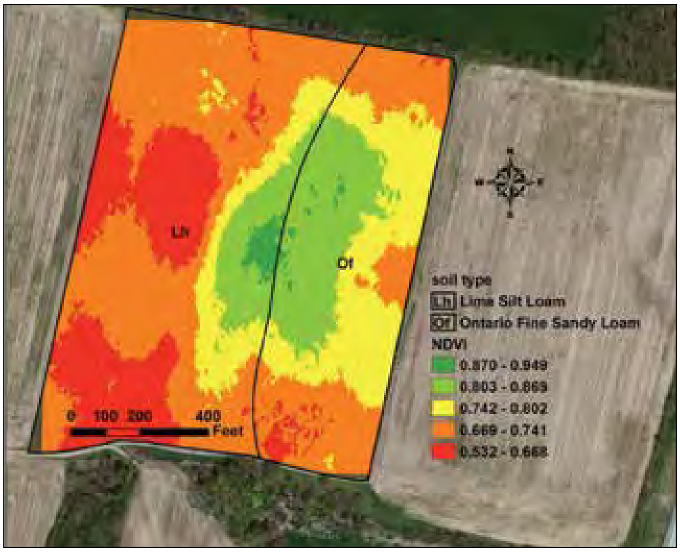


Figure 2.



Nitrogen rich strips can be established with fertilizer or by setting aside a section where extra manure gets applied. For corn, the strip needs to be created before or shortly after planting. This allows ample time to see if the crop is going to respond to the extra fertility. It is also critical that crop sensors are placed at the correct height above the crop being sensed. The sensors must be 24 to 48 inches above the crop canopy to get the correct readings.

A number of university studies have shown that a N rich strip is essential to get the most reliable information from sensor technology. Equations used in sensors have been developed by several organizations across North America, South America and India primarily for grain crops and for non-manured situations. As these sensors are now starting to be used on dairy farms in the Eastern US, we initiated a three year study in NY in 2014 to see how N rate equations developed for other states work in NY, or if modifications are needed to better fit the production of corn silage in our soil and weather conditions.

In some crop years such as 2014, dairy producers wonder if enough manure was applied to meet crop N requirements. Some could not return to the field to sidedress N. They may or may not have lost yield. Others decided to apply N but did not know if the application was the right thing to do. Optical sensors can provide a sound way to check on crop status and to evaluate if additional N is needed. Farms that have invested in yield monitoring equipment are in an excellent position to evaluate results as they can easily evaluate if application rates were justified. ❐

Cover crop and fall manure application window

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Another obstacle to early planting, in addition to wet soils, is spring manure application. Quite often wet soils in the spring, especially if they do not have drainage, do not support heavy manure tanks without significant compaction. Some farms, however, have made changes in their manure handling capabilities, by adding capacity, labor, or maybe using frost injection of manure in the early spring if that was keeping them from early planting. How about cover crop kill or spring tillage? Some farms have solved this challenge by reducing their tillage or spraying their cover crops and planting no-till or zone till into the killed cover crop.

Dairy producers face significant challenges in trying to plant a corn silage crop in late April or early May. May of 2011, 2013, and 2014 were wet, which hampered timely corn planting. Corn planting in New York was 43%, 87%, and 58% completed by June 1 in those respective years. Unfortunately, most of the unplanted corn by June 1 those years was corn silage by dairy producers. Yet many successful dairy operations were able to finish corn silage planting before first cut of perennial forages in those wet May months.

The easy management practice for an early silage harvest and successful establishment of a fall cover crop by early October is to plant an early season hybrid. The more challenging management practice is to plant full-season hybrids during the last 10 days of April and first 15 days of May and harvest the silage at the same time that an early-season hybrid planted in late May/early June is harvested. Many dairy producers, however, are able to pull it off. If the soils are too wet to plant from April 20 to May 20, then dairy producers can switch to a shorter-season hybrid for late May and June plantings to have a timely harvest for successful cover crop establishment. But selecting an early-season hybrid before the growing season has even commenced should not be the default option if attaining maximum silage yields is also a high priority.

I think that dairy producers "can have their cake and eat it too," especially those who have well-drained soils.They can maximize corn silage yields on their farm and successfully establish a cover crop to tie up excessive soil N and prevent erosion by being prepared to plant corn anytime from April 20 to May 20.

Other benefits of planting corn early is that corn silage planting does not have to take a back seat to perennial forage harvest when first cut is ready (thereby delaying corn planting until June 5 to 20), corn plants are shorter and sturdier so lodge less, and brown mid-rib (BMR) hybrids dry down by mid to late September with less plant health issues. The easy management practice is to select an early hybrid and plant it when it is convenient during May and June. A more challenging management option is plant full-season hybrids during late April and early May, which typically results in maximum silage yields, timely harvest and subsequent successful cover crop establishment. Home-grown forages are crucial to the success of dairy operations. The old 1970s and 1980s mindset that "field crops are a necessary evil on a dairy farm" and not of sufficient importance to place a high priority on to insure a timely planting date is no longer valid. To stay competitive in a global dairy market, dairy producers should take advantage of the high-quality, high-yielding corn silage that we can produce in NY if planted on well-drained soils in a timely manner. ❐

Table 1. *Corn plant populations at the 4th leaf stage (V4), averaged across two corn hybrids, and planted on five dates at three depths at a seeding rate of 31,800 kernels/acre on a well-drained soil at the Aurora Research Farm in Cayuga County in 2013 and 2014.*

DEPTH	PLANTING DATE				
	4/10	4/20	5/6	5/19	5/30
inches	Plants/acre				
			2013		
1.5	27,000	28,000	27,500	28,000	**29,000**
2.0	24,500	28,500	28,500	28,000	**29,000**
2.5	24,500	28,500	28,500	27,500	**28,000**
Avg.	**25,300**	28,333	28,166	27,833	28,667
			2014		
1.5	27,800	27,000	27,750	24,350	28,310
2.0	27,315	28,250	29,500	**28,375**	29,440
2.5	26,750	27,000	28,500	**28,000**	27,815
Avg.	27,288	27,750	28,853	**26,909**	28,522

+ Bold numbers indicate the lowest values in the same row (planting date).

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