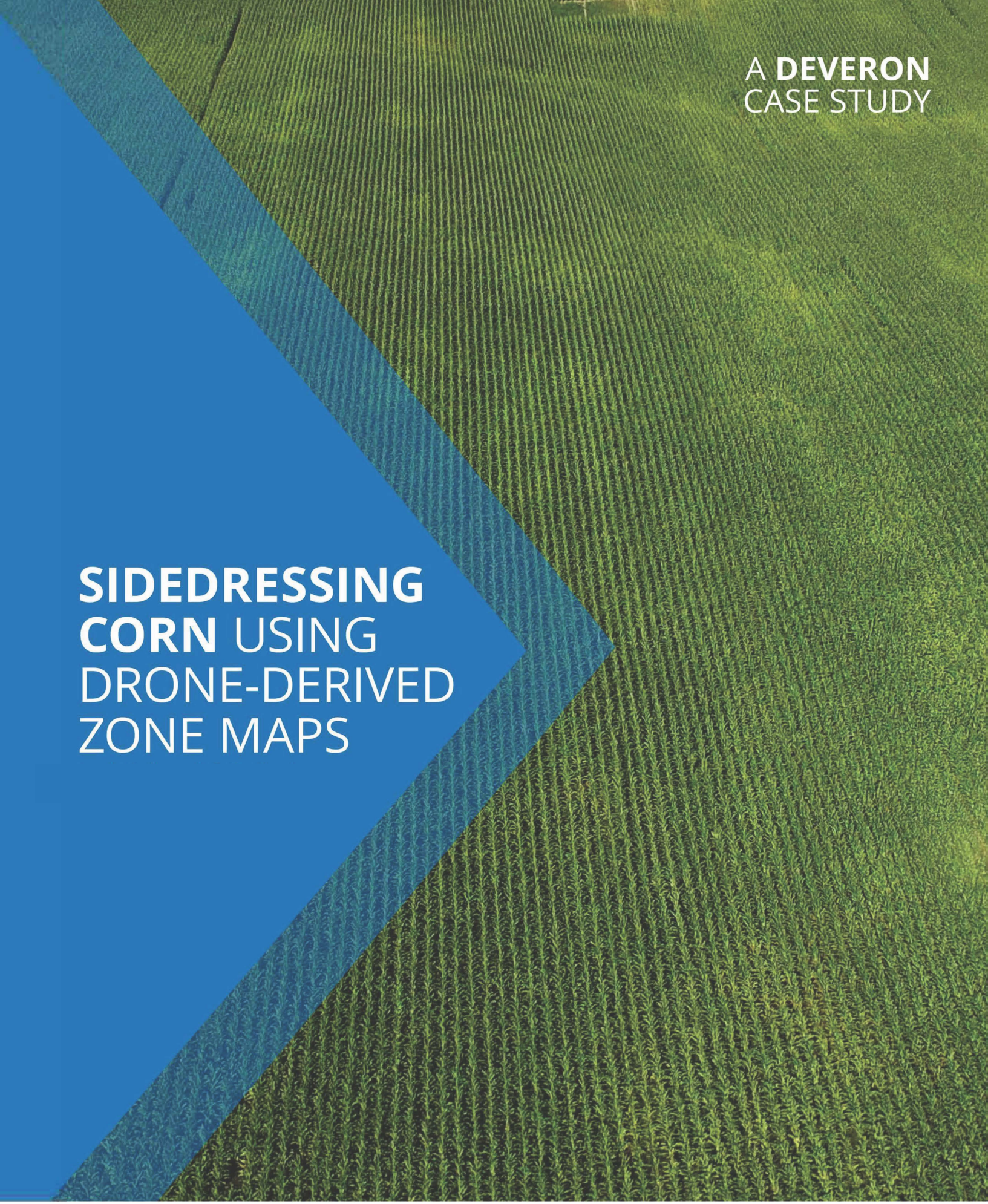

A **DEVERON** CASE STUDY

SIDEDRESSING CORN USING DRONE-DERIVED ZONE MAPS

DEVERON
A New Level of Farming

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SIDEDRESSING CORN USING DRONE-DERIVED ZONE MAPS

NITROGEN MUST BE OPTIMIZED IN BOTH TIME AND SPACE

Next to the seed, nitrogen (N) fertilizer is typically the most expensive individual input for a corn crop. Unfortunately, N is also mobile and easily lost to the atmosphere and through the soil, resulting in low nitrogen use efficiency (NUE; units of N taken up per units of N applied) on the field scale. These N losses represent a significant economic cost to the farmer, and a pollution risk to surrounding water sources. The International Plant Nutrition Institute proposes using a "4R" approach to optimizing NUE. This means ensuring that N is applied at the right time, to the right place, using the right rate, of the right source.

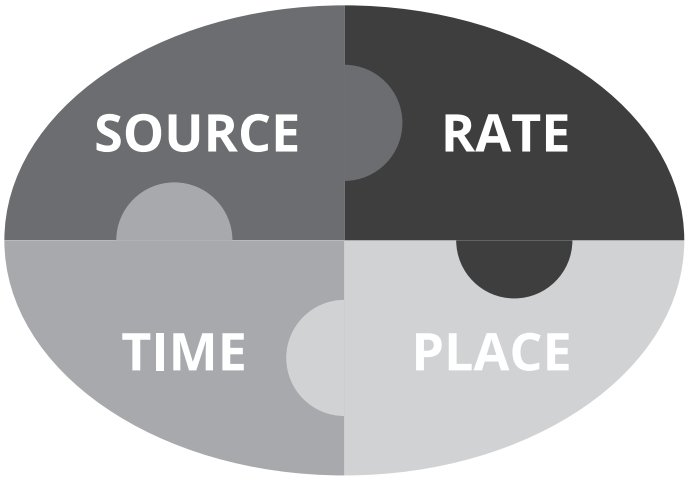

Image Credit: *International Plant Nutrition Institute*[1]

Sidedressing as a strategy to avoid N loss has long helped growers address the timing issue by delaying the majority of N application to be closer to the period of rapid uptake (Fig. 1). In addition to temporal variation in N demand, there is spatial variation due to many factors, including topography, soil texture, and organic matter. Matched with slow-release sources of N, and site-specific management for spatially optimizing rates, corn N fertilization strategies are fully capable of completing the 4R puzzle.

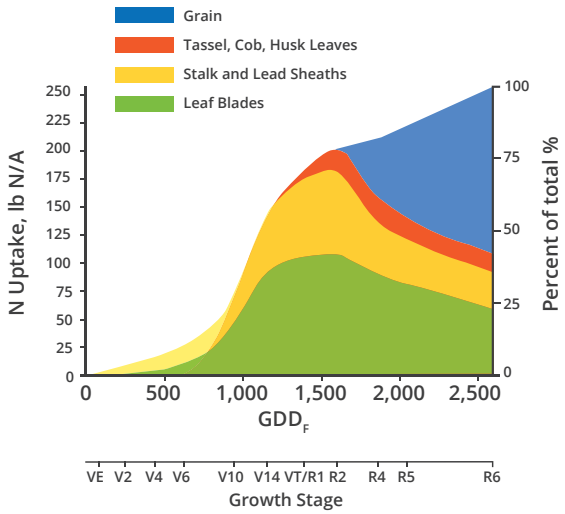

Figure 1: *The corn N uptake curve*[2] *demonstrates how sidedressing delays N application to the V6-V10 stage, right when the crop begins to take it up quickly. Combined with site-specific management, sidedressing N can address the time, rate, and place components of the 4R strategy.*

SITE-SPECIFIC NITROGEN MANAGEMENT

Successful site-specific management hinges on the ability of growers to identify zones of different yield potential, and then the management of inputs around that variation. While human-collected ground data, like soil and tissue sampling, provide valuable information about the current soil-N supply, they cannot deliver the spatial coverage of a drone at the same speed or value.

Deveron uses visible colour and near infrared (NIR) imagery for crop mapping because of the sensitivity of the latter to vegetation. These wavebands are associated with crop growth metrics through mathematical formulas, called vegetation indices. The Normalized Difference Vegetative Index (NDVI) is a robust choice for crop monitoring due to its ability to differentiate poorly performing crops from high performers. The NDVI is ideal for N monitoring because it uses red light, which is absorbed by the N-rich chlorophyll pigments that drive photosynthesis, and NIR light which is indicative of the leaf area. Variability in NDVI at the sidedress timing in corn is, therefore, strongly associated with variability of N status and can be used to delineate management zones for in-season fertilizer applications.

CASE STUDY: VARIABLE RATE SIDEDRESS IN ACTION

Deveron generated and validated management zones for a customer's corn field. Different rates of N were prescribed to one of three zones identified by Deveron's imagery, and the grower imported the prescription into the sprayer's field computer for application. The following sections describe the study site, methods, and return on investment.

FIELD DETAILS

The ROI analysis was conducted in 2016 for a cornfield in South-Central Ontario. The site consisted of a loamy-sand soil spread across rolling topography. This area was under historic drought conditions, and received little to no rain for roughly 8 weeks after planting.

MATERIALS AND METHODS

The grower employed a delayed application strategy with an initial application of 100lbs/ac. flat rate across the entire field, followed by sidedressing at the V8 development stage. The flat-rate was applied as 70lbs/ac. of biosolids in the spring then immediately incorporated using a single-pass vertical tillage implement, followed by 30lbs/ac. of granular 46-0-0 applied on the planter.

The grower applied the sidedress application using a 60ft New Holland™ sprayer equipped with Y-Drop™ high-clearance nozzles. A Viper™ field computer automatically altered the applied rate to the ones specified in the prescription map. The rate control maintained the applied rate to ±2 gal/ac. that of the target rate (Table 1).

Deveron surveyed the field on July 6 at the V8 stage using a Sequoia multispectral sensor, and produced an NDVI map that was downsampled to 20cm/pixel spatial resolution (Fig. 2). Deveron then took the NDVI map and delineated three management zones within it (Fig. 3). The three zones were prescribed different rates of 28% UAN for high, medium, and low productivity estimates (see rate summary in Table 1), which were based around the grower's typical flat-rate of 17 gal/ac. (50lbs actual-N/ac.). Veritas also randomly placed check blocks in the prescription, ranging from 0 to 25 gal/ac. in 5 gal. increments. Where possible, each rate appears in each of the three management zones to determine if there is a response to N, and to determine the economic impact of the prescribed rates compared to checks receiving more extreme rates.

Figure 2: The prescription map from Veritas. While 3 zones exist, 6 rates were placed at random to determine the response to nitrogen.

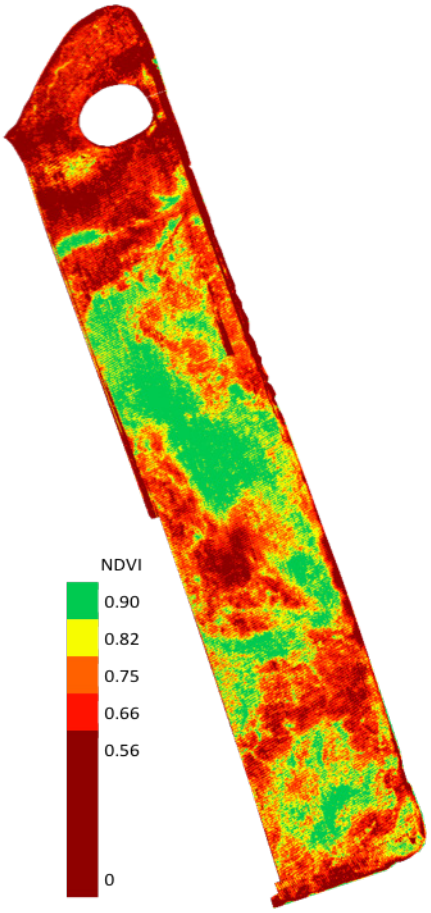

Figure 3: The NDVI map (20cm/pixel) acquired on July 6, 2016 at the V8 development stage. Each interval on the scale covers and equal area of pixels.

Table 1: The prescribed management zones and the average applied rate for each zone. Note that check blocks were removed from the applied rate and acreage calculations.

ZONE	PRESCRIBED RATE	AVERAGE APPLIED RATE	TOTAL ACRES*
Low	10 gal/ac. (30lbs. actual)	8 gal/ac. (25lbs. actual)	1.2
Medium	15 gal/ac. (45lbs. actual)	14 gal/ac. (43lbs. actual)	8.5
High	20 gal/ac. (60lbs. actual)	18 gal/ac. (53lbs. actual)	7.1

*Excludes all check blocks.

Deveron conducted a post-harvest analysis of the prescription to determine the net profit per acre for the management zones. An N response curve for each zone was generated based on a corn price of $4.75/bu. and N price of $0.52/lb-actual N. All analyses used the as-applied rate to account for the uneven rates within zones.

RESULTS

The drought stress carried through to mid-autumn resulting in significantly reduced yields shown in the yield map in Figure 4. The uncertainty of seasonal precipitation makes N rate estimation a challenge, but the variable rate strategy was still successful in improving NUE for the grower. Table 2 summarizes the profitability analysis of the prescription while Figure 5 depicts the profit response curves for each zone. The negative slope of the medium curve emphasizes the severity of the drought as it shows would have been more profitable to cut the rate sharply, which is a tactic typically reserved for low productivity zones. Conversely, the positive plateau curve shown for the high productivity zone suggests that the N rate could have been even higher before diminishing returns resulted in reduced profitability from additional N.

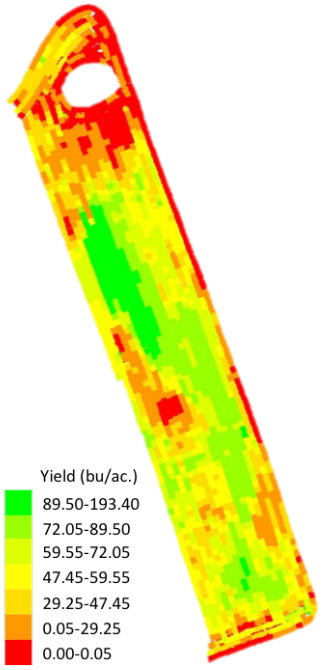

Figure 4: Yield results corrected for moisture and recorded in bushels per acre.

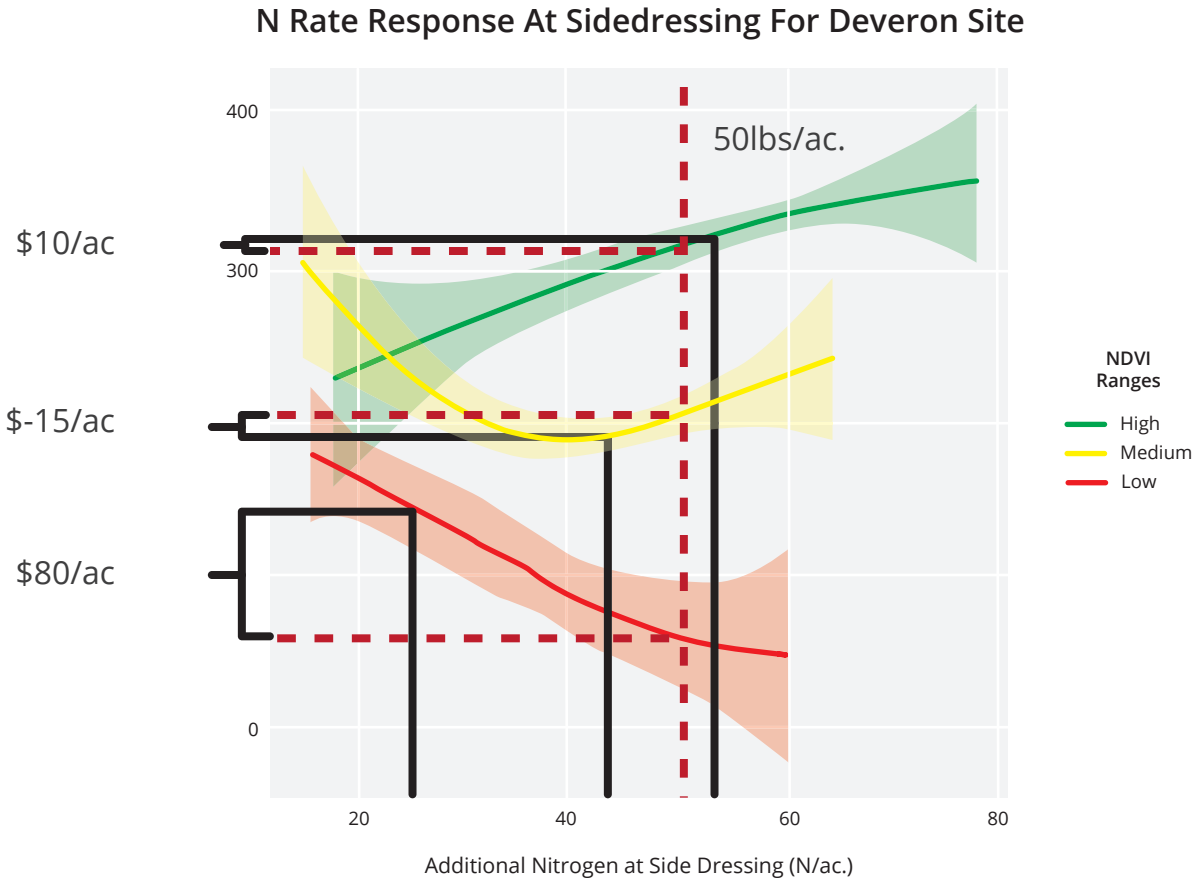

Figure 5: Profit response curves for each management zone based on a corn price of $4.75/bu. and actual nitrogen price of $0.52/lb.

Table 2: Profit-per-acre analysis by management zone using a corn price of $4.75/bu. and nitrogen cost of $0.52/lb. actual.

ZONE	GROWER RATE	PRESCRIPTION	VARIABLE VS. FLAT RATE
Low	$63	$143	+ $80/ac.
Medium	$205	$190	- $15/ac.
High	$325	$315	+ $10/ac.

CONCLUSIONS

The customer in this case study put the 4Rs to use, and saved money in the process. Deveron provided complete awareness of the spatial variability of N status to locate the right places for different N rates to go, while delayed application better synchronized the timing with the rapidly growing plants and improved estimates when determining prescription rates. This management strategy improved NUE, especially in the low zone, by eliminating the application of N to plants that did not have the yield potential to justify the typical rate. Site-specific management based on aerial imagery can play a critical role in improving the profitability of every acre while being conscious of nutrient stewardship.

REFERENCES

1. International Plant Nutrition Institute. 2016. IPNI-Nitrogen Program. Available at: www.ipni.net/
2. Bender, R.R., J.W. Haegele, M.L. Ruffo, and F.R. Below. 2013. Modern Corn Hybrids' Nutrient Uptake Patterns. Better Crops. 97(1): 7–10.