IPNI
Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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DECISION SUPPORT FOR ADAPTING CORN NITROGEN MANAGEMENT TO WEATHER

Nitrogen depends a lot on the weather. Crops demand more of it from the soil when weather favors rapid growth. Soils mineralize more of it from organic matter when they are warm and moist. And more of it gets lost when excess water either leaches it from the soil or denitrifies it in zones depleted of oxygen. So it's no surprise that N can be managed better when weather is accounted for.

Different soils respond differently to weather. A corn production study in Ontario, Canada showed that different parts of the landscape made different amounts of N available over a number of years. Among these years there were varying amounts of rain between planting and the V6 growth stage. Areas with low soil organic matter made only small amounts of N available, and the amounts declined as amounts of rain increased. In areas with high organic matter, however, amounts increased with rain to a point, but then declined sharply in the wettest years—by as much as 180 lb/A—to even less than in the low organic matter areas. Managing for yearly weather differences can require managing soil variability across the field at the same time.

The complexity of managing N for different soils and weather demands a decision support tool. Decision support generally involves a system that gathers information from many sources and quickly interprets it. One example particularly useful for corn in humid growing regions is the Adapt-N decision support tool developed by Cornell University. By accessing near-real-time weather data, it makes incorporating weather into N decisions much easier. AgProfessional magazine chose it as Top Product of the Year for 2012.

Recent research on the Adapt-N tool is indicating promise. It's designed to assess soil N supply at the "right time" – just before corn starts taking it up rapidly. In many cases its use leads to reductions in applied rates, though in some cases it can lead to increases. Users have found it very important to accurately estimate potential yields, since in high-yielding situations the crop more frequently runs short of N. Optimum N rates often don't correlate directly to corn yields, but once a few other factors—including weather and soils—are taken into account, greater corn growth does take up greater amounts of N. The law of conservation of mass does indeed apply!

There is need to innovate when it comes to "right time." The Adapt-N tool is currently configured for use in sidedress systems, in which the bulk of the N is applied around the V6 growth stage, usually in the month of June. Under favorable weather conditions, sidedressing is often the most efficient time to apply N to corn. The opportunity for losses is small, and it often produces the highest yields. Weather extremes, however, can lead to situations in which sidedress is not the optimal timing. For example, the dry conditions of the 2012 season in some fields led to reduced availability of N from sidedressed bands, as compared to preplant incorporated fertilizer. Roots simply couldn't get to the band in the dry soil. And in years with very wet conditions in June, it can be difficult to get on the field with application equipment, and the needs for N can be high owing to the large loss potential.

A real-time decision support system can be useful with different application timings as well. Applying a little more N up front at planting—for example, half or two-thirds of a normal year's optimum rate—can ensure the crop is well nourished in both dry and wet conditions. For the remainder of the crop's requirements, high-clearance equipment capable of variable rates and guided by GPS can ensure more flexible timing to implement the guidance from more sophisticated decision support.

Any decision support tool will have its limits, and needs field-testing. It's important to understand how the tool works to be able to interpret its results properly. Get acquainted with the tools available to help you deal with weather's impact on the N cycle. You can expect improvements in both yields and N use efficiency.

– TWB –

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Abbreviations: N = nitrogen; GPS = Global Positioning System.

Note: ***Plant Nutrition TODAY*** articles are available online at the IPNI website: www.ipni.net/pnt

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4R NUTRIENT STEWARDSHIP AN IMPORTANT ASPECT OF SUCCESSFUL FARMING, REGARDLESS OF REGULATION

Required plant nutrients can be most successfully applied following the 4R Nutrient Stewardship Principles. The 4R principles are described as applying the right source of nutrient, at the right rate, at the right time, and in the right place. This applies to all nutrients that are required above what the soil can supply, and for all crops, cropping situations, and nutrient sources. Having an adequate and balanced supply of plant nutrients is essential for well yielding crops, especially as cropping practices have improved using higher yielding varieties, moisture conserving conservation tillage, and more effective pest control options. As crop yields increase there is greater demand on our soils to supply both a sufficient and balanced supply of nutrients.

Benefits are realized from using the 4R principles in both environmentally-regulated and non-regulated situations. In fact, effective use of 4R usually exceeds minimum guidelines for most nutrient regulations. A useful example is a farm where I helped develop a nutrient management plan. This 3,680 acre corporate mixed farm located north of Calgary, Alberta consisted of a 500 farrow-to-finish hog operation and a 100 cow dairy. Crops included barley, wheat, canola, as well as 40 acres of pasture. All manure from the hog and dairy operation was handled using a liquid manure system with an above ground steel storage lagoon that was emptied twice a year and land applied, in early spring and mid fall.

I was asked to help the farm manager develop a nutrient management plan compliant with recent changes with the provincial Agricultural Operation Practices Act (AOPA). This act contains regulations for manure applied to farmland in Alberta. The Act applies to any confined livestock operations greater than 500 animal units. The farm was having a challenge meeting previous county bylaws that had restricted land application of the liquid manure to only 960 acres of the total 3,680 acre farm. Application of the manure to about only one-quarter of the cropped acres was resulting in excess applications of manure. Plant available soil test N and especially P were greater than crop requirements, and soil residual levels of N were greater than that allowed under the provincial manure regulations.

By following the 4R principles, a nutrient management plan for all of the cropped acres utilizing all the manure along with additional purchased fertilizers was possible. This nutrient management plan complied easily with the provincial manure legislation, and made much better use of the manure by integrating use of mineral fertilizer. This resulted in higher yielding crops, and less potential for environmental harm. Additionally, it was shown that the provincial legislation took precedence over the county bylaws. Fields where previously the county thought manure should not be applied, could receive manure applications as long as setback distances from residences, permanent water bodies, and drinking water wells were complied with.

I have yet to see a farm where use of the 4R Nutrient Stewardship Principles has not been able to exceed nutrient or manure management legislation guidelines. This means that 4R nutrient management plans can help farmers achieve high yielding crops, effectively utilize manure if the farm has livestock, and manage adverse environmental effects. It is important to note that this can be done as long as sufficient land is available to effectively utilize available manure. I did another nutrient management plan for a 1,000 farrow to finish hog farm that only had 470 acres of cultivated farmland. In this instance I recommended that manure application agreements be made with neighboring farms to adequately utilize the nutrients from the manure and avoid excess nutrient applications. These agreements were beneficial to both the farm with the hog operation as well as neighboring farms.

An important aspect of utilizing 4R Nutrient Management on a farm is that there is consideration for economic, social and environmental goals. In the first farm example used above, these goals would have been achieved whether or not there had been environmental regulations in place. This shows that achieving economic, social and environmental goals are often mutually compatible.

– TLJ –

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Abbreviations: N = nitrogen; P = phosphorus.

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WHERE DOES SULFUR COME FROM?

Sulfur is widely distributed in nature and is essential for the health of both plants and animals. It often accumulates in areas with volcanic activity, and large geologic deposits of elemental S are scattered across the world. In the 20th century, the process of melting S to extract it from underground deposits was developed, making S more accessible for agricultural and industrial purposes.

Modern Sulfur Supplies: Fossil hydrocarbons contain S since it was present in the organic matter that formed the hydrocarbons. This S is now recovered as a by-product from materials such as oil, methane, tar sands, and coal. Elemental S is currently extracted wherever oil or gas is processed and refined. Sulfur is traded globally in a solid or in a molten form.

Sulfur is an important product in many industrial processes, especially as sulfuric acid. The production of phosphate fertilizer is the single largest use of S. The global supply and price of S is closely linked with the phosphate fertilizer market.

Soil Sulfur: The majority of S in soil is present as organic compounds found in crop residues and soil organic matter (up to 98% of the total S). There are a variety of complex S-containing compounds in organic matter, but plant roots are not able to use these compounds for nutrition until they are first converted into soluble sulfate by microbial action.

Sulfur in the soil is continually transformed between organic and inorganic compounds by microbes. Mineralization occurs when sulfate is released as a by-product of microbial activity. Immobilization results when sulfate is incorporated into microbial cells during their growth.

Sulfur mineralization from soil organic matter is often too slow to meet the nutritional demands of high-yielding crops. This nutrient deficit must be overcome by adding mineral or organic fertilizers.

Only a small fraction of the total S in soil is found as inorganic compounds. Sulfate is the most abundant form of inorganic S in agricultural soils. Sulfate is generally soluble and moves with soil water. It is only weakly retained (adsorbed) by a variety of clays and soil minerals, especially in low-pH conditions.

Fate of Sulfur

- Plant uptake and removal during harvest. Annual crops typically remove between 10 to 30 lb S/A.
- Sulfate leaching from the root zone with rainfall or irrigation water can be a major pathway of loss. Annual losses are often in the range of 5 to 50 lb S/A.
- In anaerobic soil conditions, sulfate is chemically reduced by bacteria to a variety of compounds that are largely unavailable for plant uptake.
- There are no government limits on sulfate in drinking water, but the US EPA suggests a limit of 250 mg/L (ppm) due to taste and odor concerns.

– RLM –

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Abbreviations: S = sulfur; EPA = Environmental Protection Agency.

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THE NUMBERS ARE IN: CORN AND SOYBEAN YIELDS IN THE DROUGHT YEAR OF 2012

The USDA National Agricultural Statistics Service recently released annual crop production statistics for 2012. The damaging effects of the drought were evident.

Corn grain yields in 2012 were 20.3 to 33.1% lower than the last year across five states in IPNI's Northcentral region (Illinois, Indiana, Iowa, South Dakota, and Wisconsin). The average regional corn grain yield was 124.1 bu/A, representing a 21.1% yield decrease from last year, which was more than the national average reduction of 16.2%. Only one state in the region, Minnesota, showed a corn grain yield increase, which was 5.8% greater than 2011. Average yield in this state was 165 bu/A—by far the highest in the region.

Similarly, corn silage yields were also reduced for all states except Minnesota. Reductions ranged from 25.6 to 57.1% for the five states. Yields in these states ranged from 8 to 15 tons/A. The average yield for the region was 13.1 tons/A, which was a 31.1% reduction from last year. This percent decrease was almost twice the U.S. average reduction of 16.3%. Minnesota's average corn silage yield of 19 tons/A was a 5.6% increase from last year.

Soybean production generally fared better than corn. Soybean yields in Minnesota were 10.3% higher than they were in 2011 and reached a state average 43 bu/A. The rest of the states in IPNI's Northcentral region saw yield reductions ranging from 4.4 to 18.9%. Yields in these states ranged from 30 to 44.5 bu/A. The regional average yield was 41.7 bu/A, which was 7.9% lower than last year. Like corn, soybean yield reductions in this region were greater than the national average.

Average yields for 2012 and their percent change compared to 2011.

	Corn grain		Corn silage		Soybean grain	
Political boundary	Yield, bu/A	Change from 2011, %	Yield, tons/A	Change from 2011, %	Yield, bu/A	Change from 2011, %
Illinois	105	-33.1	9.0	-57.1	43.0	-9.5
Indiana	99	-32.2	12.5	-37.5	43.5	-4.4
Iowa	137	-20.3	15.0	-26.8	44.5	-13.6
Minnesota	165	5.8	19.0	5.6	43.0	10.3
South Dakota	101	-23.5	8.0	-48.4	30.0	-18.9
Wisconsin	121	-22.4	14.5	-25.6	41.5	-10.8
Regional Average	124.1	-21.1	13.1	-31.1	41.7	-7.9
U.S. Average	123.4	-16.2	15.4	-16.3	39.6	-5.5

Source: USDA National Agricultural Statistics Service. 2013. Crop production - ann. Released 12:00 pm ET. 11 Jan. 2013 [online]. Available at http://nass.usda.gov (verified 13 Jan. 2013).

Percent yield reductions translate fairly directly to nutrient removal reductions. Previous P and K applications are expected to have greater residual effects since lower amounts of these nutrients were removed. In Minnesota, higher removal of nutrients occurred. Farmers and advisers will need to account for these changes in yield as they re-evaluate their nutrient applications rates for the coming season.

–TSM –

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Abbreviations: P = phosphorus; K = potassium.

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ZINC FERTILITY FOR CORN

Corn, like all crops, requires 17 essential nutrients in varying amounts and any one of the 17 can limit yield if not present in a sufficient amount. For example, only 0.3 lb Zn/A is needed to produce a 180 bu corn crop, but corn is relatively sensitive to Zn deficiency and yield losses can occur even if all other nutrients are present in adequate amounts.

The 2010 IPNI Soil Test Summary indicated that less than 20% of the samples submitted from the southeast US were below a critical level of 1 ppm DTPA equivalent Zn. However, more and more Zn deficiency is being observed in cornfields throughout the region, often in fields that test adequate for Zn prior to planting. In many of these cases, the deficiency symptoms are not uniform across the field, which would explain why a composite soil test would not detect a Zn problem.

There are many factors affecting Zn availability across a landscape including soil temperature, pH, texture, organic matter, and previous crop. Many early season Zn deficiencies are due to cool growing conditions and the plants will grow out of the deficiency as the soil warms and yield losses are not likely. Approximately 70% of the Zn requirement for a corn crop is taken up via diffusion (driven by a concentration gradient at the root surface) and root interception (roots physically contacting Zn on soil particles as they grow). Thus, any factor that affects root growth (compaction, disease or insect damage) can also affect Zn uptake.

Zn fertilizer rate recommendations throughout the south vary some, but in general, broadcasting 10 lb Zn/A will raise soil Zn levels to an adequate amount. The broadcast recommendation (typically applied as zinc sulfate) is expected to be effective for 3 to 5 years, depending on cropping system, but soil tests should be used to determine when additional fertilization is needed. Some states recommend a lower rate if the Zn is to be band-applied. However, these reduced rates are usually anticipated to be annual applications as part of a starter blend.

Foliar Zn applications have been shown to be as effective as an in-season fertilization strategy. However, this approach is best utilized as a rescue treatment or as a compliment to a sound soil-based fertility program.

– SBP –

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Abbreviations: Zn = zinc; DTPA = Diethyl Triamine Penta-Acetic.

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CROPPING SYSTEM NITROGEN MANAGEMENT - IS YOURS SUSTAINABLE?

When fertilizer or manure N are applied to farm fields to provide the essential nutrient used in the greatest amounts by crops, it is also important to replenish the supply of N in soil organic matter. Normally, some portion of the applied N and some of the N released from soil organic matter and crop residues escapes uptake by annual crops and leaks into the environment (atmosphere, surface water, groundwater). With some leguminous crops like clovers and alfalfa, which are sometimes grown in rotation with annual field crops, it is possible to increase soil N levels through the symbiotic relationship between roots and specific N-fixing bacteria. In soybean systems, however, there is increasing evidence that the net soybean cropping effect may actually be a mining of soil N levels; not soil N replenishment or enhancement.

To sustain the N in soil organic matter, the N which is held in ionic form on soil exchange sites, and some portion in the mobile nitrate-N form held loosely in soil pores, farmers must annually fight the daunting uphill battle against the whims of Mother Nature; and do so profitably. Failure to implement such N management goals ultimately results in declining soil productivity and reduced profitability. It has often been said that if we could perfectly predict the weather, we could perfectly predict crop N management demands, and perfectly deploy the right N source, at the right rate, at the right time, and in the right place (4R N Stewardship). Although we might yearn for such perfection, we must face reality and do our best to hedge against the risks of inefficient crop N uptake, which are affected by crop genetics, the weather and management.

To help reduce the leakages of mobile N forms out of the field and into the environment, there are many opportunities and choices of tools that can enhance profitability, environmental protection and long-term sustainability. One of the first tools to use is a simple N budget, which estimates and documents the applied N and crop N removal at harvest. Measures of soil organic matter (surface and subsurface) can be made by soil testing over a period of 3 to 5 years (not just year-to-year comparisons, since such changes are often quite difficult to measure accurately), at the same location and depth in each field, to monitor levels and determine if the large pool of N in soil organic matter is being sustained. If soil organic matter is declining, the cropping system may be "mining" soil N, and causing a decline in crop and soil system resilience.

Evaluate your 2013 crop and soil N needs in view of both short and long-term sustainability goals. Talk with fertilizer dealers, crop advisers, extension workers, and leading farmers in your community. Know whether your farm lies within a watershed with recognized water quality problems like seasonal algae blooms, or elevated nitrate-N levels. Consider choices of crops and crop rotations which use N efficiently and effectively; tillage systems that protect the soil, water, and air resources, adequately; cover crops which may be appropriate for your region; other proven soil conservation practices (vegetative buffers, grassed waterways, riparian zones, biofilters, etc.); current fertilizer, equipment, and digital technologies that mesh well with your management skills. Do not be afraid to be bold in trying something new on your fields in 2013. Observe, measure, evaluate, and document the outcomes of your management choices and track your progress toward economic, environmental and social goals. It will make a difference for you and your family, your neighbors and your community.

– CSS –

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Abbreviations: N = nitrogen

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DON'T OVERLOOK THE POTENTIAL OF STARTER

The benefits of placing a portion of the crop's fertilizer needs in a concentrated band at planting have long been recognized. Placing some of the needed P, N, K and other nutrients near (starter) or with the seed (pop-up) at planting can result in a striking early season response that results in quicker canopy cover, decreased erosion potential and enhanced completion with weeds. While starter fertilizer is used in the production of many crops, corn is the most common and probably the most studied.

Several factors affect response to starter fertilizer. Soil conditions that increase the likelihood of response include cool soil temperature at planting and root growth restrictions such as soil compaction, soil acidity and soil salinity. The response to P and K is usually expected to decrease as soil test levels increase. However, this may not always be true with starter applied P and K as these stress factors (soil temperature, etc.) can overshadow the effect of soil test level. So starter fertilizer may be beneficial where early cool, moist soil conditions prevail, even though soil test P and K levels are high. An example of this is shown in a 3-year Kansas study where a 30-30-5 starter treatment increased corn yield over a 30-30-0 treatment 11 bu/A in soil that tested very high in K (Gordon, 2004. Better Crops, Vol 88, No. 1).

There are synergistic effects among nutrients in starters. For example, N and P work together in a band. Nitrogen, in the ammonium form, results in the production of acidity in the zone of soil right around the root. This can increase P uptake within the same band. Nitrogen and P can cause roots to proliferate in the zone where starter fertilizer was applied. Potassium does not proliferate roots, so co-application with N and/or P is needed for roots to more fully explore the K supply in the starter. Phosphorus also supplies needed energy early in the plant for the active uptake of K.

Placement in a 2x2 configuration (2 inches to the side and 2 inches below the seed) is the standard for starter fertilizer. Early in its development, corn has roots that grow down and to the side, at approximately a 45-degree angle. Nutrients placed 2x2 are well placed for access by the young root system. But, because of factors such as equipment cost, time and residue a 2x2 system is not the easiest to implement. One study (Gordon, 2009. Better Crops, Vol. 93, No. 2) has indicated that a "dribble" 2x0 (surface applied 2 inches from the seed) application can perform approximately as well as 2x2. When averaged across several starter formulations, each configuration increased yield by just over 30 bu/A.

The most commonly observed effect of starter fertilizer is more rapid early season growth. This effect alone has benefits (as described above), but it does not always guarantee increased yield. As a plant continues to develop its roots explorer more soil, so the dependence on starter applied nutrients is diminished with time. End of season yield response depends on how quickly and to what extent a plant root system accesses other supplies of nutrients in the soil, which is in turn related to the degree of stress in early season. Under conditions where root exploration is limited or slowed, yield response is more likely.

The use of starter fertilizer is an effective management practice that is based on sound agronomic principles. But in most cases it should not be the sole fertility program. The best approach to starter is to view it as a catalyst that promotes rapid and uniform growth for a crop that will have adequate and balanced available nutrients in the soil rooting volume as the season progresses.

– WMS –

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Abbreviations: N = nitrogen; P = phosphorus; K = potassium.