

# NITROGEN MANAGEMENT

*Strategies for Assessing and Adjusting  
Nitrogen Use Based on Spring Weather*



Do you know how  
much Nitrogen  
you need?



# Do You Know How Much Nitrogen You Need?

## Yield goals

All you need to know about nitrogen management in corn is the anticipated yield level and previous crop.

**False.** *Several factors influence nitrogen availability and supply to the crop, to the extent that most Midwestern states have dropped yield goal from their nitrogen recommendations.*

Although soybeans can fix nitrogen, the real reason corn after soybeans needs less nitrogen is the lack of corn residue tying up nitrogen.

**True.** *First, soybeans tend to use more nitrogen than they fix. And second, as soil bacteria break down crop residues, they tie up nitrogen. The more crop residue to be processed (as in the case of a corn crop vs. a soybean crop), the more nitrogen the soil bacteria need.*

Higher yielding corn environments will always require more nitrogen fertilizer than lower yielding environments.

**False.** *The amount of nitrogen fertilizer needed depends on the amount of residual nitrogen released from organic matter and how much nitrogen is lost. Often, soils higher in organic matter are more biologically active and can produce higher yields with less nitrogen fertilizer than low organic matter soils.*

## General Management

Almost all the nitrogen a corn plant uses to make grain comes from the fertilizer applied.

**False.** *Only about half of the nitrogen a typical corn crop utilizes is from fertilizer, the rest is from soil organic matter.*

The major issue with fertilizer timing is making sure it can be applied without creating a compaction problem.

**False.** *Compaction can interfere with the plants' ability to take up nutrients, but the major issue with timing and nitrogen is the closer it is applied to the time when the plant*



*is rapidly taking it up, the less nitrogen can be lost to denitrification and leaching. The plant may still get the same amount, but efficiency of nitrogen uptake will be greater.*

Soil pH can have a major impact on nitrogen management.

**True.** *In Iowa State University and Iowa Soybean Association studies, high pH soils increase the rate of nitrification from applied anhydrous ammonia, which results in more nitrate available for loss earlier.*

Fields typically have some nitrogen variability within an 80 acre area, but the differences within a field are generally minor compared to nitrogen differences between fields.

**False.** *Nitrogen availability across most fields varies considerably.*

Manure management is very similar to managing nitrogen fertilizer.

**False.** *Manure contains nitrogen as urea, nitrate, and ammonia, in very different concentrations and with varying quantities of organic matter. Depending on form (liquid, dry, amount of bedding, etc.), manure is more difficult to manage than nitrogen fertilizer.*

Variable rate application of nitrogen is well established and should be done by everyone.

**False.** *Most variable rate recommendations are based on outdated yield goals and fail to account for other factors that affect nitrogen loss and availability.*





## Sources of loss

Nitrate is the form of nitrogen easily lost with leaching rainfalls.

**True.** *Unlike ammonium, nitrate is not adsorbed by soil particles. Since it is not bound in the soil, excess water percolating downward through the soil profile can carry it below the root zone, out tile lines, and into streams and rivers.*

Regardless of nitrogen form applied, most of the nitrogen fertilizer applied will be biologically converted to nitrate in the soil.

**True.**

While it is generally accepted that granular urea should be incorporated soon after application, UAN can be left on the soil surface as long as it is applied as a preplant or weed and feed program.

**False.** *Fifty percent of UAN is urea and when unincorporated or applied to wet soils, is prone to volatilization.*

If both UAN and NH<sub>3</sub> are applied as preplant, they both have the same risk of nitrogen loss before crop uptake.

**False.** *Nitrogen from the nitrate portion of a UAN solution is almost always more susceptible to loss from leaching than nitrogen from anhydrous ammonia. In addition, the anhydrous ammonia band has a higher pH which has some nitrification inhibitor effect.*

Nitrogen loss and availability are two key concepts often ignored in nitrogen management.

**True.**

Weather is a factor, which, while it can't be predicted, can still be factored into management.

**True.** *Using management practices that reduce the risk of nitrate loss improves nitrogen management.*

Minimizing the amount of time that nitrate is present in the soil before it can be taken up is a good way of reducing the risk of nitrogen loss from leaching rainfall.

**True.**

## Availability

From a management perspective, a pound of nitrogen is a pound of nitrogen regardless of form it is applied as.

**False.** *While this may be true for nitrogen in its purest form, nitrogen fertilizer for crop production varies in forms such as Nitrate ammonium and urea. These forms vary in their risk of loss and availability which can have a huge impact on the N availability.*

## Detecting nitrogen stress

Because of the high price of grain and the financial incentive to over-apply nitrogen, there are seldom nitrogen stresses observed in the fields.

**False.** *Even when nitrogen is over-applied, there are still likely to be locations within individual fields where nitrogen is not available in sufficient quantities.*

If every farmer dropped their application rate by 50 lb nitrogen per acre, the average yield loss would be expected to be about 42 bu/a (50 lb / 1.2 lb/bu.).

**False.** *Many Iowa Soybean Association On-Farm Network™ nitrogen study participants have been able to drop nitrogen use rates by 50 lbs. per acre or more with no significant reduction in per acre profits. This is especially true when rate reductions are combined with injected sidedressed applications.*

It is easy to tell when you have a nitrogen related yield loss because the corn will turn yellow and is easy to see from a truck cab.

**False.** *While the yellowing of severe nitrogen deficiency may be noticeable from the ground, yield losses occur before symptoms can be seen while walking or driving by the field. An aerial image of the field, however, makes color gradations more easily detectible.*

After side-dressing, there are no options available for detecting or correcting a nitrogen deficiency.

**False.** *Aerial imagery can show problem areas in the field. With the right equipment, it's possible to apply – even inject – corrective nitrogen up to tasseling.*

Despite all the new technology and improved equipment, we still frequently see application errors.

**True.** *Autosteer and GPS can improve the field efficiency of equipment, but they are not infallible. And application equipment can plug or otherwise malfunction. Aerial imagery can detect problems before they become yield losses.*

# Nitrogen Management is Especially Important for 2007

*The purpose of the Iowa Soybean Association's On-Farm Network™ is to help farmers conduct meaningful replicated strip trial research on their own farms to determine the economics of practices and products. The first studies carried on in this way involved nitrogen management for corn production.*

*Established in 2000, the On-Farm Network now has seven years of data collected by farmers who have compared nitrogen application rates and timing, as well as forms. Weather across much of Iowa in the spring of 2004 was similar to weather this year. That year, many of the growers involved in on-farm nitrogen studies saw nitrogen losses from fall and spring applied nitrogen. Much of this was revealed in aerial imagery of the strip trials shot during the summer and confirmed in the fall by end-of-season stalk nitrate testing.*

*Based on what we know of past wet springs, growers should be aware of possible nitrogen deficiencies in crops this year, particularly where rainfall was well above normal. With nitrogen prices at record high levels, you don't want to pay for more than you need. At the same time, though, with grain prices well above the average for recent years, it's easier to justify additional fertilizer this year. The high nitrate levels being reported in some rivers this year, like the Raccoon River in central Iowa, are due to nitrates leaving farm fields. History has shown high nitrates in rivers mean less nitrogen available for crops.*



**On-Farm  
Network**

A program of the Iowa Soybean Association

## Tools for detecting and correcting nitrogen deficiency

### Pre-Sidedress Soil Nitrate Test

The late spring (or pre-sidedress) soil nitrate analysis has been used successfully in most Midwest states to detect nitrate concentrations in soils, allowing growers to predict the amount of nitrogen that will be available before corn plants begin intensive uptake of nutrients. The test works best where much or all of the nitrogen is applied prior to planting.

To use the test, soil samples should be collected randomly throughout a field in late May or early June, when corn plants are 6 to 12 in. tall. Sampling depth is 1 ft. More on this test can be found in the 2006 ISA On-Farm Network Conference proceedings, page A-3. This can be found online at <http://www.isafarmnet.com/agronstudies/06Nconf/A1-A5.pdf>.

Most independent soil and plant testing labs can run the analysis for you. Proper interpretation of the results is important. Generally, the critical nitrate concentration is 21 to 25 parts per million (ppm). That is, if proper analysis shows less than 21 ppm nitrate, there's a high probability that the crop would respond to additional nitrogen with enough extra yield to pay for the nitrogen. If soils have been recently manured, however, the critical nitrate concentration is only 11-15 ppm. This is because enough nitrogen to avoid an economic deficiency will likely be released by mineralization from organic matter in the manure after the test.

### Remote Sensing

Remote sensing with aerial imagery can reveal a great deal about soil and crop conditions if used appropriately. The keys are having timely imagery and knowing how to interpret what you see.

There are a number of businesses that provide imagery for a fee. The best way to find an aerial imaging service is to ask around at an area airport. Precision ag specialists at local farm supply cooperatives might also be able to recommend a service. (The On-Farm Network contracts with John Deere Agri Services for aerial imagery. For more information on this service, see the back cover of this publication.)



Growers working with the On-Farm Network™ in Iowa are provided with free imagery of fields where they have registered replicated strip trials. Because of the number and variety of strip trials in this program, it's important that participants have their registration information and field coordinates to ISA as soon as possible. On-Farm Network strip trial protocols and registration forms can be found on-line at [www.isafarmnet.com/agronstudies/index.html](http://www.isafarmnet.com/agronstudies/index.html).

Or, if you have a good camera (digital or film) and don't mind flying, you can shoot your own field images. To detect nitrogen deficiencies, you'll need to get your imagery after the crop has covered at least half the soil (V10 to V12 growth stage).

Commercial services are available to collect multispectral images that can be georeferenced. Both of these features add opportunities for vegetative indexes and permit prescriptive applications.

Request a copy of 'A Farmer's Guide to Remote Sensing' from the Iowa Soybean Association if you'd like to learn more about what remote sensing is and how to do it.

## Sidedressing

If a pre-sidedress soil nitrate test or timely aerial remote sensing suggests a nitrogen shortage, it can be corrected with additional nitrogen fertilizer. While nitrogen can be dribbled on the soil surface, injecting and incorporating liquid fertilizer into the soil is generally more successful, especially in dry years.

Determining the exact amount of nitrogen to apply when detecting a stress is difficult. With the absence of other information, 50 lbs. per acre is a common application rate.

Sidedressing is gaining in popularity as larger toolbars with better floatation become available. In general, On-Farm Network nitrogen study participants who are willing to sidedress the bulk of their nitrogen have found they can cut their normal pre-plant application rates by 50 lbs. an acre. With nitrogen approaching \$0.50 a lb., that can represent a significant savings.

If you've decided your corn crop needs additional nitrogen, leaving three or more untreated strips the width of your combine corn head will allow you to check the validity of the decision. Mark the strips with flags and GPS (if you have it) so you can compare yields from adjacent treated and untreated strips at harvest. Yield data recorded by a combine yield monitor works great for this purpose, but if you don't have a yield monitor, you can make your comparisons with a weigh wagon.

## End-of-the-Season Stalk Nitrate Analysis

By measuring the amount of nitrate remaining in the stalk at the end of the growing season, the



end-of-season stalk nitrate test can be used to evaluate whether sufficient nitrogen was available to the corn crop.

The test itself looks at nitrate content in an 8-in. section of stalk, cut 6 in. above the soil surface. Samples should be collected after the grain reaches physiological maturity (blacklayer). Details on how to collect and submit samples for analysis can be found on pages A-4 and A-5 of the 2006 On-Farm Network Conference proceedings. To access this on-line, go to <http://www.isafarmnet.com/agronstudies/06Nconf/A1-A5.pdf>.

Most soil and plant analytical labs can run stalk nitrate analysis, but check with your lab for confirmation. Samples need to be frozen or at least refrigerated right after collection if they are not being submitted immediately to the lab. It may take several weeks to get results, since stalk samples must be dried before being processed.

Nitrate concentration results will be reported to you in parts per million. In general, a concentration of 700 to 2000 is considered optimal. Rates higher than that suggest more nitrogen was available to the plant than was necessary to produce maximum yields. Rates lower than 250 ppm suggest that having more nitrogen available would likely have increased yields. In the 250-700 ppm range, additional nitrogen may or may not be profitable, depending on the price of grain and the cost of the fertilizer material.

## For More Information

For more information on the Iowa Soybean Association On-Farm Network™ or to receive a printed copy of the 2006 On-Farm Network Conference proceedings and the *Remote Sensing Guide* mentioned in this article, call 800-383-1423, ext. 233, or write to On-Farm Network, Iowa Soybean Association, 4554 114<sup>th</sup> Street, Urbandale, IA 50322-5410.

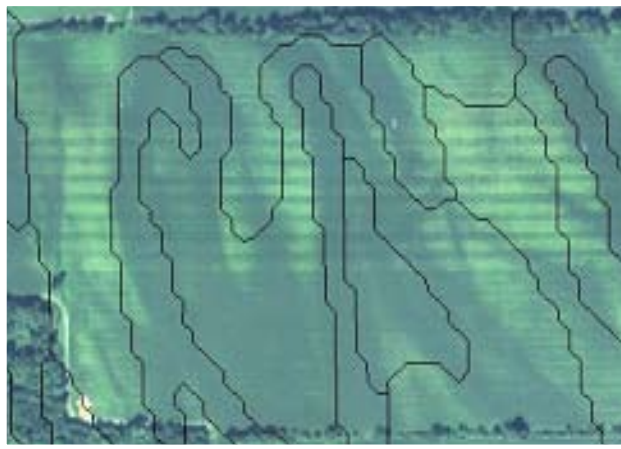


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# Remote Sensing: Learning by Looking

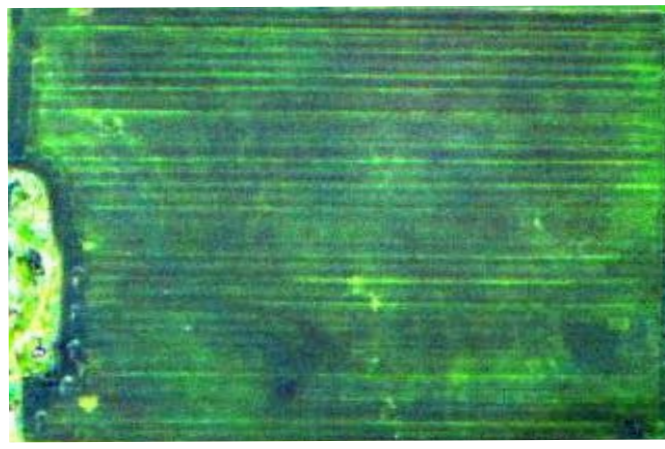


▲ Aerial Image

## Nitrogen Deficiency

In this example (above) from 2004, a custom applicator put herbicide with enough UAN carrier to provide 70 lbs. of nitrogen per acre immediately after planting. A 3-in. rain fell on the field within 24 hours and the field remained damp for two weeks. The grower reported that while weed control was excellent, the condition of the corn early in the growing season led his crop consultant to question the fate of the liquid nitrogen carrier. A pre-sidedress soil nitrate test confirmed that nitrogen was short, so additional nitrogen was sidedressed in alternating strips of 40 and 70 lbs. per acre, as part of ongoing nitrogen management strip trials with the On-Farm Network™.

Yields from strips where the grower applied just 110 lbs. of N (70 early and 40 lbs. sidedress) averaged 109.3 bu. per acre. Strips where the crop got 70 lbs. early and 70 lbs. sidedress yielded 143.6 bu., a difference of 34.3 bu. per acre.



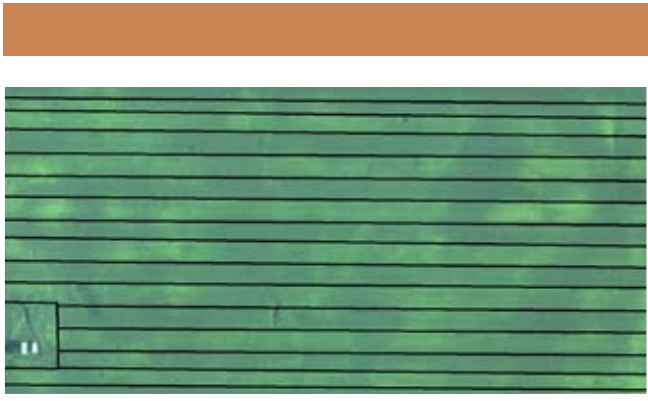
▲ Aerial Image

## Application Error

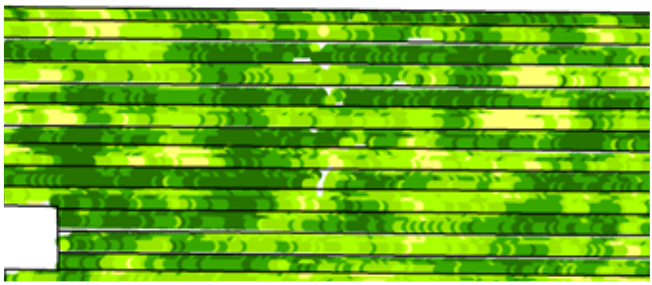
Application error often shows up in a repeated pattern across the field. In the examples above dry poultry manure had been applied across the field at 2.5 tons per acre. A 40-ft. wide application error pattern showed up in early observations of these fields. The images were taken later in the growing season, after the grower applied additional nitrogen in replicated strips (the darker stripes across the images) as a way to determine nitrogen availability from the poultry litter. The angled mark across the photo on the right shows where the applicator made an extra pass across the field at an angle. The yield loss was more than 70 bu. per acre in some areas in rows that appear light or yellow. Centered on the manure application pattern, stalk nitrate tests confirmed the problem was nitrogen stress.



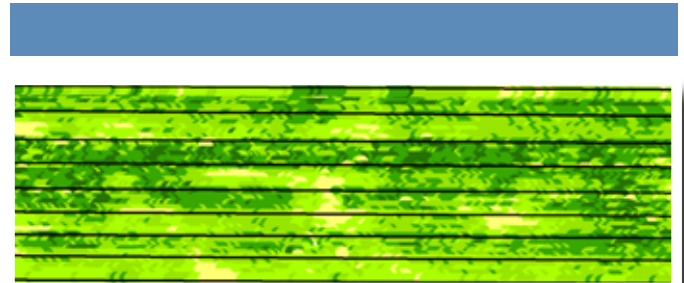
Aerial imagery can help detect and diagnose anomalies in crops. Here are four N examples from the On-Farm Network™ files that help illustrate this point.



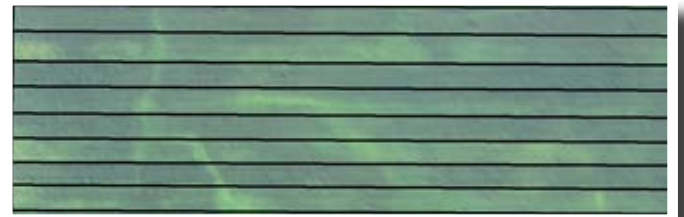
▲ Aerial Image



▲ Grain Yield Map



▲ Grain Yield Map



▲ Aerial Image

## Nitrogen Stress in Manured Fields

The use of aerial photography to detect nitrogen stress in manured corn fields is shown in these two examples.

The first example (above) was dry poultry manure applied in January 2004 without incorporation at a rate that was intended to supply corn with 150 lbs of total nitrogen per acre. An additional 50 lbs. of fertilizer nitrogen from UAN was applied in replicated strips on top of the manure in early spring to help estimate the availability of nitrogen from chicken manure.

The image of the field taken during the growing season showed that some strips were yellow, a clear sign of severe nitrogen deficiency. Analyses showed that yield response to the additional nitrogen was on average 32 bu. per acre. The yield maps confirmed (areas with yellow and light green color) that additional nitrogen would have increased yield and profit. Detecting this problem early enough would have resulted in a yield increase of more than 25 bu. per acre across six different cornfields for this particular farmer.

The second example (above) had liquid swine manure applied in the fall of 2003 at a rate that was sufficient to provide corn plants with 200 lbs. of total nitrogen, based on the grower's nutrient management plan. An additional 50 lbs. of nitrogen was applied in spring on top of the manure to get an estimate of nitrogen availability from liquid swine manure. An aerial image of the corn canopy showed areas where corn was stressed by the shortage of nitrogen.

The yield difference between strips with manure plus additional nitrogen and manure only was 16 bu. per acre. This shows that amount of nitrogen applied with the manure was not enough or some portion of the nitrogen in the manure was lost. Nitrogen availability is often difficult to predict and depends on the rate of manure decomposition.

Detection of nitrogen stressed corn using aerial photography can help avoid yield losses due to uncertainty in availability of N from different manure sources.