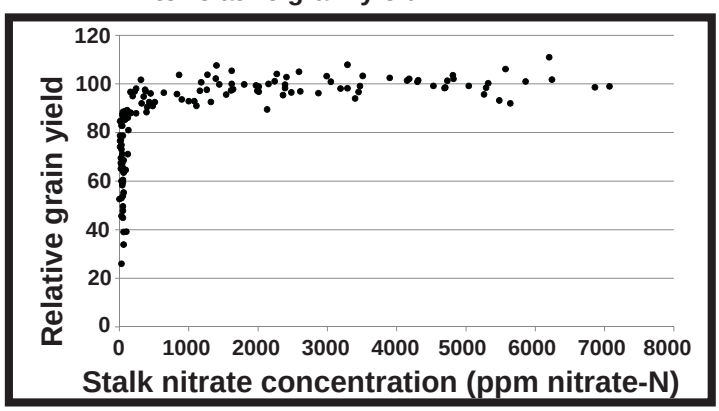
End-of-season stalk nitrate testing provides after-the-fact N management analysis

The end-of-season stalk nitrate test can be used to evaluate the availability of N to the corn crop. Nitrate concentrations in stalk sections from the lower part of a corn plant after physiological maturity indicate whether sufficient N was available.

Why does this test work?

During most of the season, the corn plant acts as a factory to produce grain. Taking up N during most of the season and then moving that N into the grain is the first priority of the corn plant. By measuring the amount of N that was left in the lower portion of the plant after grain fill, we can determine whether "extra" N was left in the plant. (See Figure 7.11.)

Figure 7.11 Relationship of stalk nitrate concentration to relative grain yield



A post-season assessment

For an initial review of what happened last season, an interpretation of the stalk values is needed for each sampling point. Table 7.12 shows the four categories for interpretation, as defined in ISU Pm-1584:

Figure 7.12 Interpreting stalk nitrate values

Class	N Concentration (ppm Nitrate-N)	Interpretation
Low	<250	High probability that greater availability of N would have increased yields
Marginal	250-700	Slightly lower than economic thresholds
Optimal	700-2000	High probability that N availability was within the range to maximize profits
Excess	>2000	High probability that N availability was greater than N applied at economic optimal rates (More N was available than needed for optimal profit.)

How to collect the samples

Stalk samples can be collected after the corn plant has reached physiological maturity. Sampling the correct location on the plant is critical. Eight-inch long sections, cut from 6 to 14 in. above the ground should be collected. Remove sheaths and leaves, as well as any dirt before sending samples to the lab.

Cutters designed to cut 8-in. stalk sections precisely 6 in. above the ground as recommended for the end-of-season stalk nitrate test can be used to collect individual samples. This particular cutter is manufactured by a group of former Jefferson-Scranton High School (Iowa) vocational agriculture students.

Depending on how the samples are to be used to represent a given location or a field, at least 10 stalks should be combined for a single sample. Plants that are damaged or barren should not be sampled. In order to assure a random sample, pick a number like five, and then sample every fifth plant in the row. If the fifth plant is barren, damaged, before or after a planter skip or double planted, skip to the next plant.

Collecting stalk samples after harvest

Collecting stalk samples after a field has been combined is not generally recommended for three main reasons:

1. Most combines don't leave enough stalk for correct stalk sampling position.
2. It's difficult to identify barren or damaged plants after harvest.
3. Rainfall on broken stalks after harvest can significantly lower nitrate concentrations.

Effects of rainfall on stalk nitrate values

Nitrate concentration in a given corn crop can vary. This variation is because the N availability and use by a crop is affected by amounts of rainfall. Values will be higher in drought years because N loss is less, more N is available, and grain production is lower. Wet years can result in lower values because of higher N losses that reduce N availability. In either case, the test accurately assesses what happened to the crop and is valuable.

Hybrid variation on test readings

Hybrids vary in their ability to take up N and their ability to produce grain. Stalk nitrate concentration is therefore affected, but still indicative of what the plant had available. The databases used to calibrate this test and continually verify its calibration have consisted of many hybrids and have shown that hybrid differences are minor compared to normal variability in management and spatial variability.

(Agron. J. 84: 53-59)

Guided stalk sampling compares results of N management practices across the field

While the end-of-season stalk nitrate test can be used to evaluate the availability of N to the corn crop, fields are seldom uniform. It's important to consider the location of the sample collection point in the context of the entire field. To collect multiple samples that can give a more accurate picture of the entire field, the On-Farm Network® uses a technique called guided stalk nitrate sampling.

Why a guided approach is needed

In many fields, N availability can vary more within a 20-acre area than between the average of two different 20-acre areas. Unlike phosphorus or potash, nitrogen deficiency is easily detected by normal remote sensing. Combining the power of remote sensing with soil survey information makes it possible to characterize differences in the field that are likely to change the N availability to the corn crop.

How the points are selected

In a typical field, we try to select four different sampling locations. One sampling point is based on the color image, trying to locate an area of the field that looks deficient. The other three sampling locations are guided by the soil map units. One sample is collected from each of the three dominant soil map units in the field. This pre-selection of varying soil map units will help reflect any N differences caused by soil variability.

A handheld GPS instrument assists in locating sampling points within a field.

Tools available for point selection

Tools used include remote sensing, GPS, and GIS mapping software. Computers with GIS make it easy to use aerial imagery and digitized soil surveys to pick the four sampling locations. Iowa is very fortunate to have soil survey information for the entire state available at no cost on the Internet at *http://icss.agron.iastate.edu/*. In addition, a number of other sources of georeferenced imagery (images with known location points) are available.

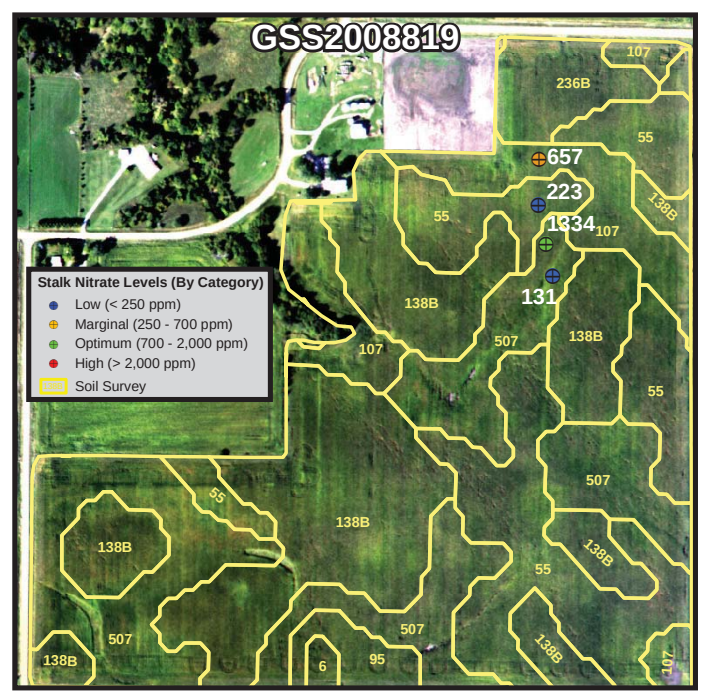
In addition to GIS programs, hand-held GPS units are now common with ag service providers. Most ag service providers can load GPS points onto handheld units and use them to find their sampling location in the field.

Picking points without imagery

While a late August/early September image of the cornfield is extremely helpful in guiding where to sample, it is not always possible to obtain such an image. In these circumstances, it's recommended that a soil map of the field be used to select three points based on the three main soil types in the field. Other imagery, such as the digital orthoquads (DOQs), can provide assistance in identifying soil differences, such as elevation or soil organic matter. For Iowa, DOQs from 1990-2000, color infrared DOQs from the spring of 2002, color orthophotos from 2004 and 2005 are all available at *http://ortho.gis.iastate.edu/*.

Evaluating over time

It is critical that rainfall data be considered. For the best result, tracking a subset of a grower's fields that represent the different management practices and types of soils over a number of years is recommended.



This aerial image was used to select the four points marked where stalk samples were collected. The stalk nitrate test results for each location are shown.

Replicated strip trials

Replicated strip testing is a methodology for comparing yields from two different management practices across a field. These strips of alternating N management are harvested with combines equipped with GPS and yield monitors. Management practices may focus on differences in rate, timing, and source of N.

Guidelines on replicated strip testing

The basic premises for replicated trials used in the Iowa Soybean Association On-Farm Network® studies are:

1. Keep it simple, just compare two management practices in a given trial.
2. Keep all other practices the same (*i.e.*, same hybrid, seed treatment, planting date).
3. Replicate it at least three times, in side-by-side strips across the field at least the width of your combine header. More replications are better.
4. For N rate differences, 50 lbs. N/acre difference is recommended. If a smaller difference is used, more replications are needed.

Selecting a field

Unlike small plot research, field variability can make a trial more valuable. Because GPS and yield monitors permit yield measurements in site-specific places, a single trial could characterize a number of different soil types or landscape positions.

Fields that have significant soil or landscape variation that lies perpendicular to the treatments are preferred. This way both treatments are affected relatively the same.

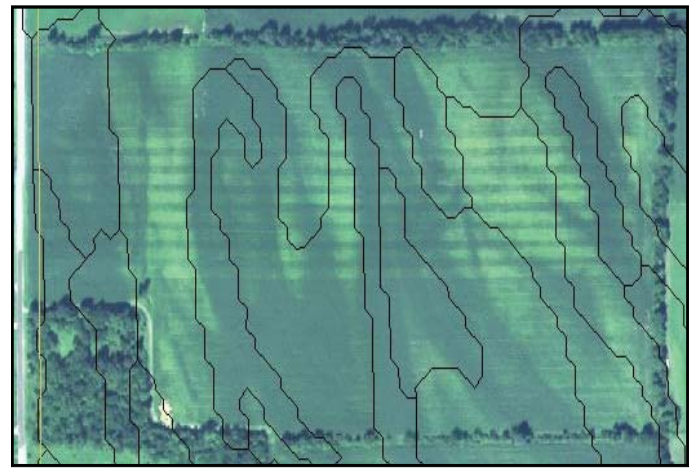
Fields with frequent terraces or point rows are less suitable for strip testing because of the difficulty in finding an area large enough and similar enough to make multiple side-by-side passes.

Figure 7.15 Yield by soil type in one specific replicated trial

Soil Name	Label	% of Field	140# N Yield (bu/a)	Soil Name	Label	% of Field	110# N Yield (bu/a)	Yield Difference
Sparta	41	5.8	109.1	Sparta	41	5.4	62.6	46.5
Sparta	41B	8.5	119.7	Sparta	41B	8.0	82.1	37.6
Ankeny	136	5.2	160.1	Ankeny	136	5.8	131.6	28.5
Watseka	141	18.9	141.9	Watseka	141	19.6	102.6	39.3
Bolan	174	1.4	142.4	Bolan	174	1.1	102.3	40.1
Dickinson	175	3.8	178.8	Dickinson	175	3.1	161.6	17.2
Dickinson	175B	1.2	165.0	Dickinson	175B	1.9	149.4	15.6
Kennebec	212	1.9	177.4	Kennebec	212	1.9	154.3	23.1
Pillot	450B	0.9	186.1	Pillot	450B	0.9	163.0	23.1
Spillville	485	2.4	180.7	Spillville	485	2.2	156.3	24.4

	140#	110#
Average Yield (Bu/a):	143.6	109.3

Yield Difference: 34.3 bu/a



Above is an example of an aerial image of a replicated strip trial with two different rates of N. The black lines are the soil map units.

Yield summaries

From the yield of each strip, the average yield difference for each N rate is easy to calculate. In addition, both yields and difference in yields between N management practices can be calculated for each soil type as shown in the above summary comparing replicated strips of 140 lbs. of N to 110 lbs. of N.

Types of comparison

While there are many different types of comparisons that can be made using replicated strip trials, here is a list of some of the most popular N trials:

- Normal N rate vs normal N rate minus 50 lbs. (shown in bottom left figure using a normal rate of 150 lbs. N/acre)
- Sidedressing 75 lbs. of N vs. 125 lbs. N for corn following soybeans
- Fall vs spring application of N
- Manure plus 50 lbs. N/acre
- Manure equivalency for N
- Nitrogen product comparisons such as UAN vs anhydrous ammonia
- Application method comparisons such as broadcast vs. incorporated N