Recent studies have shown that the nitrogen (N) status of a corn crop can be assessed by measuring nitrate concentrations in the lower portion of cornstalks at the end of the growing season. This finding led to the development of a new tissue test that can be used to evaluate N management practices used in any field in any year. The test is called the “end-of-season cornstalk test.”

**How the test is done:** The time for sampling is between one and three weeks after black layers have formed on about 80 percent of the kernels of most ears. Black layer normally forms about 60 days after silking or 20 days after denting. The portion of each plant sampled is the 8-inch segment of stalk found between 6 and 14 inches above the soil. Leaf sheaths should be removed from the segments. Stalks severely damaged by disease or insects should not be used. Fifteen 8-inch segments should be collected to form a single sample to be sent for analysis. Areas differing in soil types or management histories should be sampled separately. Collecting one composite sample from each of several small areas (less than an acre) that seem to be representative of larger areas within a field is an effective strategy. Samples should be sent to a laboratory for analysis as soon as possible after collection. Samples should be placed in paper (not plastic) bags to enable some drying and minimize growth of mold. The time normally required to mail samples to a laboratory is not a problem. Samples should be refrigerated (but not frozen) if stored for more than a day before mailing. Laboratories will dry the samples as soon as they are received. The samples should be ground and analyzed for nitrate concentrations. Concentrations are expressed as ppm (parts nitrate-N per million parts of dry stover). Most soil testing laboratories will do this test.
Interpretation of stalk nitrate concentrations: Stalk nitrate concentrations can be divided into four categories:

1. **Low** (less than 250 ppm N),
2. **Marginal** (250 to 700 ppm N)
3. **Optimal** (700 to 2000 ppm N), and
4. **Excess** (greater than 2000 ppm N).

The low category indicates high probability that greater availability of N would have resulted in higher yields. It should be noted that concentrations in this range give little indication of the magnitude of yield increase that might be expected from more available N. Visual signs of N deficiency usually are clear when nitrate concentrations are in this range. The marginal category indicates that N availability was very close to the minimal amount needed. Although producers should not be concerned when samples test in this range, this range is too close to economic penalties to be the target for good N management under most conditions. The optimal category indicates high probability that N availability was within the range needed to maximize profits for the producer. The higher end of this range is more appropriate when fertilizer N is relatively cheap and grain prices are relatively high (compared with prices during the past decade). The lower end of the range is most appropriate when fertilizer N is relatively expensive and grain prices are relatively low. Visual signs of N deficiency often are observed in this range. The excess category indicates high probability that N availability was greater than if fertilizer N had been applied at rates that maximize profits for producers. The concentration of nitrate in the stalk at the end of the season reflects all factors that influenced N availability and N needs during the growing season.

Because many factors influence N availability after fertilizers are applied, it is unrealistic to expect any producer to attain optimal concentrations in all fields in all years. Indeed, experience has shown that the optimal range is difficult to consistently attain with existing management practices. When interpreting the results of the test, consideration must be given to weather conditions that occurred during the growing season. Rates of fertilization that are most profitable over many years should be expected to result in low concentrations in some years and in excess concentrations in other years. Lower than desired concentrations should be expected in years having unusually large amounts of in-season rainfall that results in unusually large losses of N and (or) high yield potential. Higher than desired concentrations should be expected in years when unusually low rainfall limits N losses and/or yield potential. It is possible that deficiencies of N early in the growing season sometime limit yield potential in ways that are not directly indicated by the stalk test. Additions of more fertilizer than needed after such damage has occurred will result in concentrations of stalk nitrate that correctly indicate that higher rates of fertilization would not have increased yields. This problem is avoided if enough N is applied before planting or if the late-spring soil test routinely is used to ensure that such deficiencies are unlikely. After appropriate consideration is given for weather conditions, fertilization rates should be increased for areas that usually test in the low range and decreased on areas that usually test in the excess range. The test does not directly indicate how much N rates should be increased or decreased, but continued use of the test for several years enables producers to make adjustments toward optimal rates.
Concentrations in the **excess** range indicate that use of the late-spring soil test to guide N fertilization will probably increase profits for the producer.

**Documentation Required:**
- A map showing where the activities are applied
- Date of test
- Acres for each treatment area
- Soil test results for each treatment area
- Manure analysis results (if applicable)
- Crop yields (both yield goals and measured yield, if available)
- Amounts of all nutrients applied in each treatment area
- Change in annual N applied due to adaptive management change per treatment area

**Kansas criteria for chlorophyll meter (CM) sensing N stress in corn:** Corn takes up N rapidly beginning with the V8 growth stage. Because the goal is to detect and correct any N deficiency in time for adequate yield recovery, N stress sensing can begin at the V10 vegetative growth stage and should be completed before tassel emergence with preference closer to V10. To approach in-season N management in this way, high-clearance equipment is needed to apply additional N. Applications should be completed before the silk-emergence growth stage. Each CM is provided with a calibration disc to ensure the meter is functioning properly. Always follow the CM use instructions. To collect a CM measurement, place a corn leaf between the sensors and hold the sensors together. Always place the top of the meter on the top side of the leaf. It is important to sample the same leaf on each plant at approximately the same spot on each leaf (halfway down the leaf from the tip to the base and halfway from the leaf edge to the midrib). Before tassel emergence, readings should be taken from the uppermost leaf that is fully collared (leaf collar fully visible around the stalk). If readings are collected at or after tassel emergence, they should be taken from the leaf at the uppermost ear shoot. Readings should be collected from many plants to account for sampling errors and natural color variation across leaves and between plants. The CM memory holds up to 30 sensor measurements. Pressing the CM “Average” button calculates an average of all sensor measurements. After collecting readings from 20 to 30 different plants, scroll back through the data display to review measurements. Numbers significantly higher or lower than an average CM reading is a unit-less value and by itself does not adequately determine N sufficiency/stress. When CM readings are compared with readings from an adequately N fertilized reference area, we can evaluate corn N status relative to the “greenest” corn in the field. It is critical that each field have reference strips (no more than 5% of the field total) or areas. By adjusting (normalizing) CM sensor measurements to reflect the adequately fertilized N reference area, the user reduces the effects of other variables such as hybrid differences or moisture stress. Reference strips or areas can be created by applying extra N (approximately 50 to 100% more than typically required for the rotation) at pre-plant or early sidedress. Enough reference strips are needed to characterize differing field areas. To normalize the CM readings, take the average CM reading of the corn in the
area of interest and divide this number by the average CM reading of the reference strip closest to that area. This normalized value gives you the relative CM (RCM) value.

Use the table below to determine how much, if any, additional N is needed.

**RCM value and in-season**

**N application rate.**

<table>
<thead>
<tr>
<th>Relative CM Value</th>
<th>N Rate to Apply (lb N/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCM &lt; 0.88</td>
<td>100</td>
</tr>
<tr>
<td>0.88 - 0.92</td>
<td>80</td>
</tr>
<tr>
<td>0.92 - 0.95</td>
<td>60</td>
</tr>
<tr>
<td>0.95 - 0.97</td>
<td>30</td>
</tr>
<tr>
<td>&gt; 0.97</td>
<td>0</td>
</tr>
</tbody>
</table>

[Table 1. Relative SPAD chlorophyll meter (RCM) value and in-season N application rate.]

† Readings taken from V10 to VT corn growth stages.
‡ Suggested N rate limited to a maximum of 100 lb N/acre.

**Documentation Required:**
- A map showing where the activities are applied
- Date of test
- Acres for each treatment area
- Soil test results for each treatment area
- Manure analysis results (if applicable)
- Crop yields (both yield goals and measured yield, if available)
- Amounts of all nutrients applied in each treatment area
- Plant tissue test results (including reference strips)
- Change in annual N applied due to adaptive management change per treatment area

**Soil Health Nutrient Test**

Method uses green chemistry, in that the soil analysis is performed using a soil microbial activity indicator, a soil water extract and H3A, a soil extract that mimics organic acids produced by living plant roots to temporarily change the soil pH; thereby increasing nutrient availability and decreasing nutrient over application.
Sampling: Sample should be taken in the top six inches of soil as you would a regular soil sample. The sample should be taken timely enough to plan for the next cropping season. The producer will receive a Microsoft Excel file upon completion of analysis.

In the Microsoft Excel file, lower left hand tab you will find the following:

**N-P-K**
These numbers represent the amount of N, P₂O₅, and K₂O presently in your soil in lbs. per acre. The numbers include the inorganic NH₄-N, NO₃-N and PO₄-P from the H3A extract, as well as the amount of N and P that the soil microbes will provide based on your soil microbial activity (Solvita 1-day CO₂-C), the organic C:N and N from the plant available organic N pool.

**Nutrient value per acre:** Current fertilizer prices are multiplied by the nutrients present in your soil. This is the value of your current soil nutrients in dollars.

**Soil Health**
Solvita 1-day CO₂-C: This test is one of the important numbers in soil testing. This number in ppm is the amount of CO₂-C released in 24 hours from soil microbes after your soil has been dried and rewetted (a natural field event). This is a measure of the microbial activity in the soil and is highly related to the fertility of your soil. In most cases, the higher the number the more fertile the soil.

**Water-extractable organic C:** This number in ppm is the amount of organic C extracted from your soil with water. This pool of carbon is roughly 80 times smaller than the total soil organic C pool (% organic matter) and reflects the energy source that is driving your soil microbes.

**Water-extractable organic N:** This number is the amount of the total water-extractable N minus the inorganic N (NH₄-n + NO₃-N). This pool of nitrogen is highly related to the water-extractable organic C pool and will be easily broken down and released to the soil in the inorganic nitrogen form by soil microbes that is readily available to plants.

**Organic C:N:** This number is the ratio of organic C from the water extract to the amount of organic N in the water extract. This C:N ratio is a critical component of the nutrient cycle. Soil organic C and soil organic N are highly related to each other as well as the water-extractable organic C and the organic N pools; however, the soil health tool uses the organic C:N ratio of the water extract since this is the ratio the soil microbes have readily available to them and is a more sensitive indicator than the soil C:N ratio. A soil C:N ratio above 20:1 indicates that no net nitrogen and phosphate mineralization will occur, meaning the N and P are “tied up” within the microbial cell until the ratio drops below 20:1, as the ratio decreases the more nitrogen and phosphate are released to the soil solution which can be taken up by growing plants. They apply this same mechanism to the water extract; as the C:N falls, they credit more N and P mineralization on a sliding scale. They like to see this number between 8:1 and 15:1. The C:N ratio is also used in calculating the soil health number.
Soil Health Calculation: It combines five independent measurements of your soils’ biological properties. The calculation looks at the balance of soil carbon and nitrogen and their relationship to microbial activity. A soil health calculation number can vary from 0 to 50. The number should increase over time. The number is about where your soil is now and what it needs to reach its highest sustainable state. Keeping track of this number will allow you to gauge the effects of your management practices over the years.

Cover Crop Mix: This is a suggested cover crop planting mix based on your soil test data. This is a recommendation of what you can do to increase your soil health calculation number; it is not what you have to do. It is designed to provide your soil with a multi-species cover crop to help you adjust your soil health.

Nitrogen
Total N: This value is the total nitrogen from the water extract from your soil in lbs. per acre. It contains both the inorganic N and the organic N, which are shown in the next two columns on the spreadsheet.

Inorganic N: This is the combined amount of plant available forms of inorganic N (NO₃-N [nitrate] plus NH₄-H [ammonia]). NO₃-N is the form of N that is easily lost from soil through surface runoff, subsurface leaching, erosion, and in water-logged conditions it can revert back to a gas. NH₄-H is usually quickly converted to NO₃-N by soil microbes but is less susceptible to leaching. The majority of inorganic soil N is the NO₃-N form. If NO₃-N levels are high (above 50 lbs.) then we would use grasses to convert this easily lost form of N back to the organic form by incorporating it in the grass.

Organic N: Organic N is the total water-extractable N minus the total water-extractable inorganic N in lbs. per acre. This form of N should be easily broken down by soil microbes and released to the growing plant providing minimal chance of loss since the N is bound in large organic molecules. This pool represents the amount of potentially mineralizable N in your soil.

Phosphate: This tab lists the same type of results as the nitrogen tab, but for inorganic P and organic P.

Results: Utilizing realistic yield goals the mineralizable organic nitrogen component can be evaluated in this test.
– This important nutrient source is not directly considered in traditional soil test fertilizer recommendations.
– Microbes provide plant available N in the form of NH₄-N and NO₃-N when they break down (mineralize) soil organic matter.
– Haney et al. (2000, 2004, 2008) developed methods to quickly and accurately quantify microbial activity (CO₂ released) and relate it to the amount of nitrogen released as NH₄-N and NO₃-N to help decrease the amount of nitrogen needed according to traditional soil tests.
Documentation Required:

- Acres for treatment area
- Map of treatment area
- Realistic yield goal documented
- Results of soil health nutrient test from producer for every field
- Nutrients applied (form and amount)
- Cover crop species planted according to the recommendation in the Microsoft Excel file percentages planted must match recommendation.