Sensor-based Topdressing for Winter Wheat
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Objective:
- Develop reliable sensor interpretations as a basis for on-the-go variable-rate N topdressing of winter wheat.

Accomplishments for 2009:
- Three nitrogen rate experiments were carried out in conjunction with sensor measurements at the pre-jointing growth stage.
  - Two were near Columbia at the Bradford Research & Extension Center.
  - One was near Centralia at the USDA research area.
- The most profitable N application time for all three experiments was just prior to jointing. This timing was more profitable than:
  - All N applied at greenup–this timing gave poor yield responses
  - N split between greenup and just prior to jointing
- The most profitable N rate (applied just prior to jointing) was similar for all three experiments:
  - 72 lb N/acre in the Columbia East experiment
  - 65 lb N/acre in the Columbia West experiment
  - 94 lb N/acre in the Centralia experiment
- These rates are below but fairly close to typical rates of 90 to 100 lb N/acre used by producers.
- This range of rates is not wide enough to justify use of precision agriculture techniques to diagnose and apply the correct N rate. If future experiments find a similarly narrow range of rates, sensor-based topdressing of winter wheat may not be needed in Missouri.
- All experiments followed soybean. When wheat follows corn, as is often the case in south Missouri, the need to diagnose optimal N rate may be stronger. Past research has shown that the amount of N available after a preceding corn crop is much wider than the amount available after a preceding soybean crop.
- A range of crop appearances and N sufficiencies at the pre-jointing stage was created by applying either 0, 30, or 60 lb N/acre at greenup. Each of these greenup N rates was followed by a complete range of N rates and by sensor measurements at the pre-jointing stage.
- Each experiment thus produces three data points of sensor value and optimal N rate:
  - One with no N applied at greenup
- One with 30 lb N/acre applied at greenup
- One with 60 lb N/acre applied at greenup

- This automatically widens the range of optimal N rates measured at the pre-jointing growth stage.
- The relationship between sensor readings and optimal N rates was good for, and consistent between, the two Columbia experiments.
  - This was true for both sensors (Greenseeker and Crop Circle 210).
  - It was also true when sensor readings were taken from either 20 inches or 40 inches above the canopy.
  - An example is shown in the graph below.
  - Relative sensor reading is the sensor reading for the plot to be fertilized divided by the sensor reading taken from the high-N plot at the same time. A value of 1 indicates that the two plots looked the same. The farther this value is above 1, the more difference there is in appearance between the two plots.

\[ y = 142x - 160 \]
\[ R^2 = 0.71 \]

- Unfortunately the results at the Centralia experiment were not consistent with the Columbia experiments.
  - The difference between high-N wheat and zero-N wheat at Centralia was small when readings were taken on April 16-17.
  - High-N wheat at Centralia at this stage gave measurements that were no better than zero-N plots in the Columbia experiments measured two weeks earlier.
  - Both of these observations may have been related to late planting—the Centralia experiment was not planted until about November 20, while the Columbia experiments were planted on October 11.
  - The small difference in sensor measurements and appearance between zero-N and high-N plots on April 16-17 would normally suggest that the soil was supplying a substantial amount of N, allowing the zero-N plots to keep up with the high-N plots. This would be associated with a low need for fertilizer N.
    - This was not the case, as this experiment actually needed MORE N than the other two experiments (see graphs on first page of report).
  - The small difference measured by the sensors on April 16-17 had changed into a large difference in appearance between zero-N and high-N plots by the time aerial photographs were taken on May 6 (see photo below).
The poor agreement of the Centralia experiment with the Columbia experiments further weakens the case to use sensors to guide N rates (see graph). If future experiments agree with the 2009 Columbia experiments we will still have a viable system.

Aerial image of the Centralia experiment taken on May 6. Differences between zero-N and high-N plots are large, despite being small in sensor measurements taken on April 16-17. Zero-N plots did not stand out nearly as much in the Columbia experiments.

We have not yet tested our data in recommendation systems developed by other states. There may be some improvement due to the use of degree days which would help account for the small and poor appearance of the Centralia wheat when sensing was done. But we don’t expect much improvement, since all other recommendation systems also assume that a larger difference between zero-N and high-N plot also means a larger need for fertilizer N.
**Budget for 2010:**

<table>
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<tr>
<th>Item</th>
<th>Amount</th>
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<tr>
<td>Larry Mueller 40%</td>
<td>16,900</td>
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<tr>
<td>Benefits (31%)</td>
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<td>Fertilizer and other supplies</td>
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<td>Total request for 2010</td>
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