# Sensor-based sidedressing for cotton

Peter Scharf, Gene Stevens, David Dunn, and Luciane Oliveira
University of Missouri, Division of Plant Sciences
Collaborator: Earl Vories, USDA-Agricultural Research Service

**Objective:**
Develop reliable sensor interpretations as a basis for on-the-go variable-rate N sidedressing of cotton.

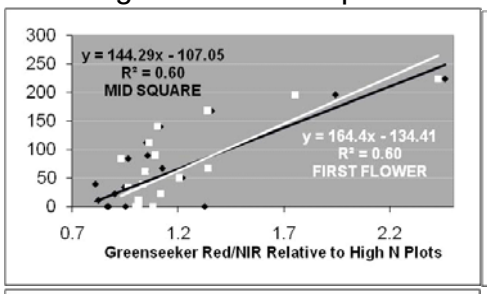
- Determine sensor model and height that gives the best prediction of sidedress N need.
- Determine the best growth stage for sensor-based sidedressing.
- Develop recommendation equations to convert sensor readings to N rates.

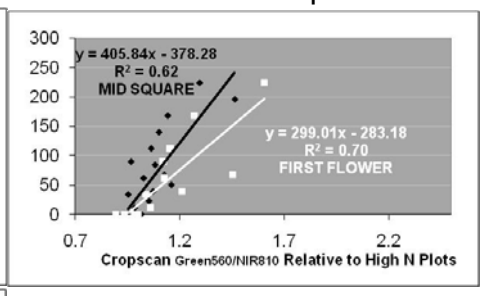
**Accomplishments for 2008:**

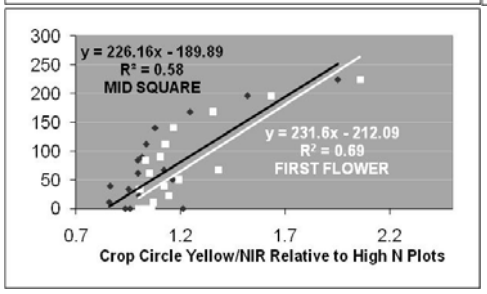
- All three sensor models gave good predictions of N need in the analyses we completed this year of our 2006-2007 data.
- For all three sensors, a height of 20 inches above the canopy gave the best predictions.
- Found that N rate recommendations were more reliable at the mid-square and early flower growth stages than at the early square growth stage.
- We developed recommendation equations for all three sensor models that can be used to convert sensor readings to N rates.
- We demonstrated sensor-based sidedressing in a 40-acre cotton field using a retailer's fertilizer applicator.
- Changed our experimental design to apply N at the time that the sensor readings give the best diagnosis–mid-square and early flower.

<u>Predicting N need with different sensors</u>

- Our experiments used Crop Circle, Greenseeker, and Cropscan sensors. All three had good relationships between sensor value and optimal N rate (graphs below).

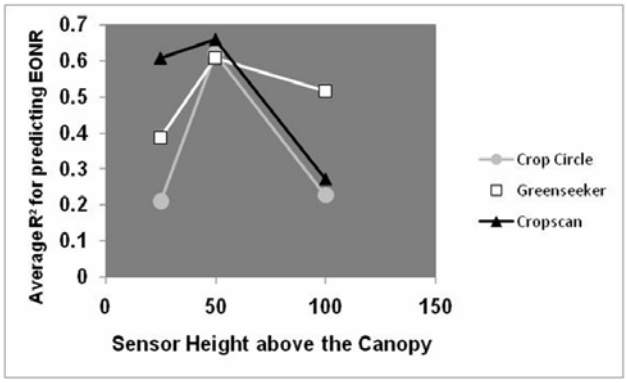


Effect of cotton growth stage and sensor height

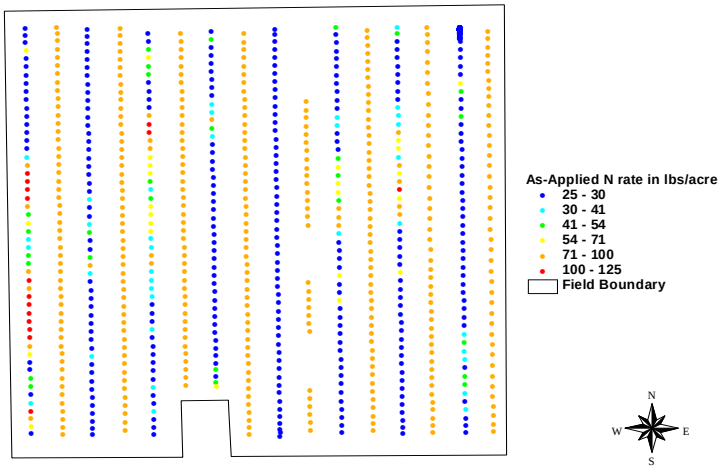
- Although the early square stage seemed to be too early to accurately diagnose N need of cotton from sensor measurements, all sensors gave good predictions at mid-square and early flower stages (graphs on previous page). Equations were not statistically different for these two stages, giving at least a 10-15 day window to use them.
- We have combined the data in the graphs above to produce a single recommendation equation for each sensor that can be used from mid-square to early flower.
- The best predictions for each sensor were obtained using a height of 20 inches above the canopy. The Greenseeker also worked well at 40 inches above the canopy, and the Cropscan also worked well at 10 inches above the canopy. This is shown in the graph at right. A higher $R^2$ value means a more accurate prediction of N need.




Field-scale demonstration in 2008

- With the successful development of equations to predict N need from sensor values, we decided to do a field-scale demonstration of variable-rate N application to cotton based on sensor measurements. The photograph below shows the demonstration in progress along with some of the details of the demonstration.

- The demonstration consisted of alternating strips of the producers N rate and strips where the N rate was variable and controlled by what the sensors saw.
  - The producer's sidedress N rate was 82 lb N/acre (orange dots on application map shown below).
  - With the sensors, most places in the field were diagnosed as having low N need and the 'floor' rate (which we had set at 25 lb N/acre) was applied (dark blue dots). However, in a few places the sensors saw stressed cotton, diagnosed high N need, and a high N rate was applied (red dots).
  - Average N rate based on the sensors was 36 lb N/acre, which is a savings of 46 lb/acre relative to the producer rate.

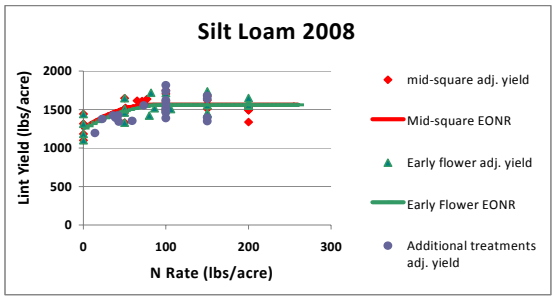


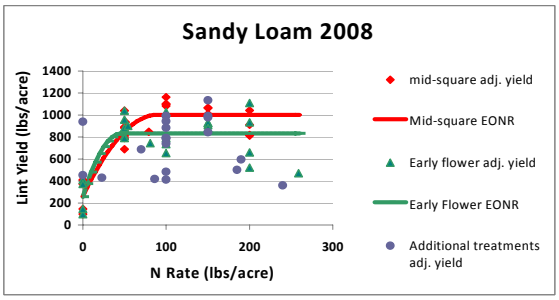

- We do not yet have the yield map for this field to analyze how the sensor-based sidedressing performed economically. However, ground observations throughout the summer and an aerial photo taken on July 18 did not reveal any problems or N stress associated with the lower N rates in the sensor-based strips.
- At harvest time, defoliant was applied to prepare the crop for harvest. In the strips where N rate was based on sensors, defoliation was more complete. The cooperating producer did not think that this influenced ease of harvest, but did think that it might have reduced leaf contamination of the harvested cotton. Leaf fragments in cotton can result in a lower price being paid for the cotton.

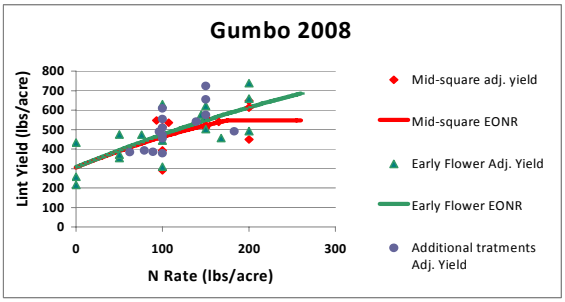
## Sensor-based strips defoliated better


Nitrogen response experiments in 2008

- Since sensor measurements diagnosed N need more accurately at the mid-square to early flower growth stages, we modified the design of our small plot experiments for 2008 to apply a range of N rates at these stages.




- Yield response to N applied at these stages is shown above. This analysis is preliminary. There was little if any difference in yield response to N between the mid-square and early flower stages in the silt loam and gumbo experiments. In the sandy loam experiment, early flower was too late to apply N and yield potential was lost by delaying N application to this stage.
- Sensor data from the 2008 small-plot experiments has not yet been analyzed, but will be analyzed over this winter.