Sensor-Based Nitrogen Management: Adaption to Irrigated Systems

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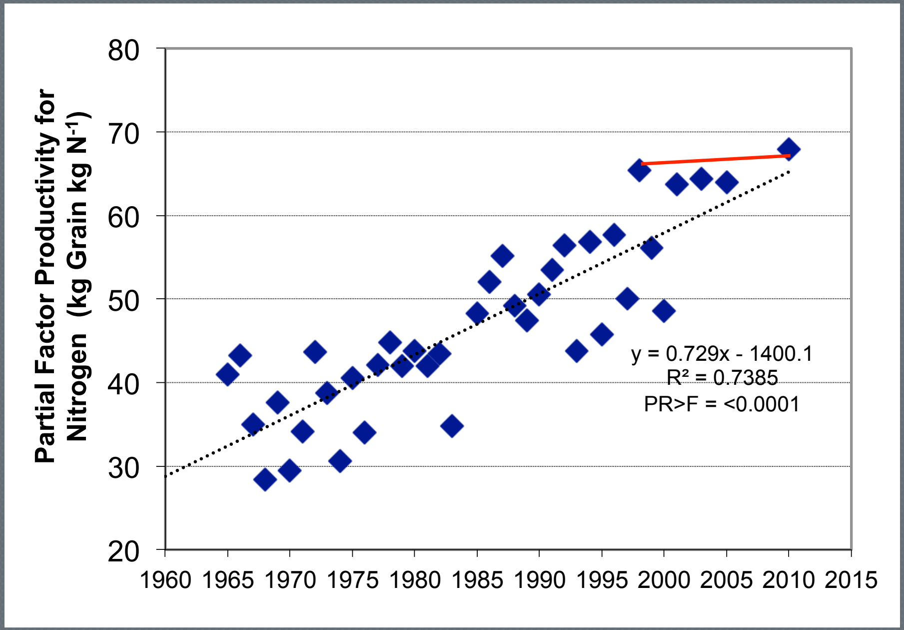
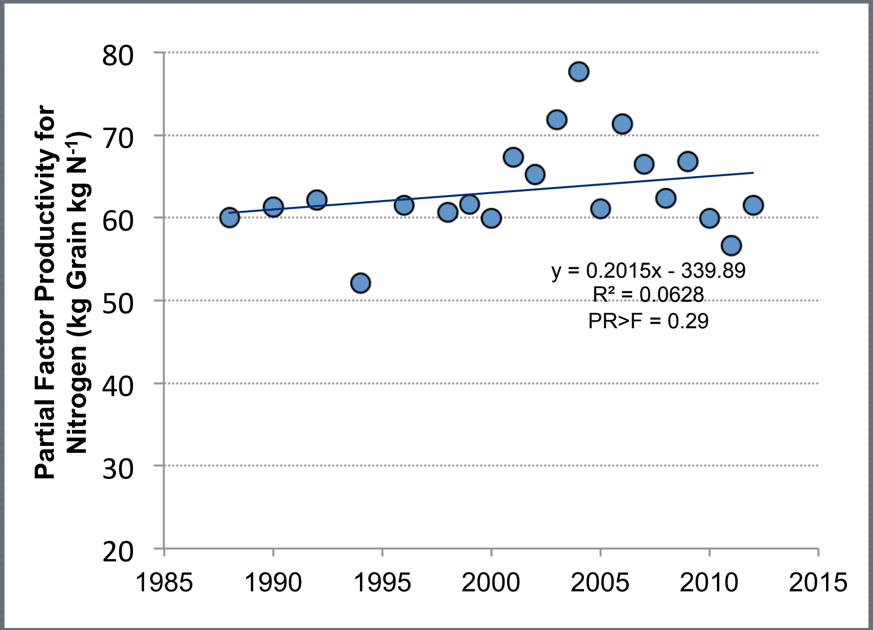
Nitrogen Use Efficiency



Nebraska statewide, rainfed and irrigated corn.



Nebraska's Central Platte River Valley, Groundwater Management Area (GWMA) producers, predominately irrigated corn.

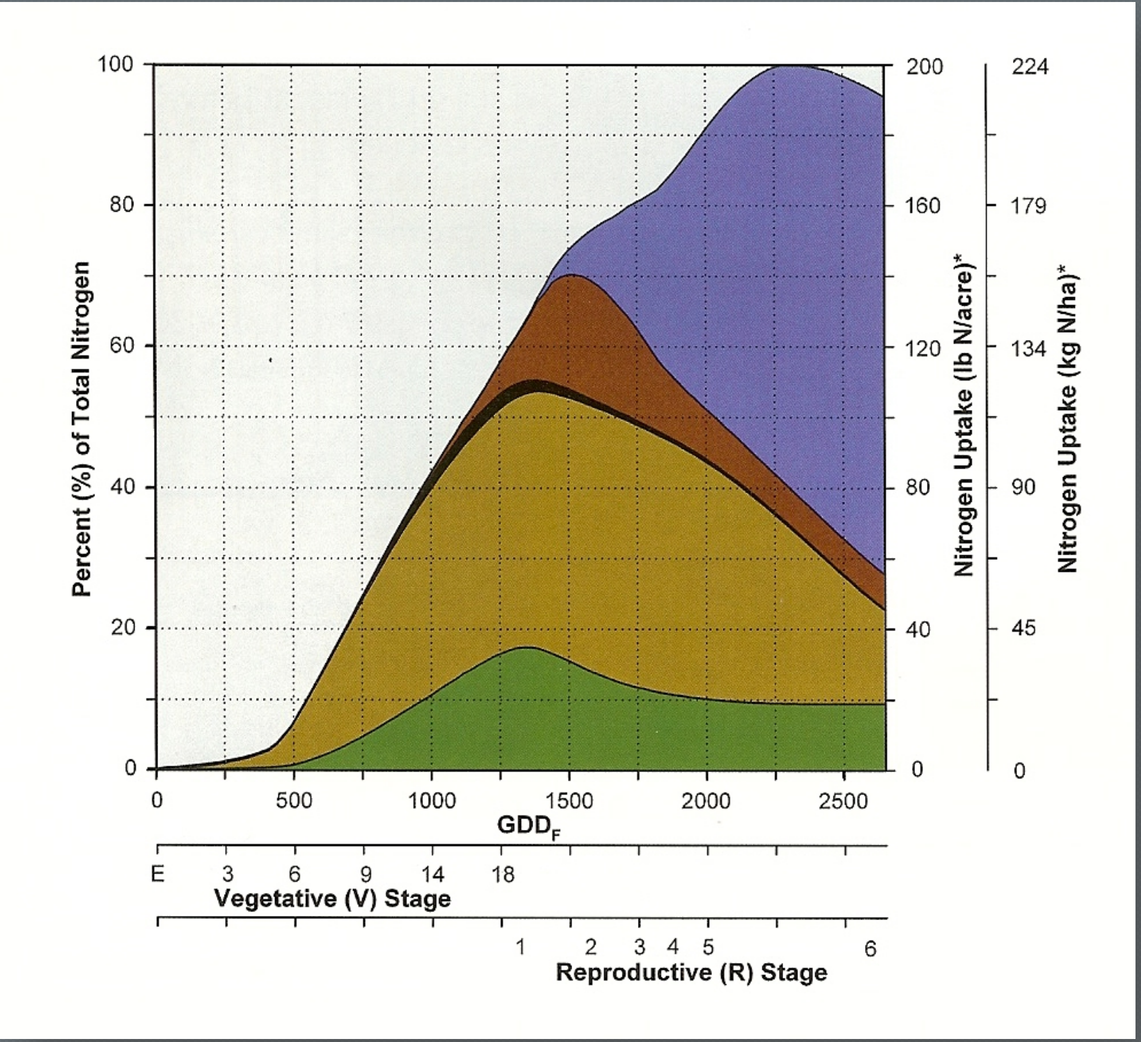
Water and Nitrogen

- Water and nitrogen use efficiencies are tightly coupled. Deficiency or excess of one will directly influence efficiency of the other. A successful nitrogen recommendation system will be sensitive to water deficit or excess.
- Irrigated producers are moving toward the capacity to manage both water and N supply temporally and spatially.
- An ideal system will supply the profit-optimizing rate of N and water to every location in a field at the right time.

Sensor-Based N Management in Irrigated Systems: Advantages vs. Rainfed Systems

- The irrigated environment reduces risk of water stress, and increases the likelihood that N supply is the factor most limiting yield potential.
- Nitrogen mineralization during the growing season is more predictable due to stability in soil moisture.
- The potential is lower in semi-arid environments for wet weather to interfere with late sidedress application than in more humid environments.
- Sprinkler irrigation allows incorporation of surface-banded fertilizer.
- Nitrogen rates often are higher due to greater yield potential in irrigated environments, affording flexibility in N management.
- *Predicting* the economic optimum N rate (EONR) can be a challenge. A *reactive* approach, using crop canopy sensors, has been proven through research to be an effective way to approach EONR, adjusting for spatial and temporal variation.

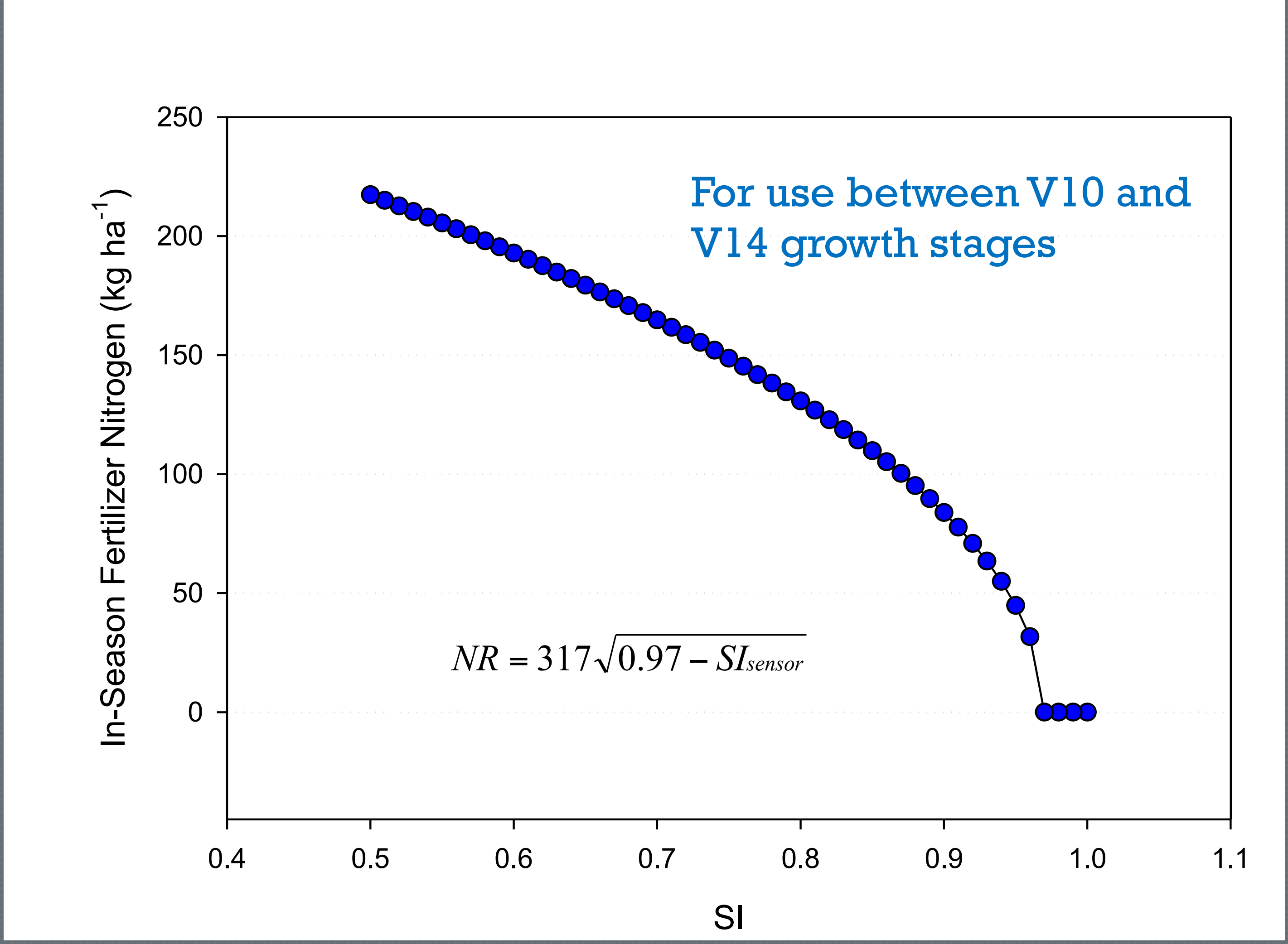
Nitrogen Uptake Pattern of Corn



Abendroth, et al., 2011. Corn Growth and Development. PMR 1009. Iowa State University


Crop Canopy Sensors
Canopy temperature sensor
Crop Circle ACS-210 2 band
Crop Circle ACS-470 3 band
Ultrasonic height sensors
CropScan 2 band (laser)
JOHN DEERE

In-Season N Application for Maize
Holland Scientific ACS-210 Active Canopy Sensor



Solari, et al., 2010

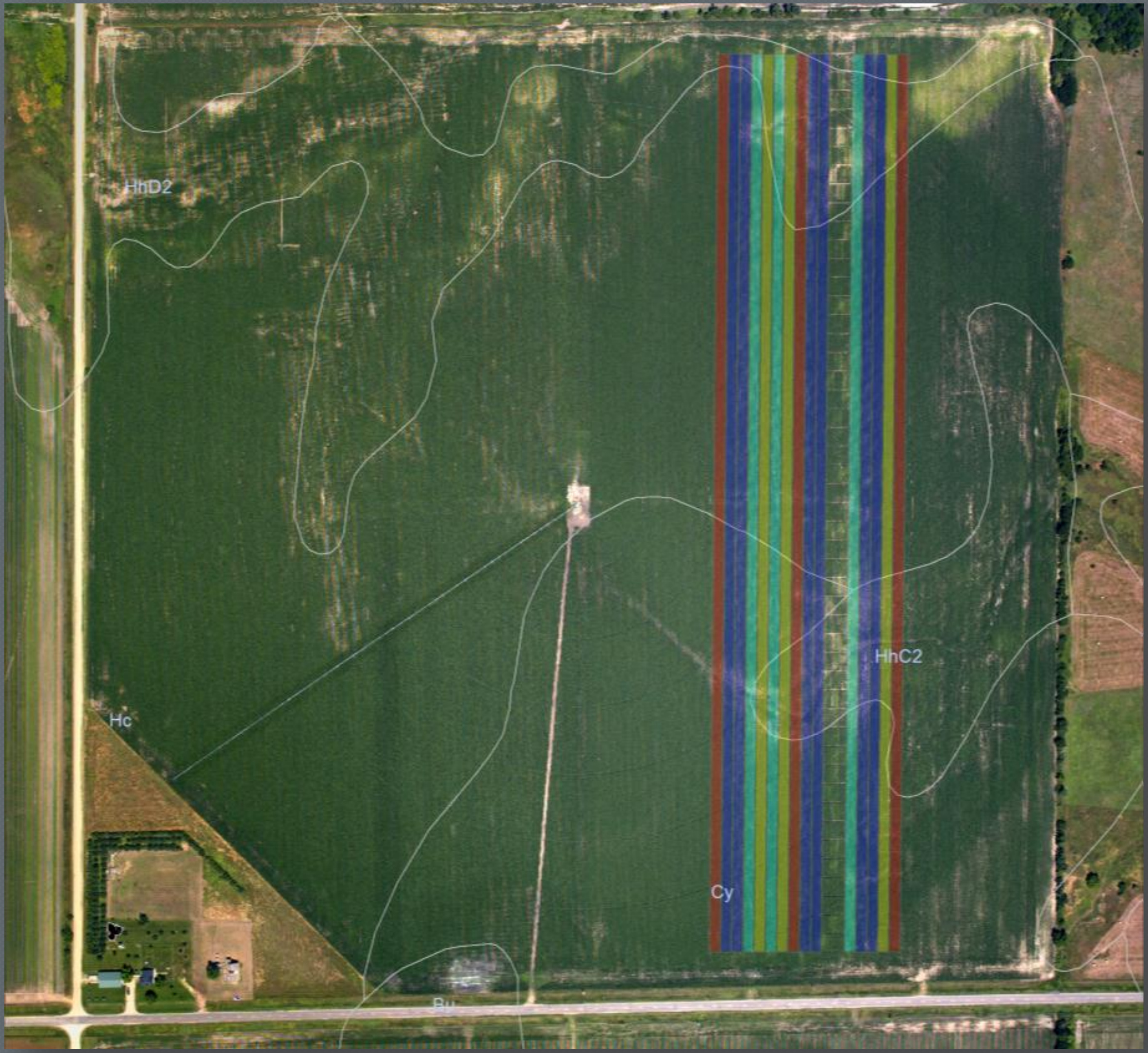
Universal Sensor Algorithm
Holland and Schepers (2010)

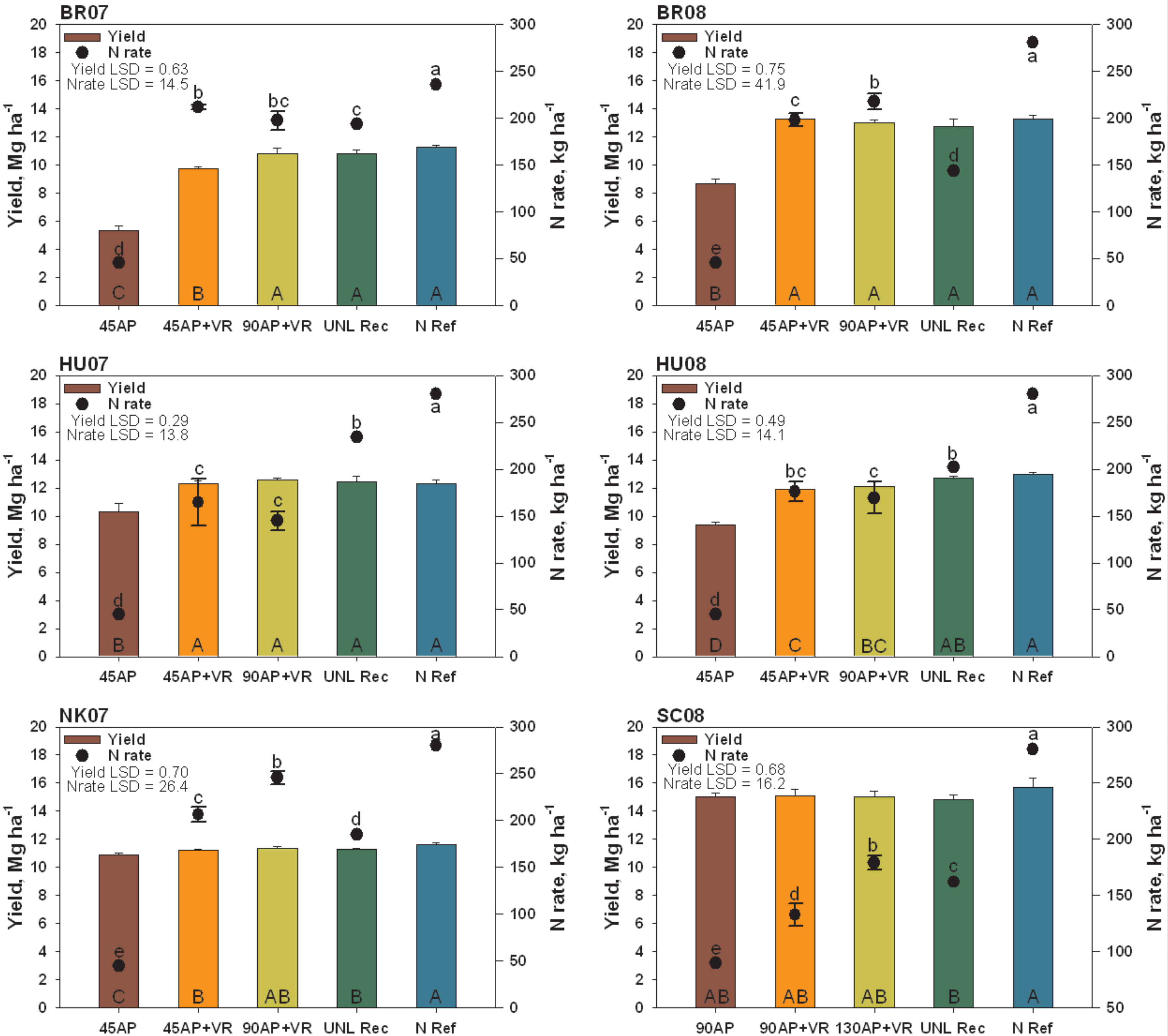
$$N' OPT * \sqrt{(1-SI)/\Delta SI} * (1+0.1 * e^{m(SI\ Threshold - SI)})$$

$$N'_{OPT} = N_{OPT} - N_{PreFert} - N_{CRD} + N_{COMP}$$

N_{OPT}	EONR or producer-selected maximum N rate
$N_{PreFert}$	N applied prior to in-season sensing
N_{CRD}	N credits – manure, irrigation water, legumes
N_{COMP}	N required in excess of N_{OPT} under soil limiting conditions at a given growth stage
SI	Sufficiency Index
m	Backoff rate variable
$SI_{Threshold}$	Backoff point

Typical Field Experimental Design With Reference Strips





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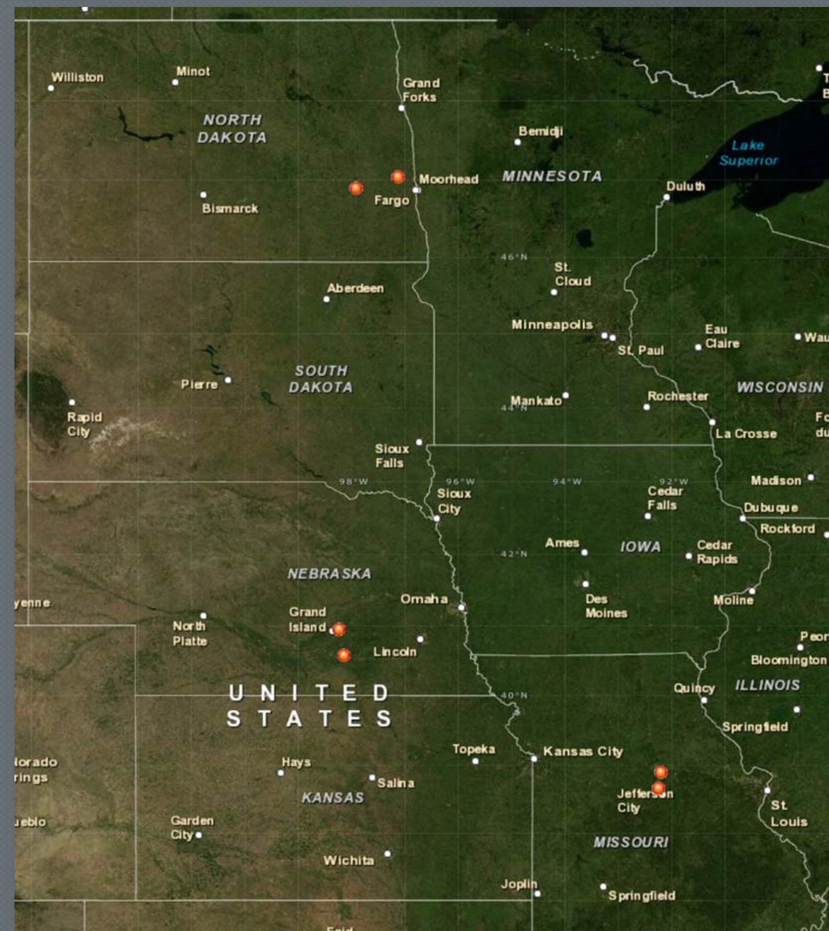
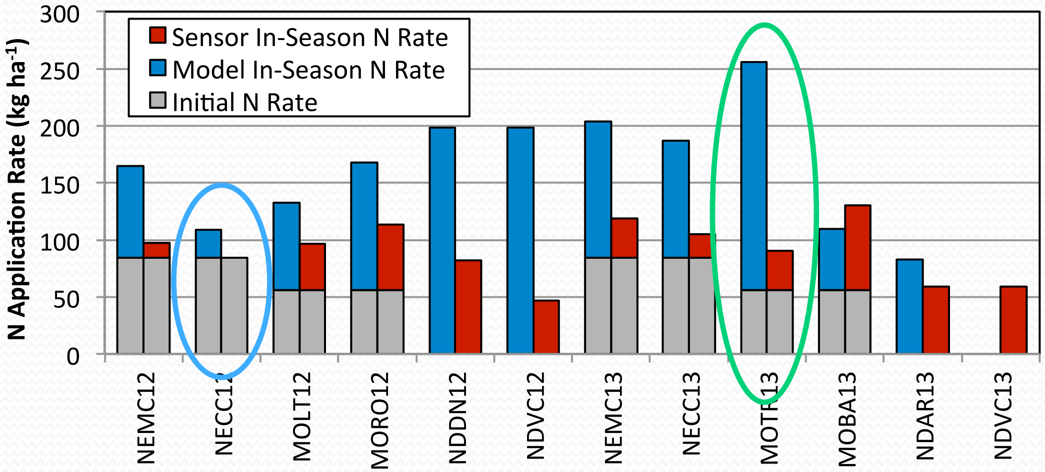
Comparison of In-Season N Strategies

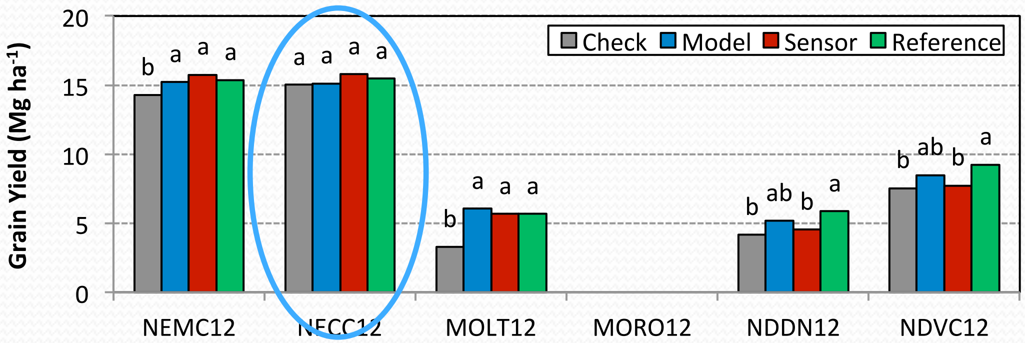
Regional study – North Dakota, Nebraska, Missouri – 2012-2013.

- How does corn hybrid color or architecture influence use of crop canopy sensors?
- Does plant density affect sensor readings?
- How does a sensor-based approach compare to a model-based approach (Maize-N)?
- In-season N ~ V9.

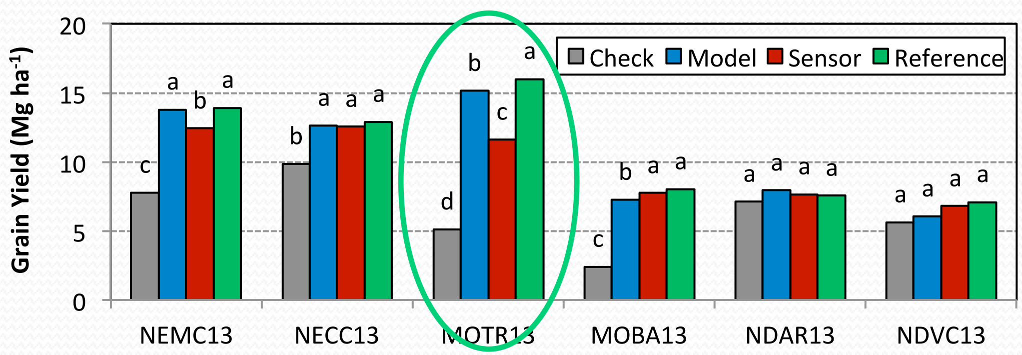


Regional Study: N Rates and Grain Yield





2012



2013

Sensors accounted for abnormally high N mineralization early in the growing season.

Higher N rates with model and reference treatments allowed additional yield with optimal late season growing conditions.

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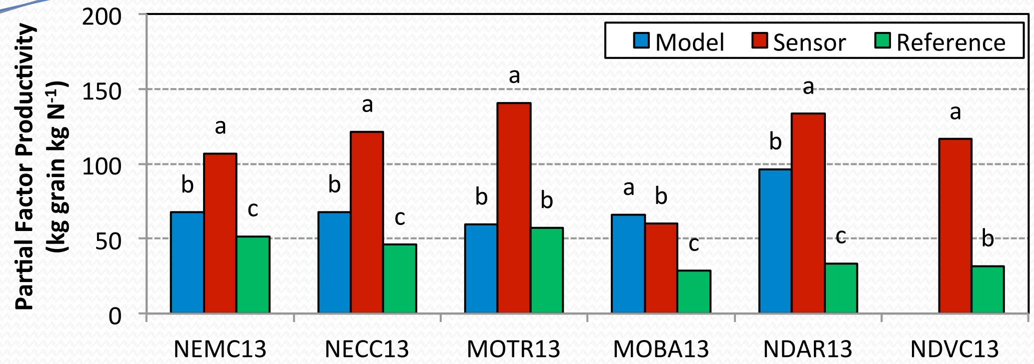
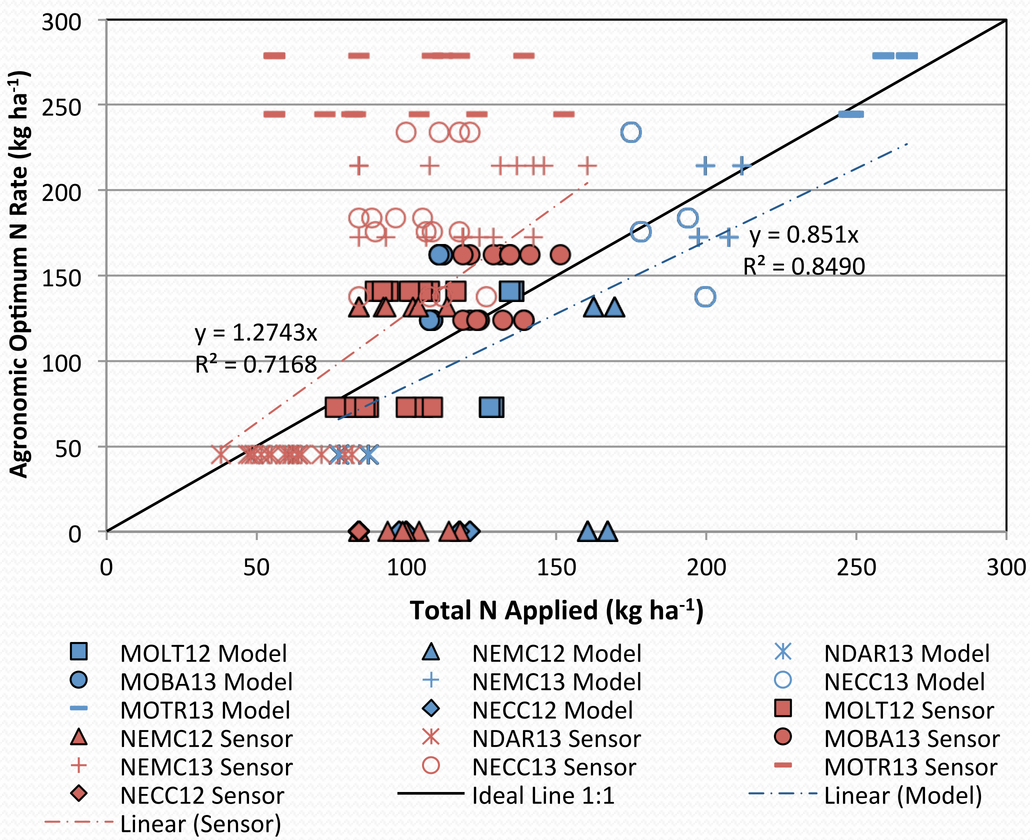
Regional Study: Nitrogen Use Efficiency and Agronomic Optimum N Rate





Summary

- Historic trends of increasing NUE may be plateauing with preplant application and *predictive* N rate strategies.
- *Reactive*, sensor-based, in-season N fertilization often, but not always, uses less N for similar yield compared to conventional N recommendation strategies.
- Sensor algorithms need to be responsive to different soils with varying capacity to supply N.
- Water and N management need to be coupled.

Future Use of Sensors in Irrigated Agronomic Systems

- Combination of sensor information with ancillary data layers and/or models.
- Combination of optical reflectance with supplemental sensors – canopy height, canopy temperature, etc.
- Use of canopy sensors for management of other inputs – irrigation water, fertilizers other than N, pesticides, etc.
- Sensor integration: in-situ, UAV, robotic, pivot-fixed, pivot-mobile.


Questions?