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Components of a Variable Rate Nitrogen Rec

Brian Arnall
Precision Nutrient Management | Oklahoma State University

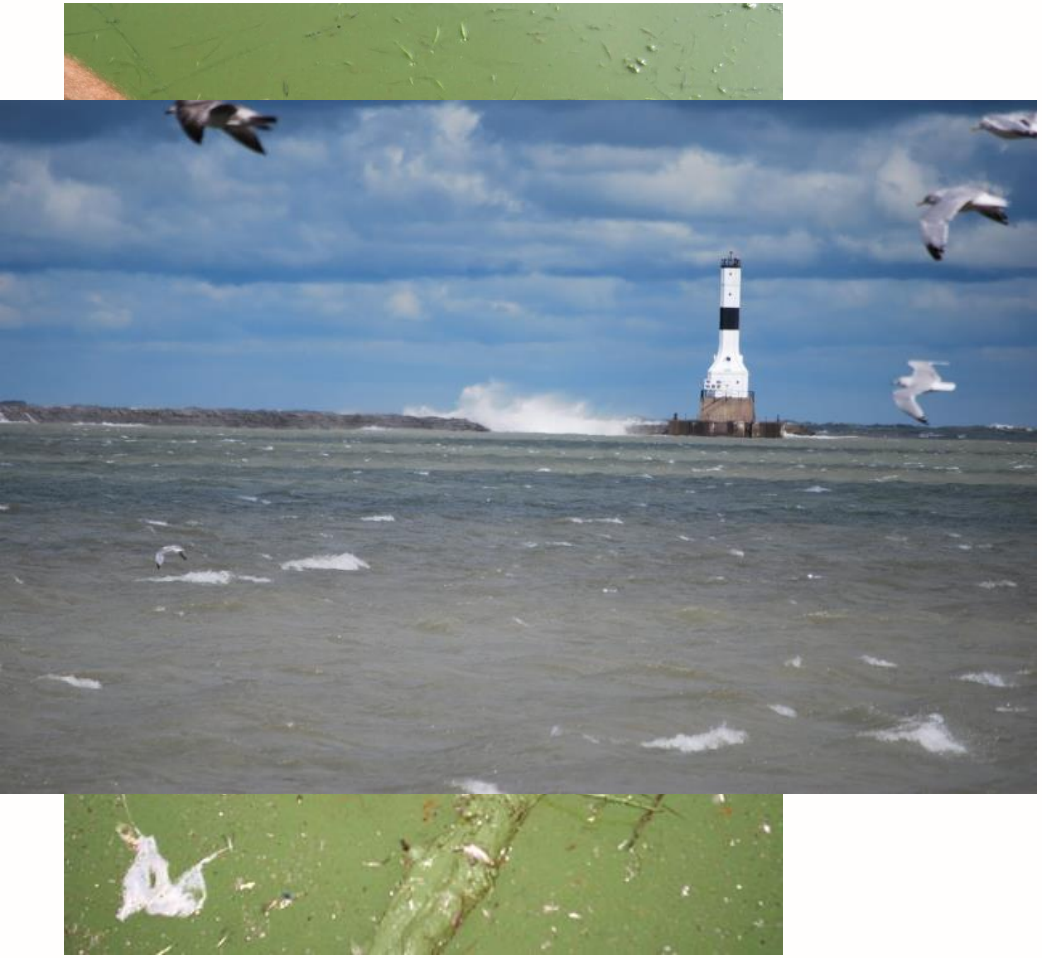
40 min

Overview

- Share current on goings in US
- N Management Concepts
- VRT recs How and Why

- Hopefully sometime down the road it causes some thought.

VRN backdrop



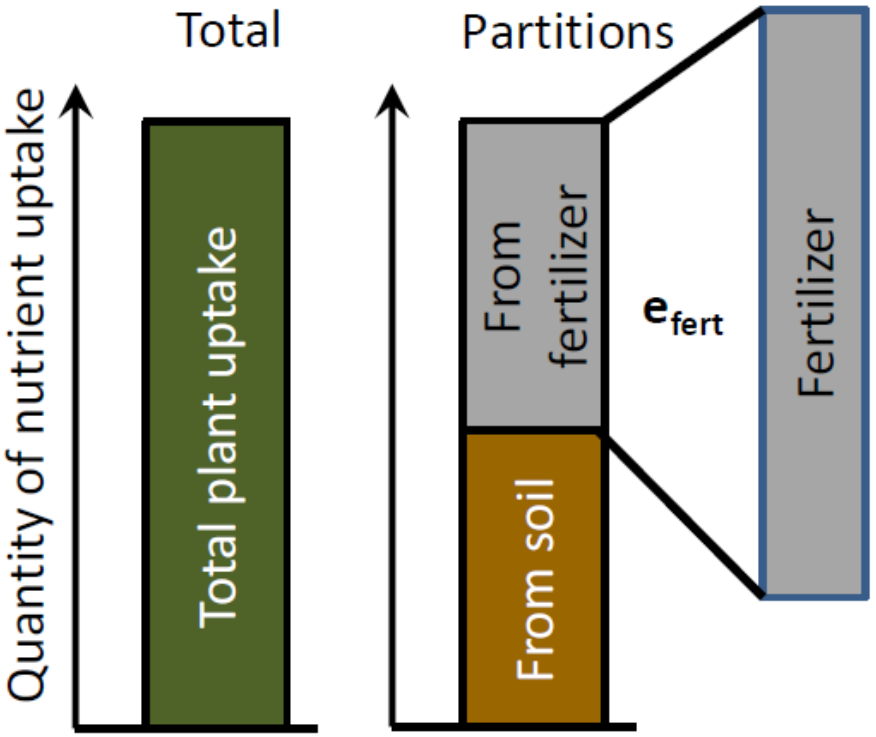
- In past
  - Chesapeake Bay
  - Oklahoma Sues Arkansas
- News is about Lake Erie
- Des Moines

- Impact elsewhere

Land-grant N recs

- Stanford Equation

$$N_{fert} = (N_{crop} - N_{soil}) / e_{fert}$$



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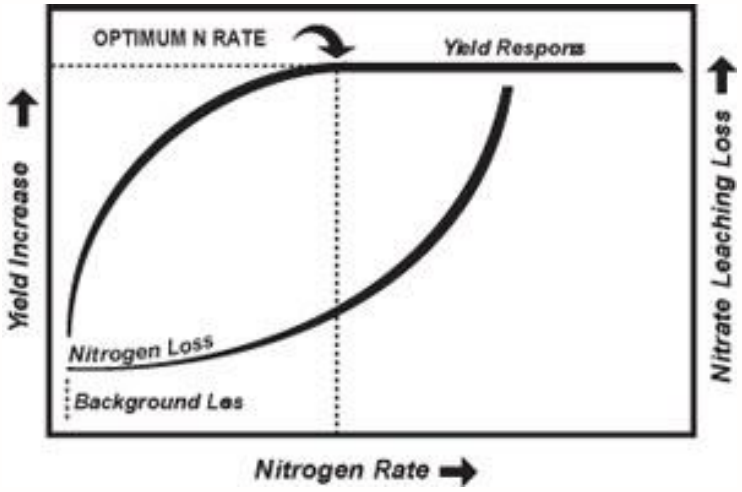
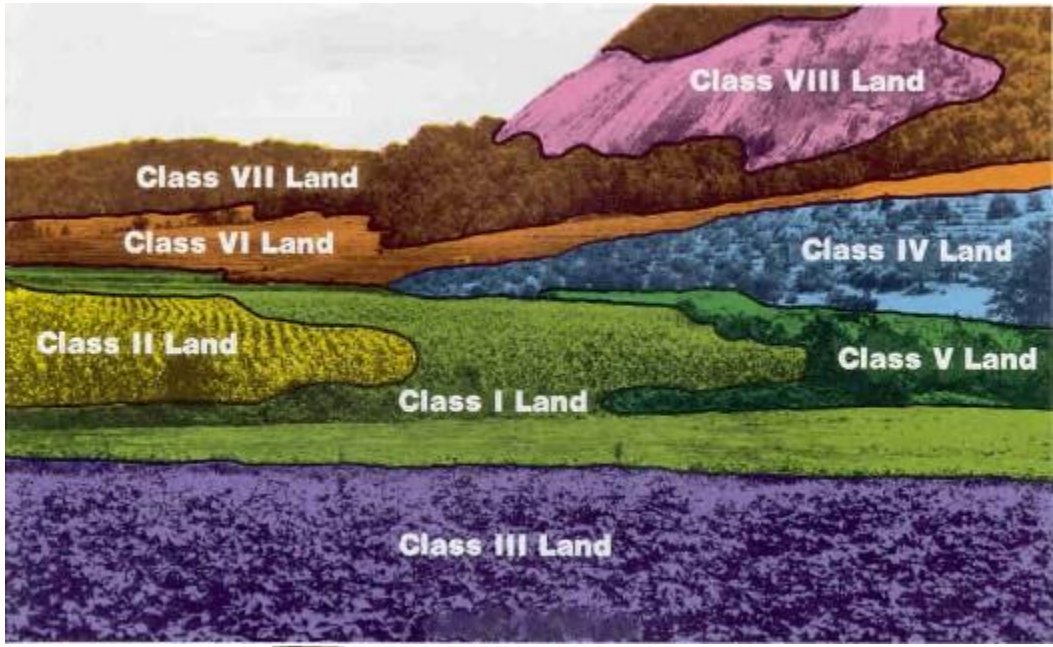
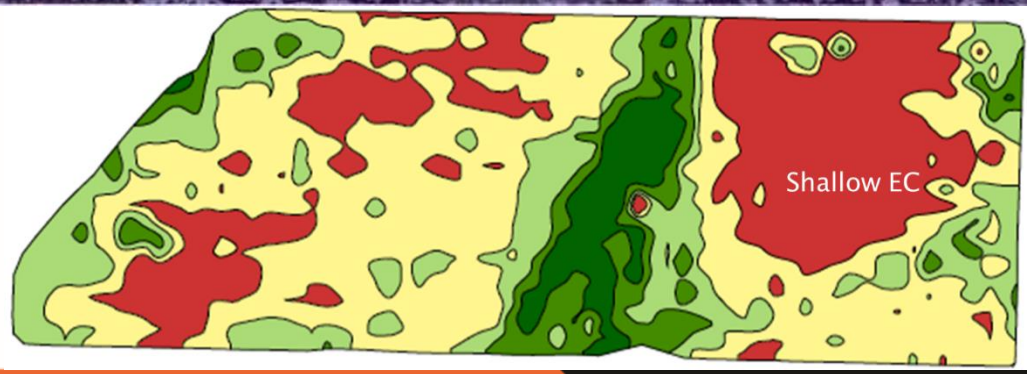
Yield

- N_{Crop}
  - Yield Goal
  - Soil Class
  - Yield Map
  - Biomass Map
  - Growth | Uptake Model, later.







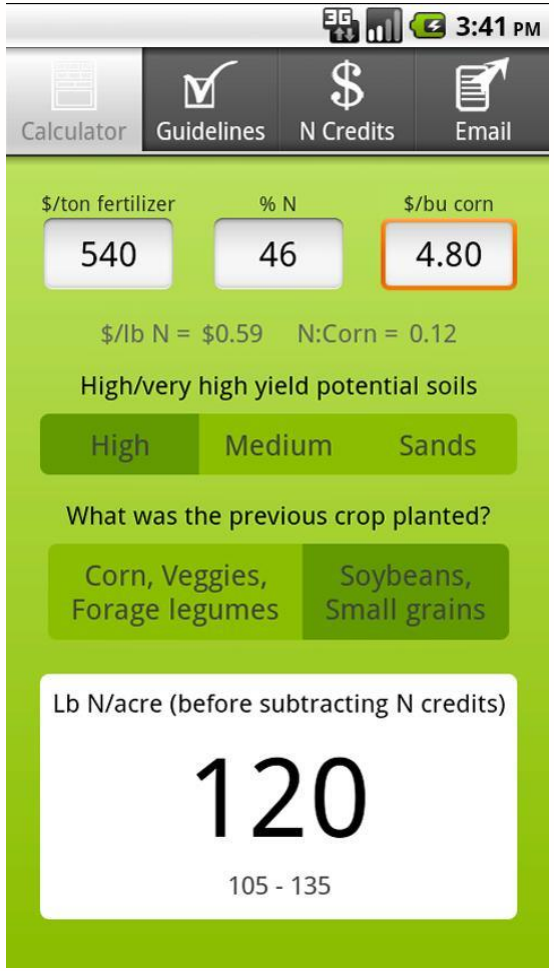
Yield Goal | Nitrogen Removal Rates

Yield	HRW Wheat	Canola
20	**30**	**38**
30	**45**	**57**
40	**60**	**76**
50	**75**	**94**
60	**90**	**113**
80	**120**	**152**
100	**150**	**188**

Crop	*Units	N	P_2O_5	K_2O
Canola	lb/bu	1.88	0.4	0.32
Corn	lb/bu	0.9	0.38	0.3
Oats	lb/bu	0.8	0.3	0.2
Sorghum	lb/bu	0.84	0.42	0.22
Soybean	lb/bu	3.8	0.8	1.4
Sunflower	lb/cwt	1.9	1.5	2.8
Wheat Grain	lb/bu	1.5	0.5	0.35

MRNT | EONR

- Regionally | Soil Specific
- Uses a Large Data Base
- Includes Economics



MRNT

- It must be recognized that rate **guidelines** developed from analysis of trials conducted across a wide geography will be **general in nature**. Those guidelines reflect the research data and provide insight into general fertilizer N needs. However, **they cannot predict site-specific** N requirements, and they are **unlikely to provide an accurate estimate of the optimum N rate needed in each specific environment**. It is well documented that optimum N rate varies among sites and years within sites (Figure 5, 6, and 7). Nevertheless, guidelines **should provide an N rate that reflects economic value** and probability of achieving **expected economic return** across a range of locations and period of time. The MRTN approach provides both the above-mentioned benefits and allows analysis across a range of N response trials.

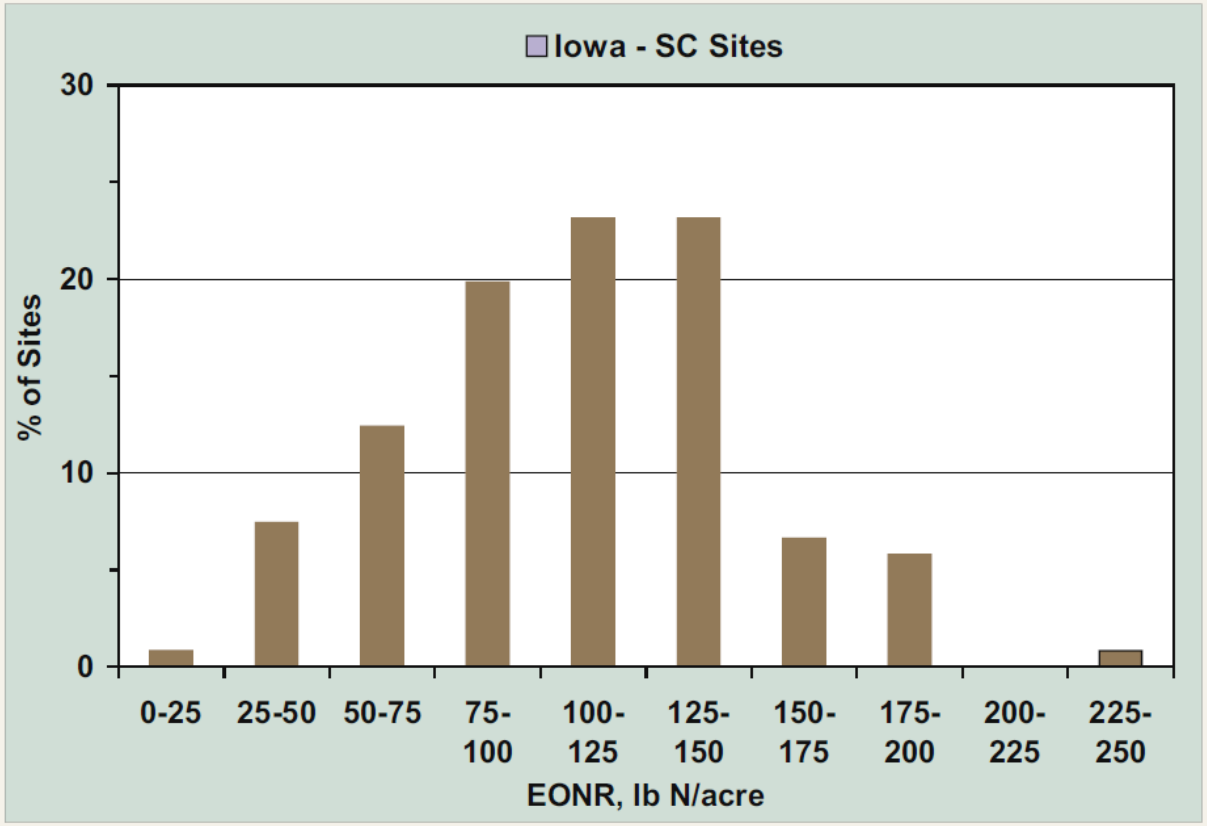
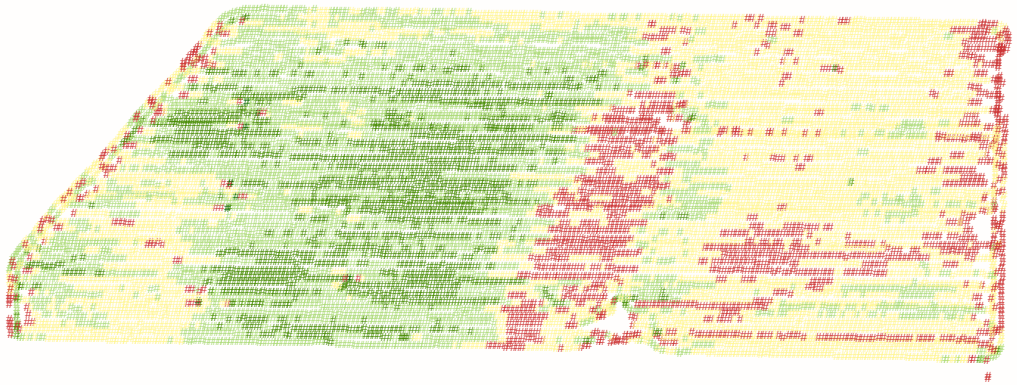


Figure 6. Frequency distribution of EONR (0.10 price ratio) for SC sites in Iowa.

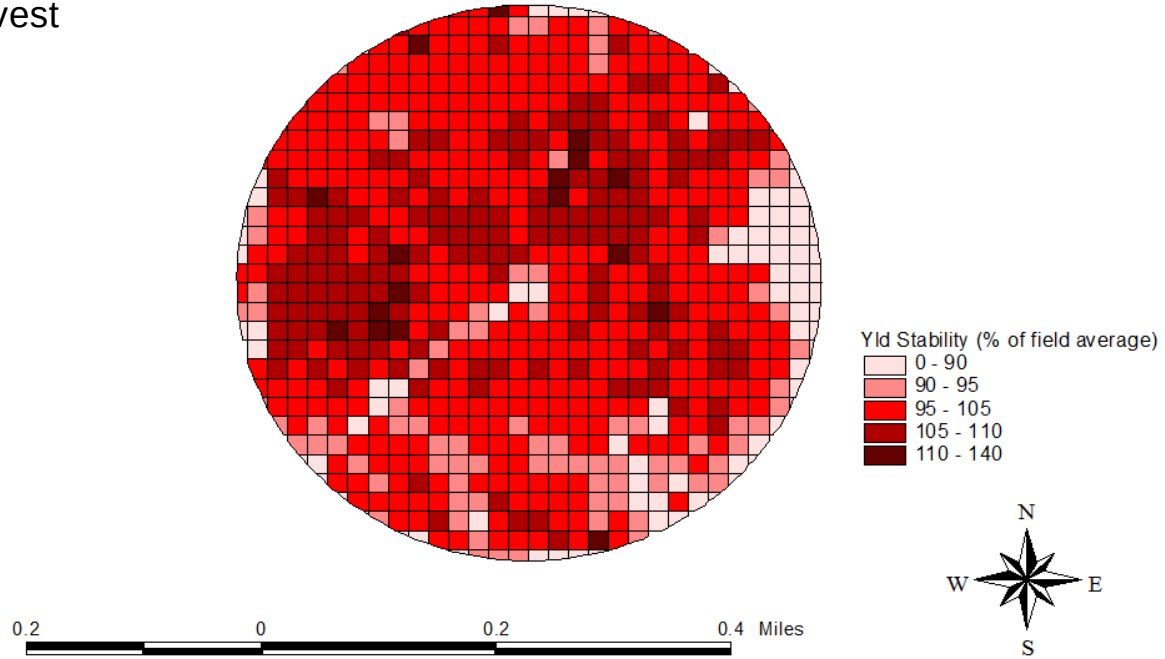
Yield Monitor



Rendel 2010 Harvest

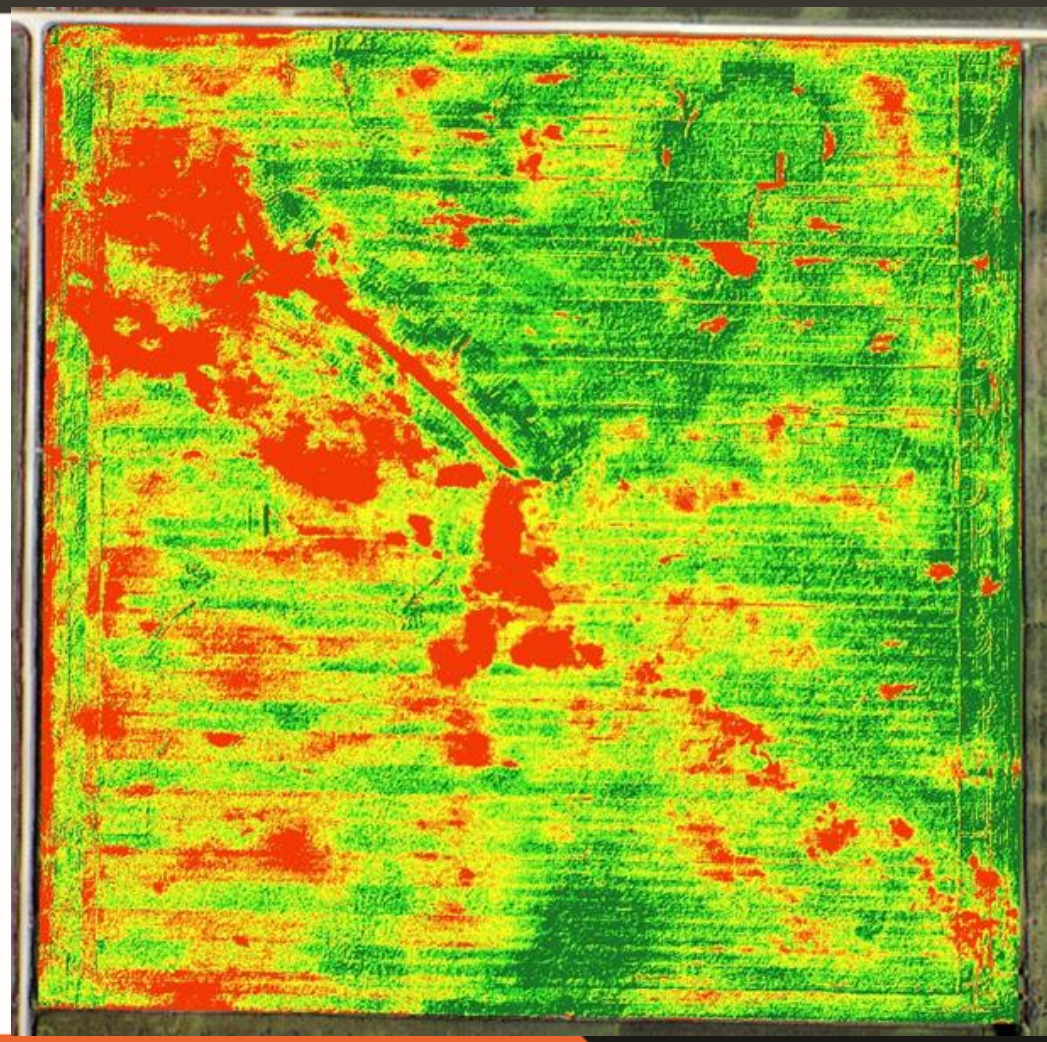
- 5 - 19.8
- 19.8 - 28.7
- 28.7 - 37.8
- 37.8 - 83.6
- 83.6 - 166.5

Field 3; Yield Stability 2006-2009



Biomass

- Biomass is a Proxy for Yield
- NDVI et al. is a Proxy for Biomass
- Therefore NDVI is a Proxy for Yield.
  - Understanding Bio -> Yield essential.



Yield By Soil

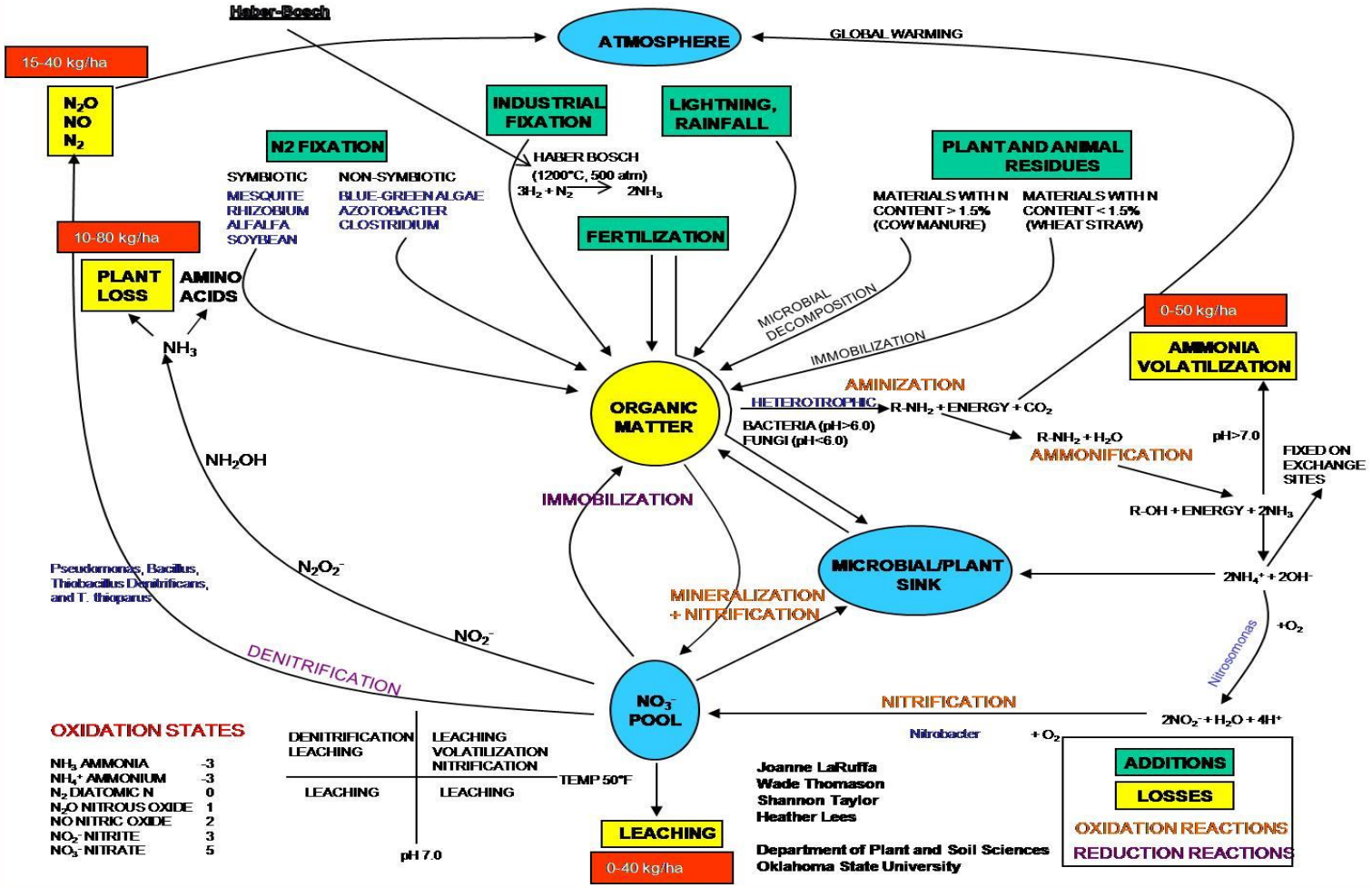
- Yield Potential determined by
  - OM
  - Texture
  - Soil type

Soil

- N_{Soil}
- Soil Test
  - Pre
  - In-Season
- Mineralization
- Losses
- N Addition and N Loss via Weather.

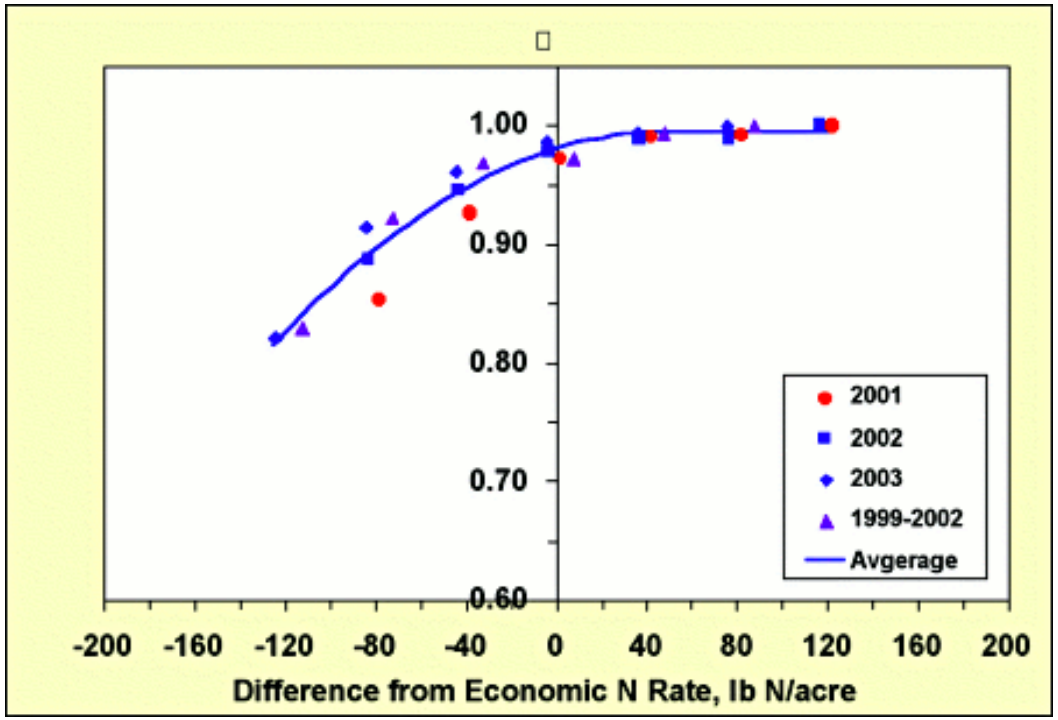
PPSTN | PSNT | ISNT

- Accounting for soil N levels before or after crop has been planted.
- One the first and most regionally successful attempt to conquer the Nitrogen cycle and mineralization.



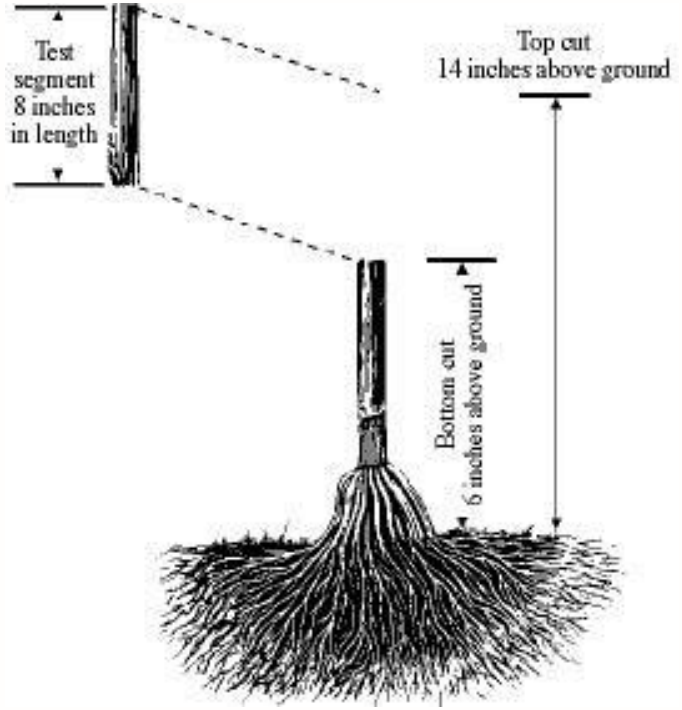
Chlorophyll

- Spad Meter
- Lets the Plant tell you about the Soil it sees.



Stalk Nitrate Test

- Post Mortem Evaluation. Check up of this year performance.
- Which is great, if the optimum N rate is consistent from year to year.



•Low = Less than 450 ppm nitrate-N = High probability that nitrogen is deficient
•Optimal = 450 - 2000 ppm nitrate-N = Yields are not limited by nitrogen
•Excessive = Greater than 2000 ppm nitrate-N = Uptake exceeds requirements

Models

- Encirca, Yield 360, AdaptN, FieldView Pro…..
- For the most part are looking at two variables.
- The deference may be how much priority is given.
- Growth Model, Heavily based on GDD.
- Soil Model, Heavily based on rainfall and temp.
- Most utilizing NOAA data.

Biomass Plus

- NDVI plus a Reference Strip.
- Yield + Soil (Environment)

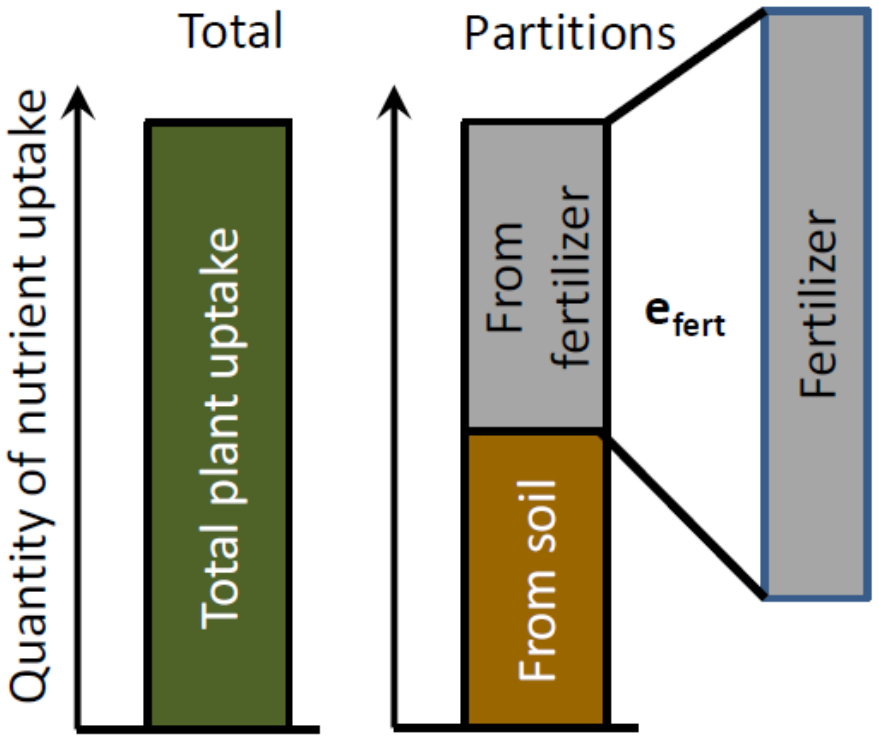
eFert

- *e*Fert
- 4Rs
  - Source
  - Placement
  - Time
  - Rate
- NUE –
  Lbs of N per Bushel?????
  - Consistent low v high?

Integration of Parameters

- Stanford Equation

$$N_{fert} = (N_{crop} - N_{soil}) / e_{fert}$$



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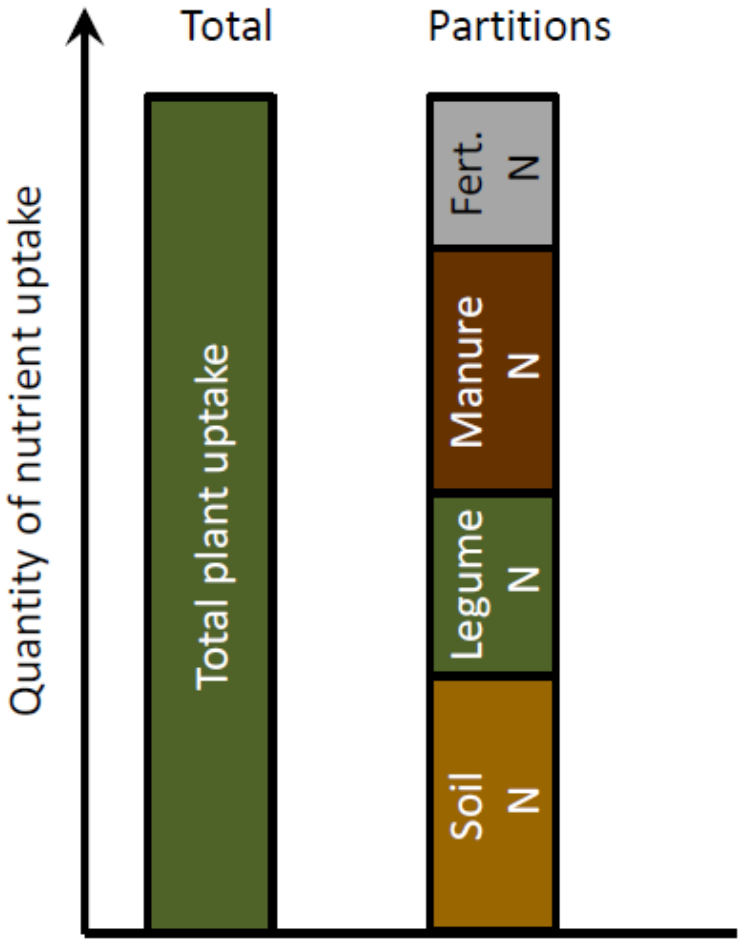
Ncrop and Nsoil

$$N_{fert} = (N_{crop} - N_{SIN} - N_{SON} - N_{CRN} - N_{manure\ RON} - N_{manure\ IN} - N_{manure\ ON} - N_{leg}) / e_{fert}$$

N_{fert}	= Total fertilizer N required
N_{crop}	= Total N in Crop
N_{SIN}	= Available soil inorganic N
N_{SON}	= Available soil organic N
N_{CR}	= Available crop residue N
$N_{manure\ RON}$	= Available manure residual organic N
$N_{manure\ IN}$	= Available manure inorganic N
$N_{manure\ ON}$	= Available manure organic N
N_{leg}	= Available legume N
e_{fert}	= Fertilizer N efficiency



What a theoretical N models look like.

$$N_{fert} = ([Yld \times N_{crop}] - [N_{SIN} \times e_{SIN} \times R_{SIN}] - [N_{SON} \times M_{SON} \times e_{SON} \times R_{SON}] - [N_{MRON} \times M_{MRON} \times e_{MRON} \times R_{MRON}]$$

$$- [N_{MIN} \times e_{MIN} \times R_{MIN}] - [N_{MON} \times M_{MON} \times e_{MON} \times R_{MON}] - [N_{LN} \times M_{LN} \times e_{LN} \times R_{LN}]) / e_{fert}$$

- Yield Records
- PPNT
- Soil Quality, **Weather, Models**
- Soil Quality
- **SOM Test, ISNT**
- Soil quality, **weather**, crop residues characteristics, tillage, **models**
- Manure application records & manure analysis
- Soil Quality, Weather, Tillage & characteristics of source, **Models**
- Soil Quality
- Manure application records & Manure analysis, PSNT
- Soil Quality, weather, manure application timing and method, **models, PSNT, sensors**
- Soil Quality
- Manure application records & Manure analysis **PSNT**
- Soil Quality, Weather, Tillage & characteristics of source, **PSNT, Sensors, Models**
- Soil Quality
- Assess Legume Stands
- Soil Quality, Weather, termination, Tillage, characteristics of the source, **Models**
- Soil Quality
- Source, Method, timing of fertilizer application Weather

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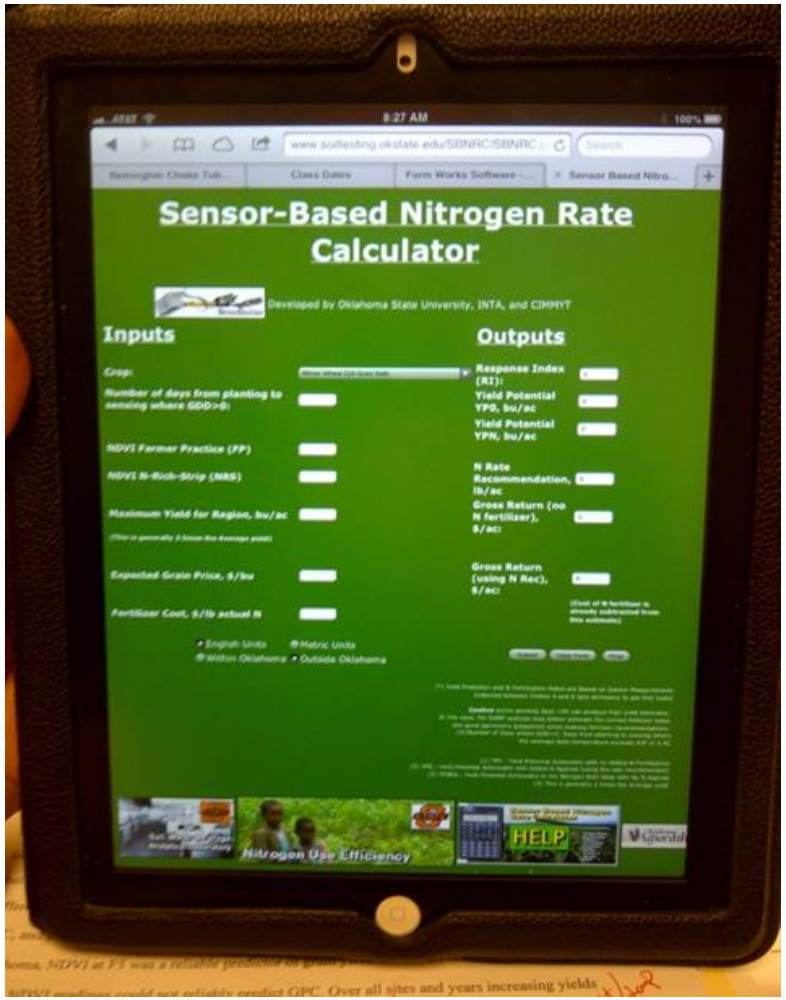
Integration of Approaches

- Ok State Optical Sensor.
  - YP RI model
- Yield by Soil by Weather.



Where is YOUR Opportunity

- N-Crop: Is you yield Temporally Variable? Spatially Variable?
- N-Soil: Do you have at least .5% OM and inconsistent Weather
- E-Fert - is your texture or landscape spatially variable?
- Can you adjust based on Management.

$$N_{fert} = (N_{crop} - N_{soil}) / e_{fert}$$

Nutrient Rich | Un-rich Strips

Article

Published December 22, 2016

Methods of making

variable-rate nitrogen

recommendations

While a variable-rate N strategy that works across all regions, landscapes, and cropping systems has yet to be developed, those methods that are capable of determining the three inputs of the Stanford equation while incorporating regional specificity will capture the greatest level of accuracy and precision. Earn 0.5 CEUs in Nutrient Management by reading this article and taking the quiz at www.certifiedcropadviser.org/certifications/self-study/811

By Brian Arnall, Nutrients for Life Foundation Professorship of Soil & Food Crop Nutrition, Precision Nutrient Management, Oklahoma State University, Stillwater

Precision ag focus

Link for full article at www.OSUNPK.com

Thank you!!!

Projects supported by the International Plant Nutrition Institute and the Oklahoma Fertilizer Checkoff Program.

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