Several Sensor Based N Rate Calculations exist.

There are two distinct approaches to N rate calculations.

- Use of Yield Prediction and Response
- Use of Response only
Algo 101

- This Workshop
- Will walk through the published Algorithms built by 5 institutions. All are used/available in Commercial systems.
- We are not going to compare specific N rates applied.
- We are going to look and the Metrics and Agronomics behind each.
Optical Sensor Values

- **NDVI**
  - Regardless of sensor is essentially a measure of biomass.
  - \( \text{NDVI} = \frac{(\text{NIR} - \text{VIS})}{(\text{NIR} + \text{VIS})} \)

- **Simple Ratio**
  - \( \text{SR} = \frac{\text{NIR}}{\text{VIS}} \)

- **Red-edge: Chlorophyll measurement**
Reflectance

Winter Wheat at Feekes 5 in potted soil

- 0 Nitrogen
- 100 lb Nitrogen/acre

Photosynthetic Potential

Measure of living plant cell’s ability to reflect infrared light

Reflectance

Wavelength, nm

400 500 600 700 800
Response

- Response is thought of in two ways.
  - RI: Increase above standard pre-plant high/low >1
    - Increase in yield due to N
    - RI 1.2, Expect an increase in yield of 20% w/ N
  - SI: Percent of high level low/high <1.0
    - Sufficiency of standard practice
    - Typically uses a Base N rate
    - SI of .75, Expected N need 200  FP = 150
- Can be calculated using NDVI or SR
Graph of SI

\[ SI = a_2 \cdot N^2 + a_1 \cdot N + a_0 \]

Figure from Holland and Schepers: 2010 Agronomy Journal.
Response

- Correlation between OSURI ndvi of RI Ratio

![Graph showing the relationship between RI-OSU vs Ratio(tar)/Ratio(ref)]

The graph shows a logarithmic relationship with the equation:

\[ y = 2.2491 \ln(x) + 0.7767 \]

with an R² value of 0.9995.
RI NDVI and RI Harvest

- A few of the groups have determined that the relationship RI of NDVI and RI of yield is not a 1 to 1 relationship.
- Therefore some algorithms use adjusted RI based on research. Calculation differs across crops and environments (great plains vs east coast).
N–Rich / Reference Strip

- **What**: A high rate of N applied in, across, through, over or under each and every field (NR).
- **How Much**: Rate significantly higher than standard practice (Farmer Practice FP).
- **How and Where**: 10 to 100 ft wide, anywhere representative.
- **Timing**: Crop and Environment specific
N–Rich / Reference Strip
Zero N Strip Low N

- Used in Several areas and algorithms.
RI calcs

- **OSU**: \(1.64 \times \frac{\text{NR}}{\text{FP}} + .5287\)
- **tOSU**: \(-1.5926 \times \frac{(1-\text{LN})/(1+\text{LN})}{(1-\text{NR})/(1+\text{NR})} + 2.6557\)
- **VT**: \(\frac{\text{NR}}{\text{LN}}\)

**Yield with N, YPN**

- **OSU**: \(\text{YN} \times \text{RI}\)
- **tOSU**: \(20 \times \exp(-.06 \times ((1-\text{FP})/(1+\text{FP})) \times \text{DFP}) \times 100 \times 2.2/56/2.47 \times \text{YP0}\)
- **VT**: \(3500 \times \exp((\text{FP} \times (\text{NR}/\text{LN})/\text{DFP})\)
Virtual RI

- Measurements from the greenest area of the field for N-Rich value
- Used with SI on On-The-Go sensors.

Yield with N YPN

- OSU YPN*RI
- tOSU 20*exp(-.06 *((1-FP)/(1+FP)) *DFP)* 100*2.2/56/2.47*YP0
- VT 3500*exp((FP*(NR/LN)/DFP)
OSU/Canada/KSU/LSU

- Uses Yield Prediction and RI (OSU) in ex.
- If (YP0*RI<YPNR, YPN*RI, YPNR)–YP0
  *56lb/bu * .0125 %N / .60%NUE
The OHIO State tOSU

- Uses Yield Prediction and RI(tOSU) LowN
- Min: (YP0*RI, Max Yld) – YP0
  *65*.0125/.60
Virginia Tech

- Uses Yield Prediction and RI(tOSU) LowN
- \( \text{Min}\ \{((0.0125/0.6) \times (YPN-YP0) + 100-PreN)), \}
- \([168-PreN}\}

\(100=\text{Sidedress Base Rate}\), \(168=\text{Max N.}\)
Sufficiency Index and Max N

Min ((Max N–SI)–Index Ceiling, Max N)
- Max N Changes by stage V6–V7 & V8–V10
- Index Ceiling change by sensor and stage

Min SI used in GS
UNL Solari

- Uses SI and Optimum N Rate
- Based on a Chlorophyll Meter Algo.
- $\text{Min}(317 \times \text{SPRT}(0.97 - \text{SI}), \text{OptN})$
Holland Sci

- SI, Delta SI, Nopt
- (OPTN–Npre–Ncred+Ncomp)*
  \[ \sqrt{\frac{1-SI}{\Delta SI \times (1+0.1\times e^{-\text{backoff} \times (SI_{\text{threshold}}-SI)}}} \]
  - Delta SI is .3+/- .1 or FP/RI
  - Backoff 0, 10, 20, 50. controls N dec w/ dec SI
    - Adjust based on ability of crop to recover.
  - SI threshold .7
Back off
None
Intermediate
Aggressive
References

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Thank you!!!

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