Proximal sensing for early detection of nitrogen deficiency in corn

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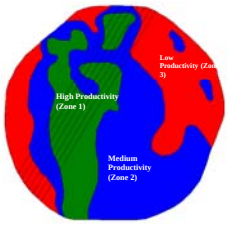
2nd GLOBAL WORKSHOP ON Proximal Soil Sensing

- Spatial and temporal variability in soils is well documented
- In the last decade, soil scientists have made significant progress in quantifying and characterizing spatial variability in soils using proximal sensing technologies

Management Zones

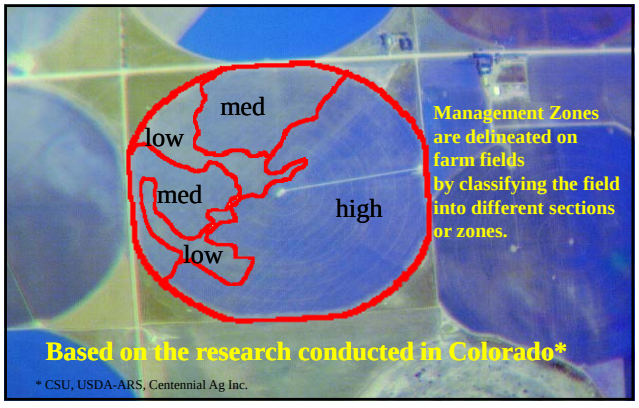
- Management Zones:
  A sub-region of a field that expresses a homogeneous combination of yield limiting factors
- In Colorado, we have developed four techniques of delineating management zones



Management Zones

Soil Zones...

I. Soil Color based Management Zones (SCMZ)



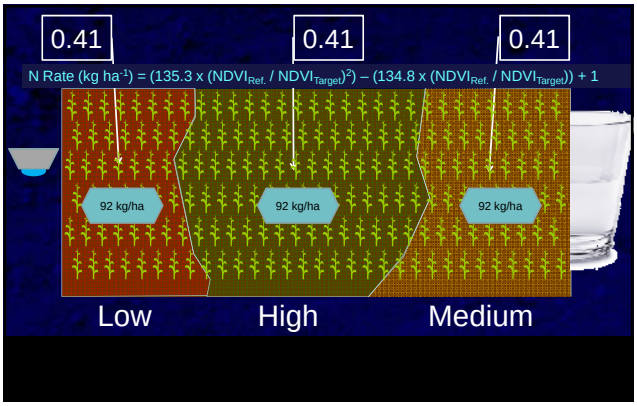
Soil Zones...

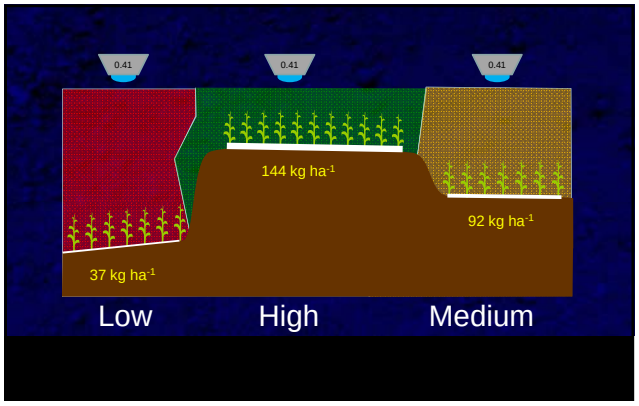
I. Soil Color based Management Zones (SCMZ)
II. Soil properties + past year's yield map based Management Zones (YBMZ)
III. Soil Electrical conductivity based (ECMZ)
IV. Smart sampling + remote sensing based (SSMZ)

Precision Nutrient Management Across Soil Zones...

- has shown to enhance:
  - (i) overall grain yield of the field,
  - (ii) nutrient use efficiency,
  - (iii) net $ returns to farmers and
  - (iv) reduces overall nutrient losses from the field.

What's the problem?





Soil Sensing + Crop Sensing

Soil sensing efforts must be coupled with crop sensing

- to make better and most efficient nutrient management decisions

Previous work with Proximal Sensors:

Holland Scientific Crop Circle:

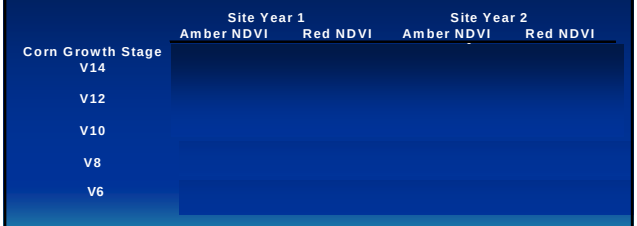
Amber NDVI
-Visible waveband = 590 nm
-Near infrared = 880 nm

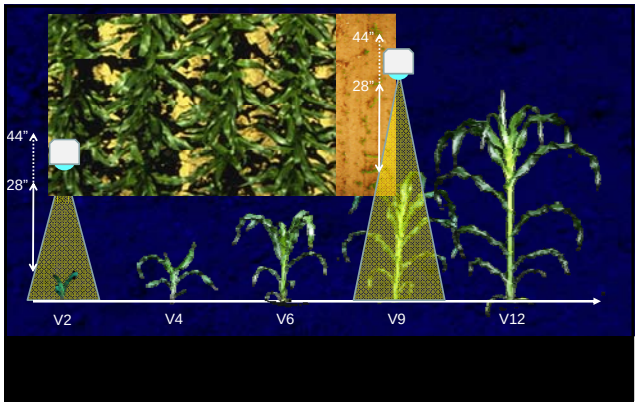
NTech Industries GreenSeeker:

Red NDVI
-Red visible waveband = 660 nm
-Near infrared = 770 nm

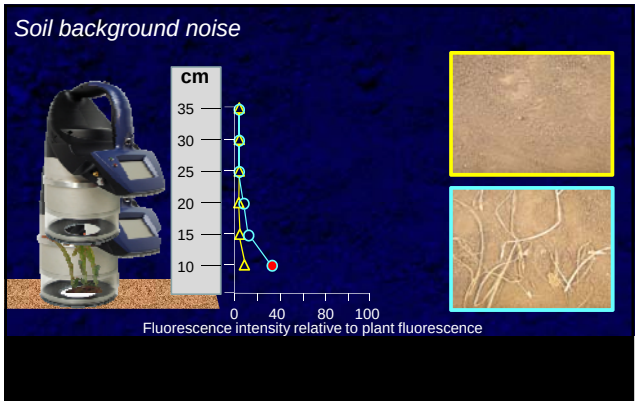
Visible ~ 400 to 700nm (G, B, R)
Near infrared ranges ~ 750nm to 1400nm

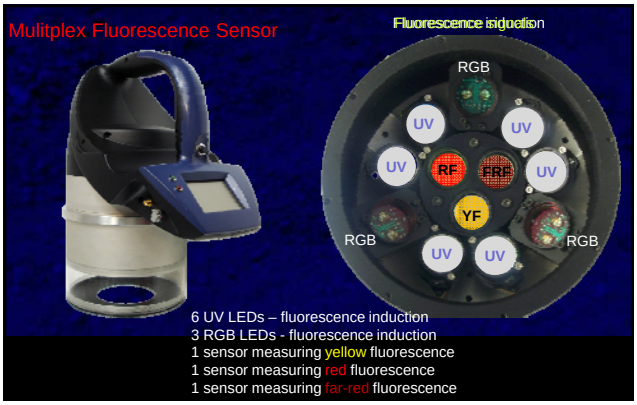
Amber and Red NDVI correlation with nitrogen application rates across site years.

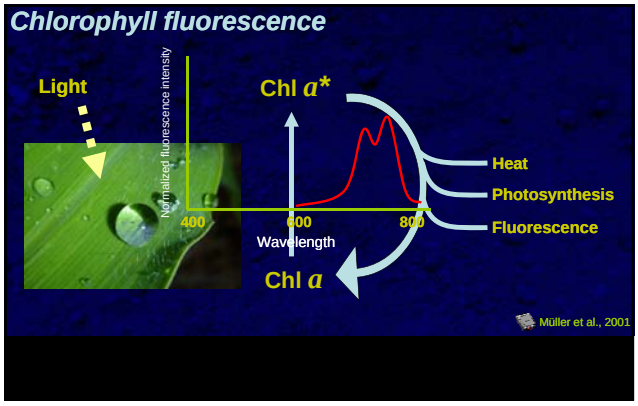


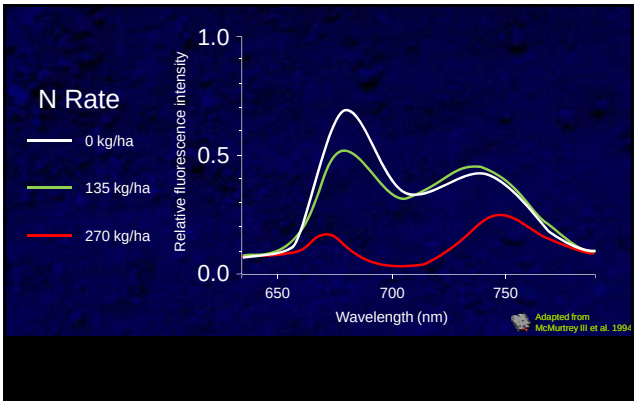

44"
28"
44"
28"
V2
V4
V6
V9
V12

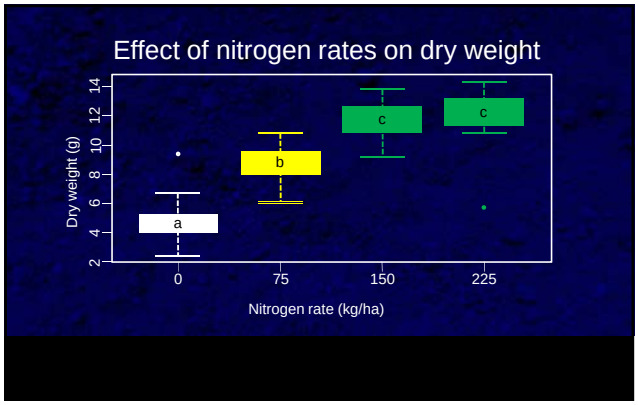

Mulitplex Fluorescence Sensor

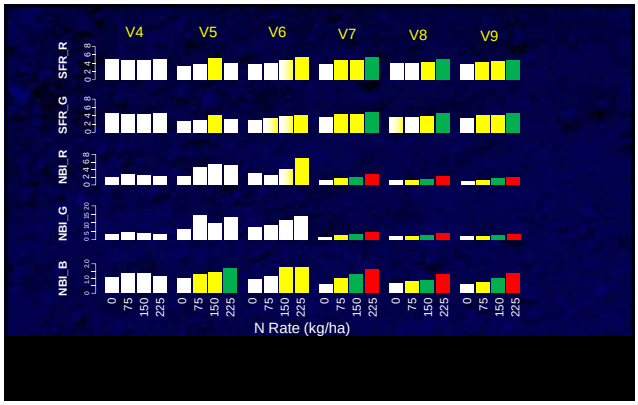

Soil background noise
cm
35
30
25
20
15
10
0
40
80
100
Fluorescence intensity relative to plant fluorescence


Mulitplex Fluorescence Sensor
RGB
UV
UV
UV
RF
FRF
UV
YF
RGB
UV
UV
RGB
6 UV LEDs – fluorescence induction
3 RGB LEDs - fluorescence induction
1 sensor measuring yellow fluorescence
1 sensor measuring red fluorescence
1 sensor measuring far-red fluorescence


Chlorophyll fluorescence
Light
Normalized fluorescence intensity
400
600
800
Wavelength
Chl a*
Chl a
Heat
Photosynthesis
Fluorescence
Müller et al., 2001


N Rate
0 kg/ha
135 kg/ha
270 kg/ha
Relative fluorescence intensity
1.0
0.5
0.0
650
700
750
Wavelength (nm)
Adapted from McMurtrey III et al. 1994





Summary

- Fluorescence based sensor has potential to detect early nitrogen deficiency in corn
- Soil background noise is minimal
- Coupling soil and crop sensing is important for precision nutrient management

Acknowledgement

- We want to acknowledge the support provided by Force-A company, France

Thank you