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Remote Sensing Contributions to Precision Agriculture

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Introduction

- Research Interests
  - Remote sensing instrumentation.
  - Bidirectional reflectance
  - Image processing
  - Agriculture and Forestry applications.
- University of Lethbridge and Remote Sensing.
- Positioning Alberta for the knowledge economy.

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Outline

- Remote Sensing Definitions.
- Challenges.
- Contributions to Precision Agriculture.
- Solutions?

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Remote Sensing – a few definitions

- Looking but not touching…information from a distance.
- Satellite and airborne methods.
- Mostly reflected sunlight…occasionally emitted heat.
- Reflectance is a ratio computed by dividing how much energy is reflected by the surface by how much is available.
- So what colour are plants?

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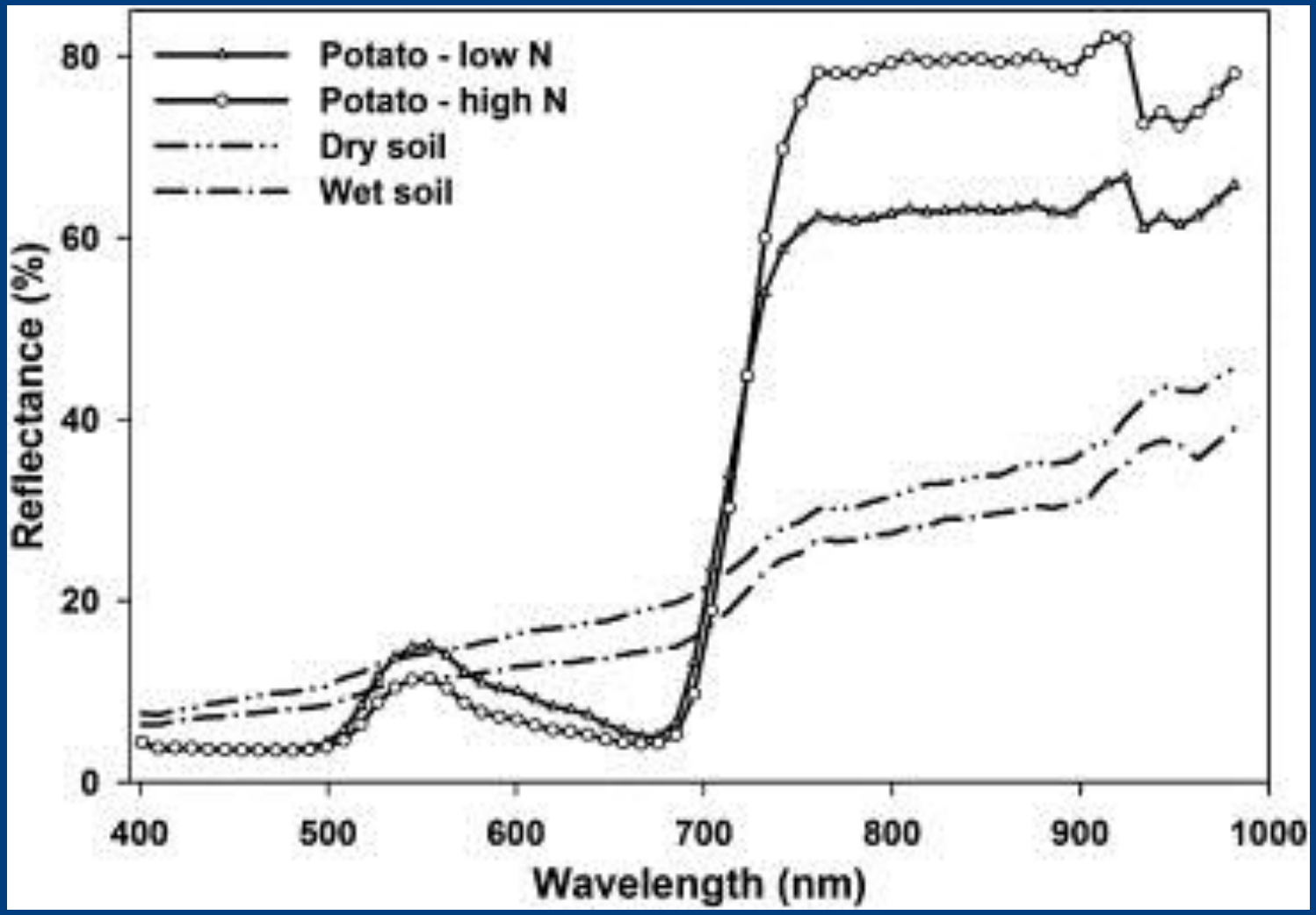
Reflectance



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Contributions

- Applications characterized by sensor spatial resolution from regional to plant-level.
- Temporal resolution improving from space – techniques for airborne are getting better.
- Long list: Crop yield and biomass, nutrient and water stress, weeds, insects, soil properties.

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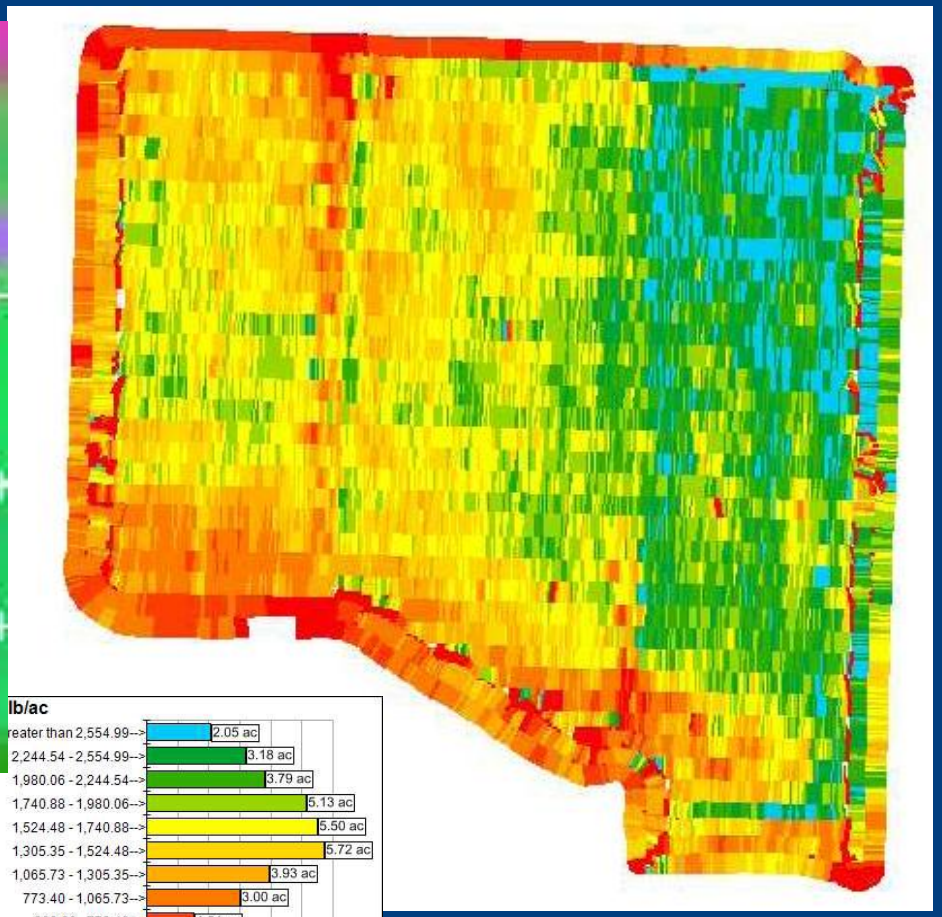
Durum Yield



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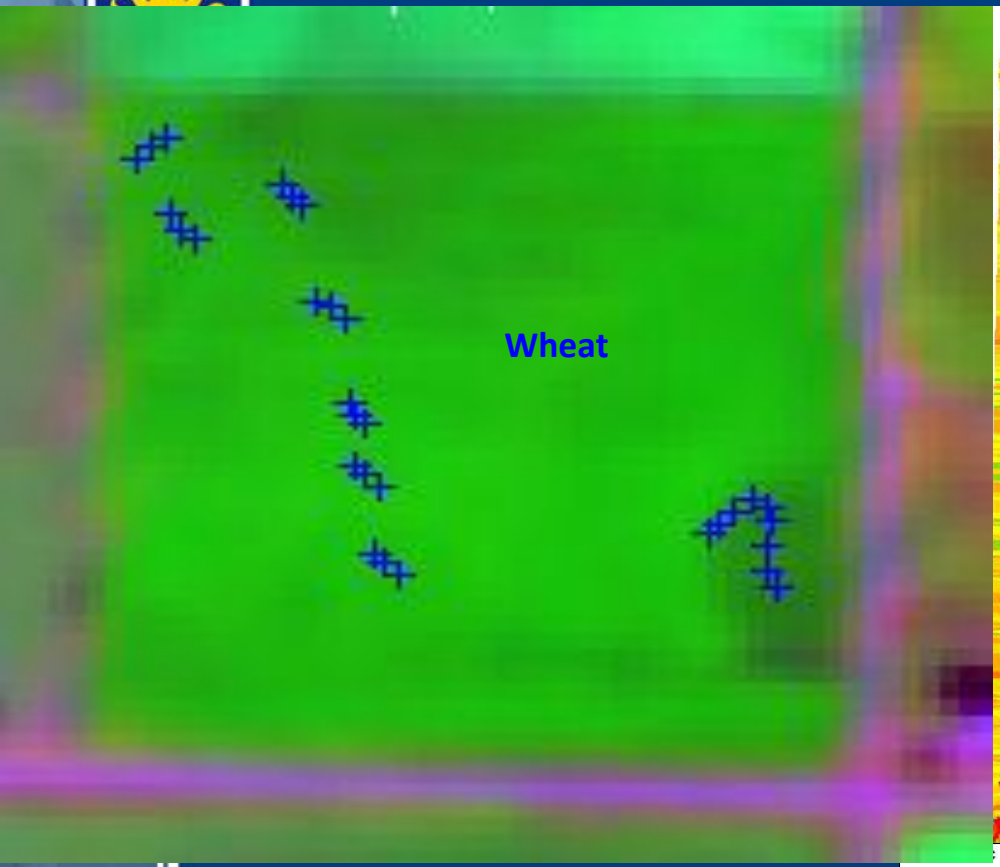
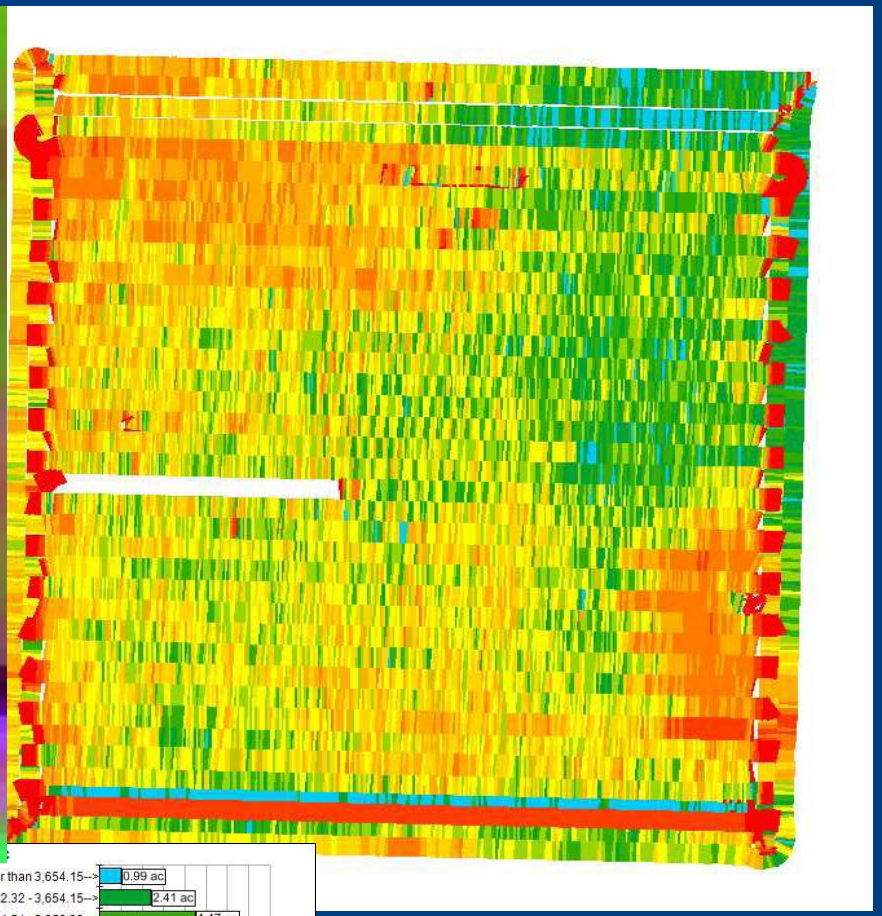
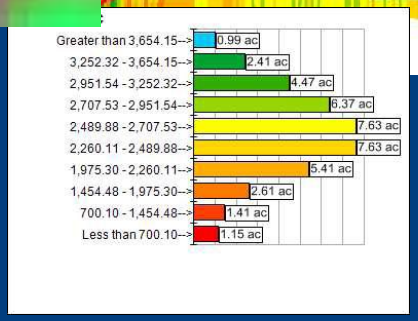
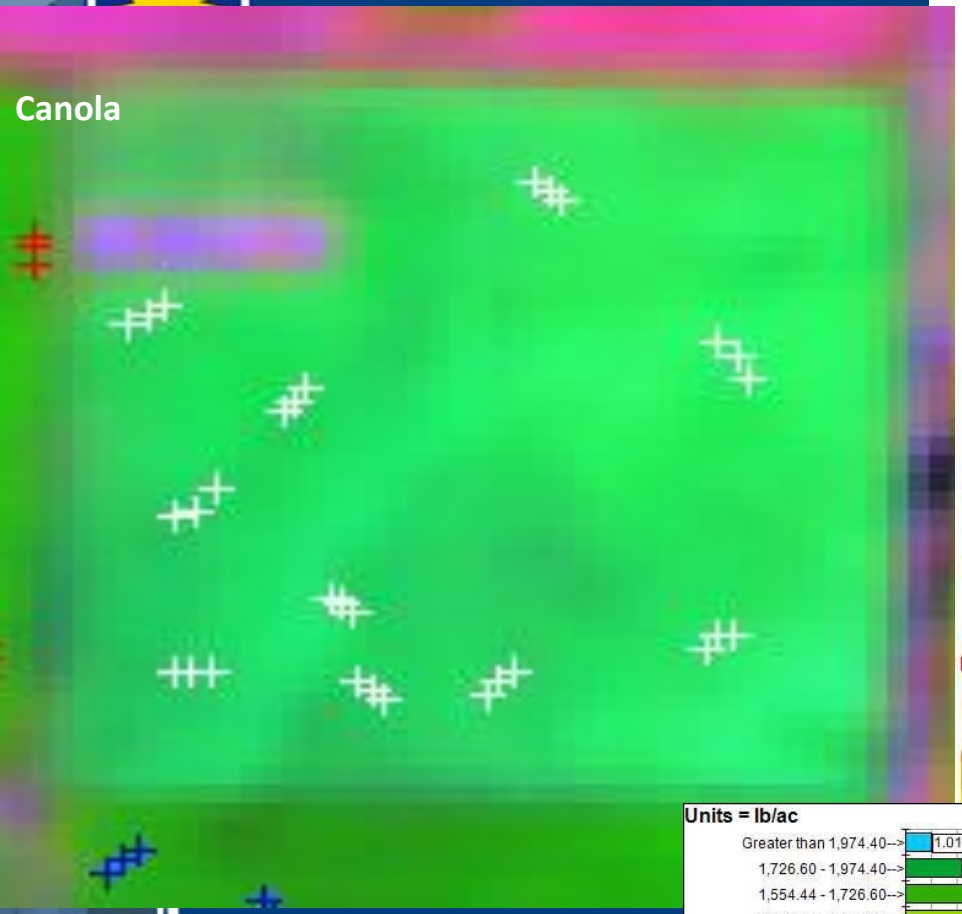
Wheat Yield

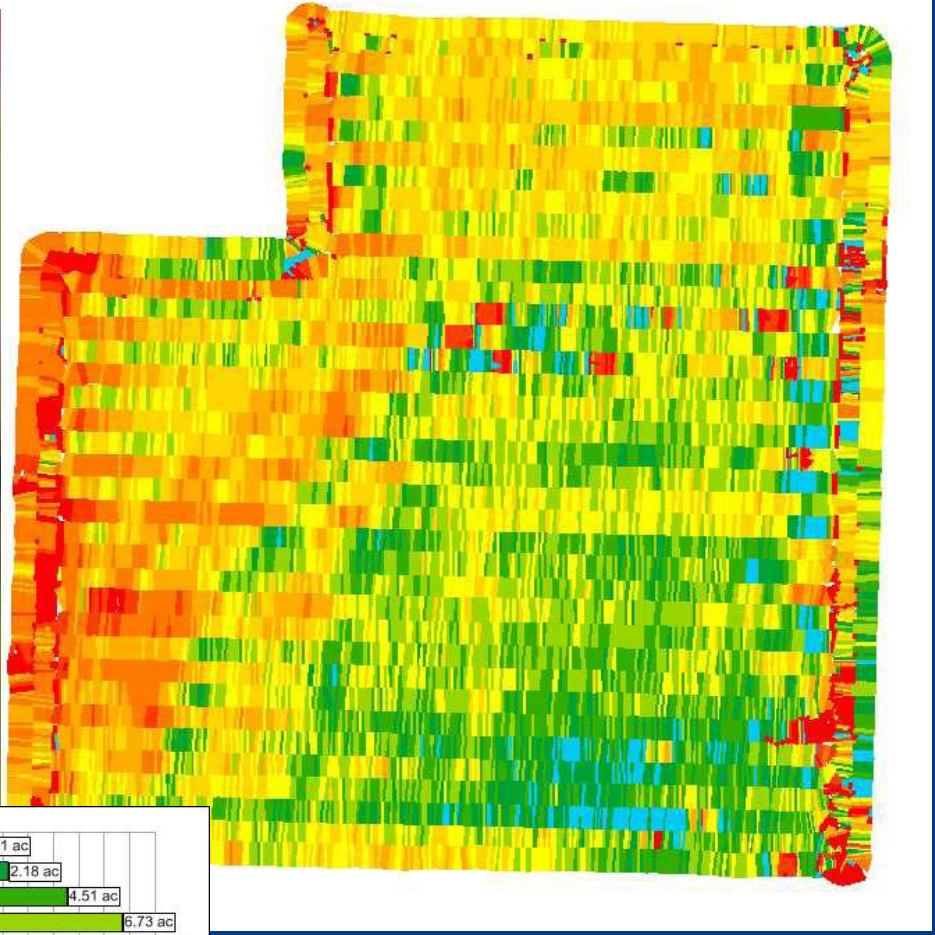


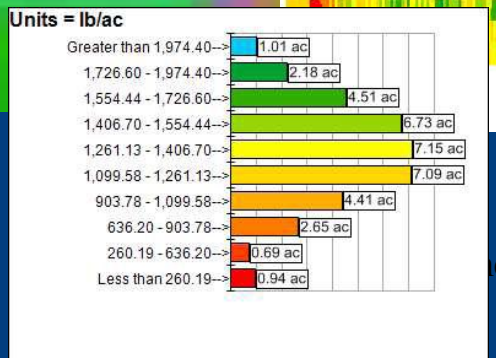




Canola Yield







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Canopy-Reflectance Interaction

- What does an airborne/spaceborne sensor measure?
  - More than a single leaf – multiple leaves, shadow, multiple vegetation layers, stems, twigs, branches, non-vegetated (background) materials (e.g., soil, water,etc.).
  - Complex targets are difficult.
- The more uniform the target, the higher the confidence in the response.

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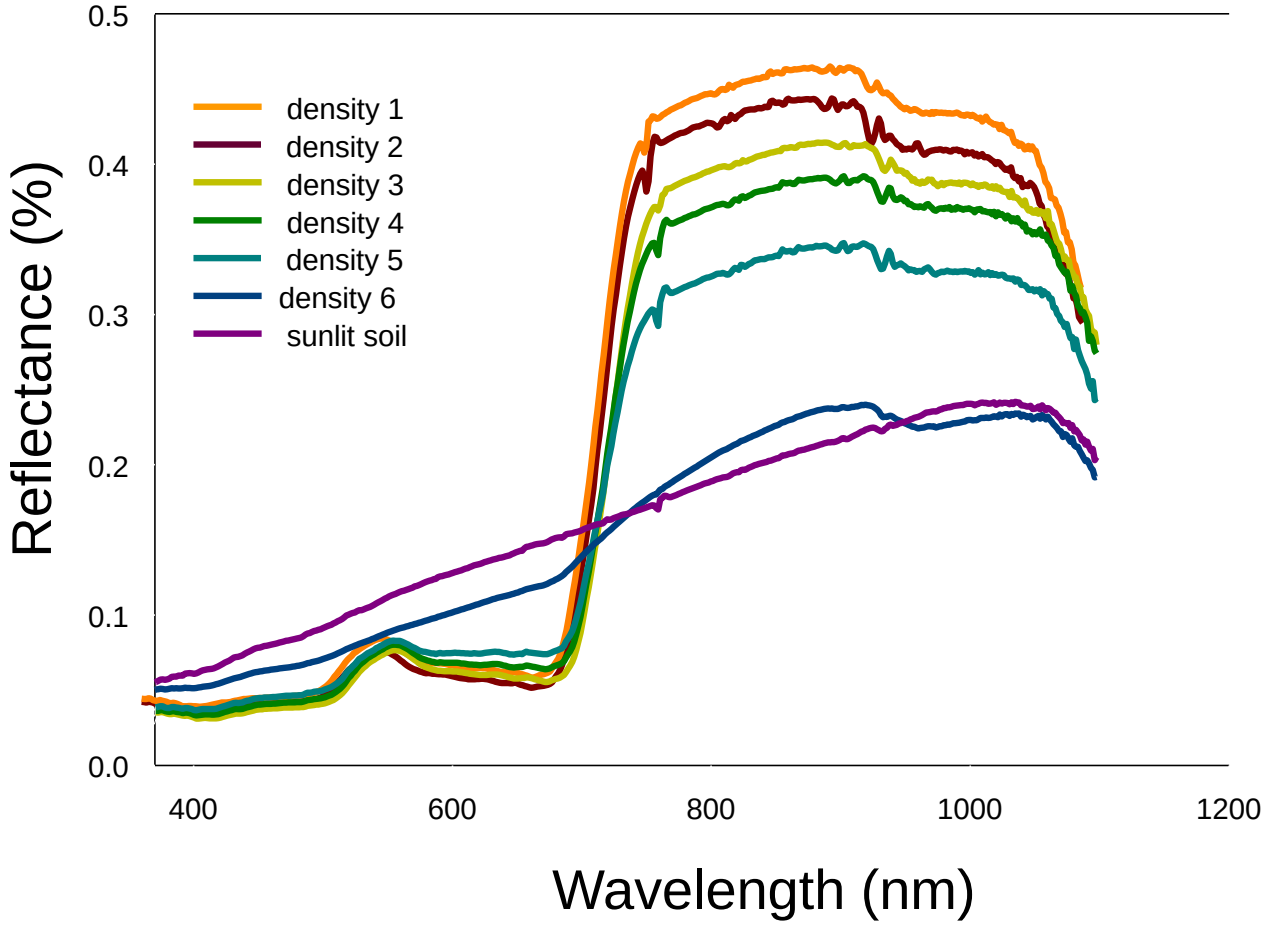
Impact of Density on Reflectance



Density 1: 100 %
Density 2: 80 %
Density 3: 60 %
Density 4: 40 %
Density 5: 20 %
Density 6: 0 %

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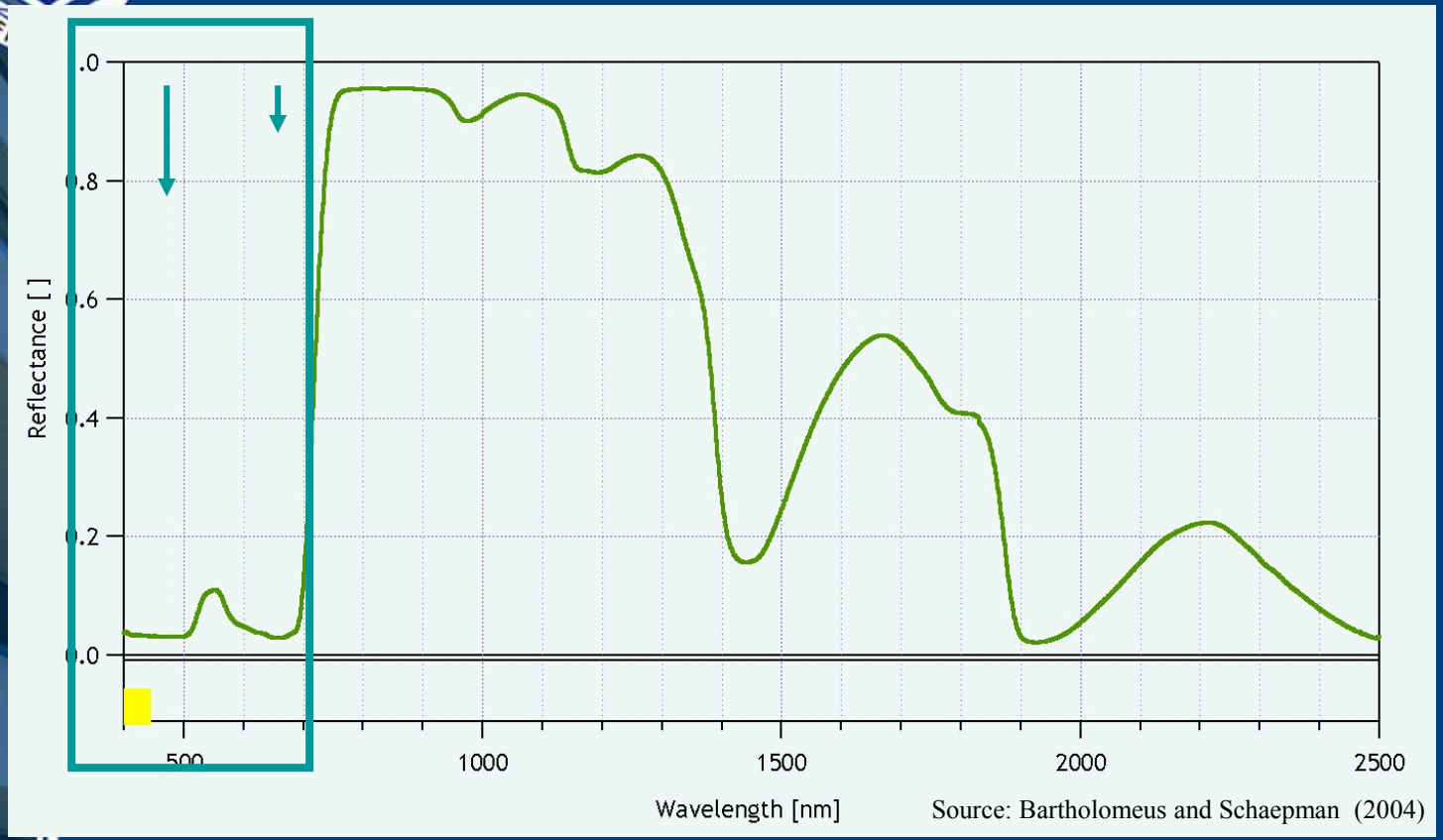
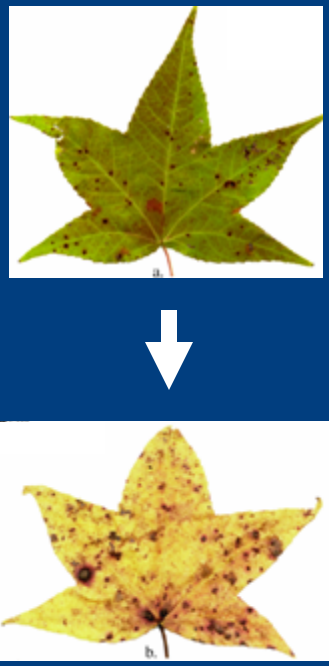
Leaf Pigments

- Impact of decrease in chlorophyll on reflectance





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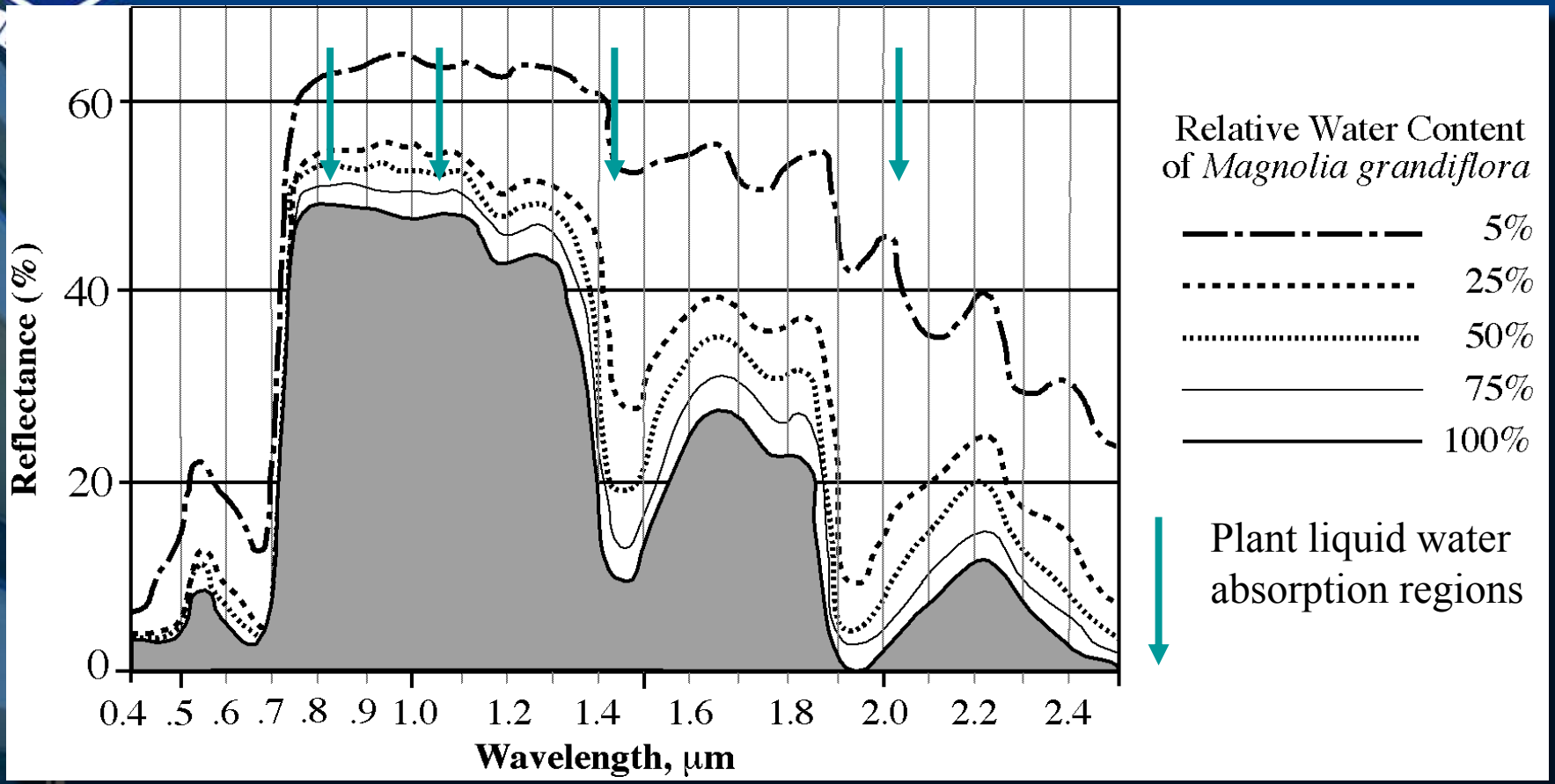
Water content in leaves on reflectance



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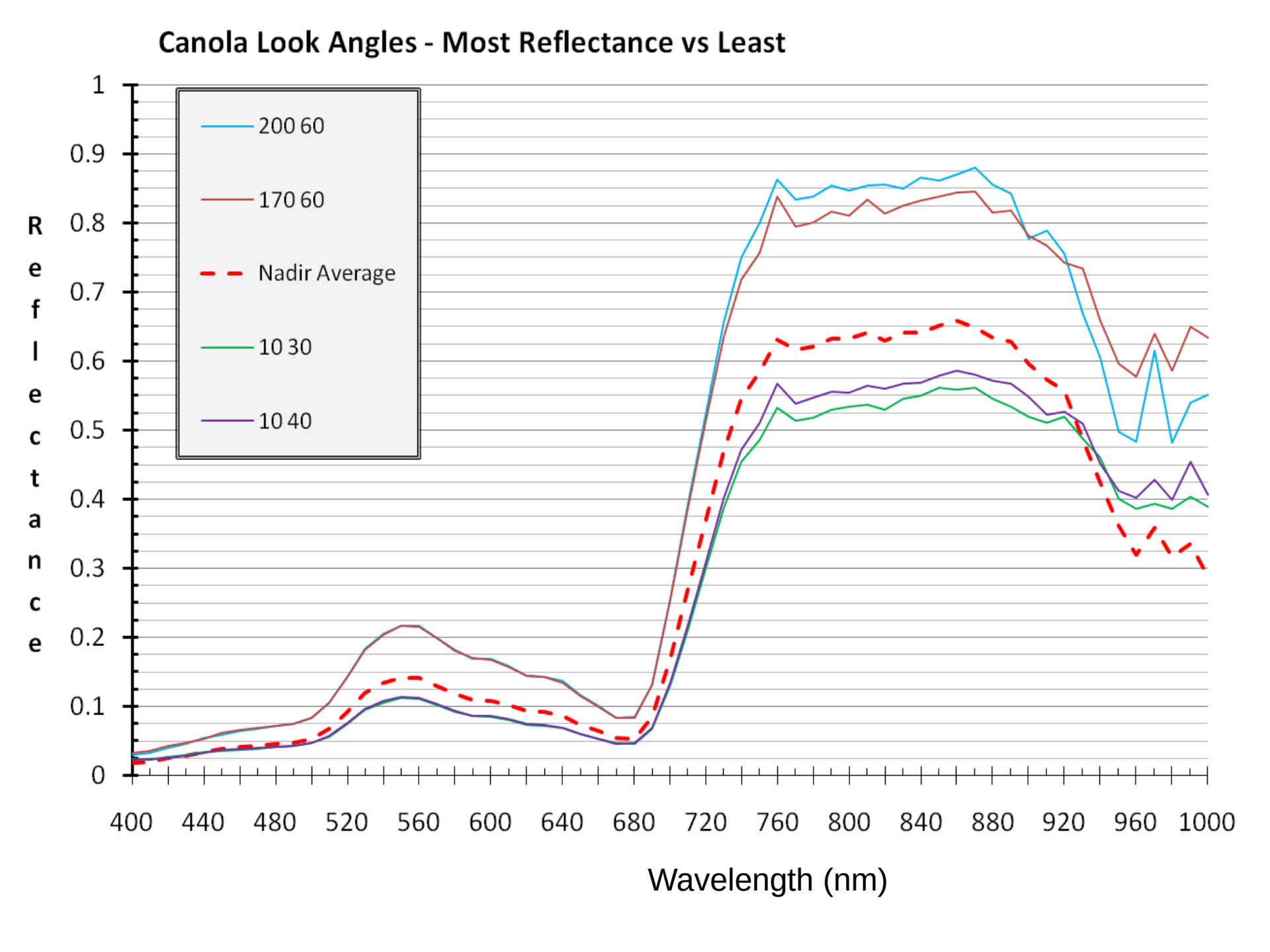
Knowledge Gaps

- Precision farming needs vast quantities of high quality data to assist with informed decisions.
- Real-time applications are severely challenged by confounded variables.
  - Keep it simple…but not too simple.
- More data options exist…but are they calibrated and reliable?
- Cost – it has to make sense and cents.


Canola Look Angles - Most Reflectance vs Least
200 60
170 60
Nadir Average
10 30
10 40
Reflectance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
440
480
520
560
600
640
680
720
760
800
840
880
920
960
1000
Wavelength (nm)

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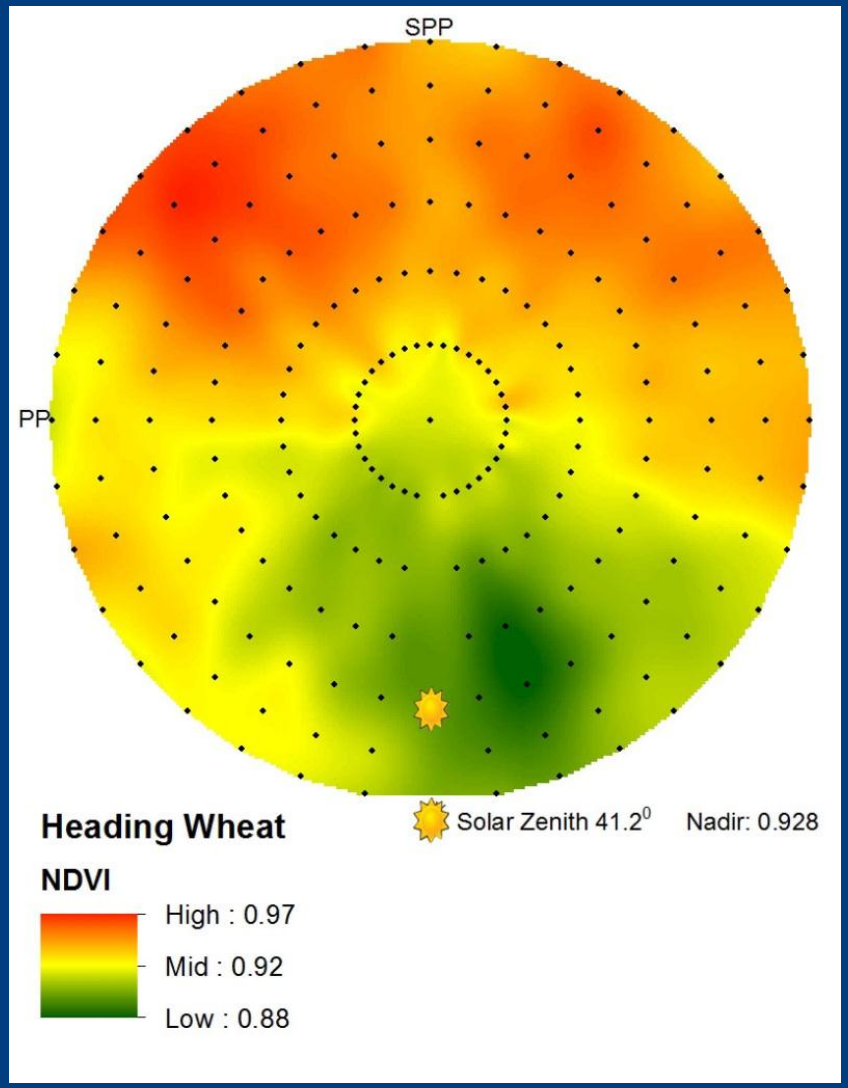
NDVI



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Issues

- Quantitative remote sensing requires that the thing measured be consistent.
- What are we measuring?
- Can we measure it?
- Biophysical/Biochemical relationships.
- Measured using RS data using ratios of reflectance.
- Vital information.

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Solutions?

- Most RS works best when resolutions (spatial, spectral, temporal and angular are limited).
- If we understand what we are sensing – then it is possible to extract the right information for the correct use.
- Remove the effect of directionality if estimating crop type.
- NDVI.
- Retrieve structural parameters from inversion if measuring biomass, plant cover, density, etc.

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Horizons

- We are continuing to study the effect that view angle has on image information content.
- There is additional biophysical information in the angular data
  - Structure, density, height etc.
- More instruments are in development.
- Good research yields as many questions as answers.

Questions?

Field Photos

Field Pea

LAI = 2.79

Wheat

LAI = 3.4

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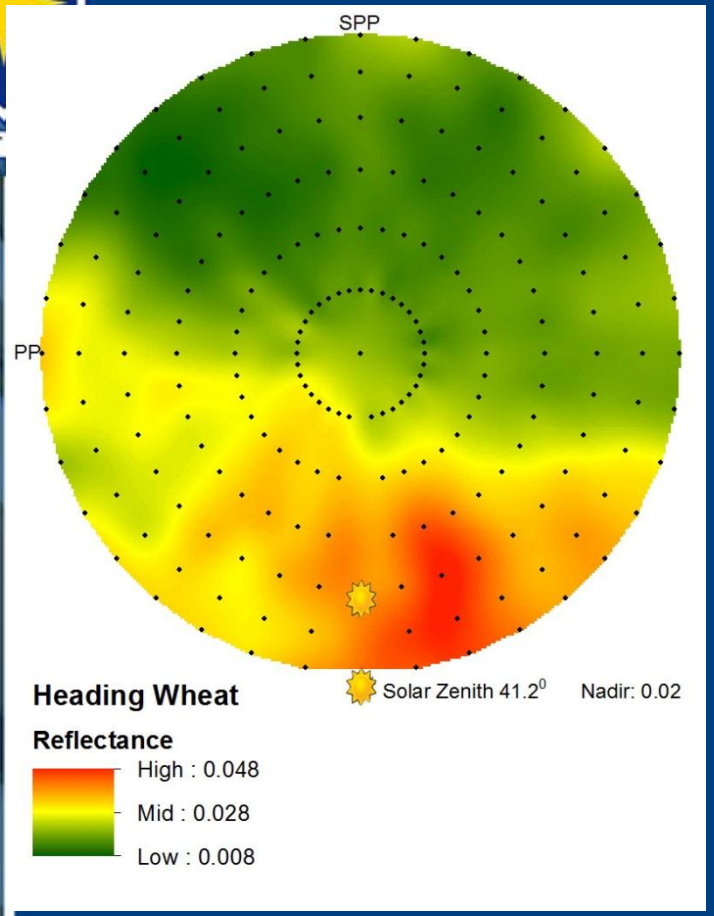
Reflectance 670nm



- SPP
- PP
- Asymmetry
- Symmetry

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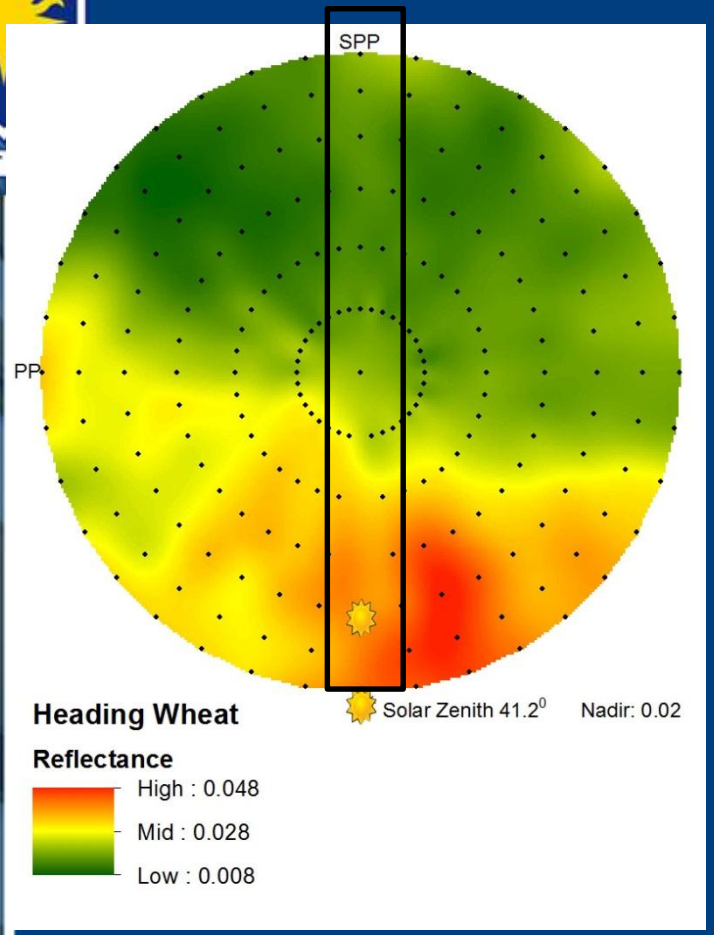
Reflectance 670nm



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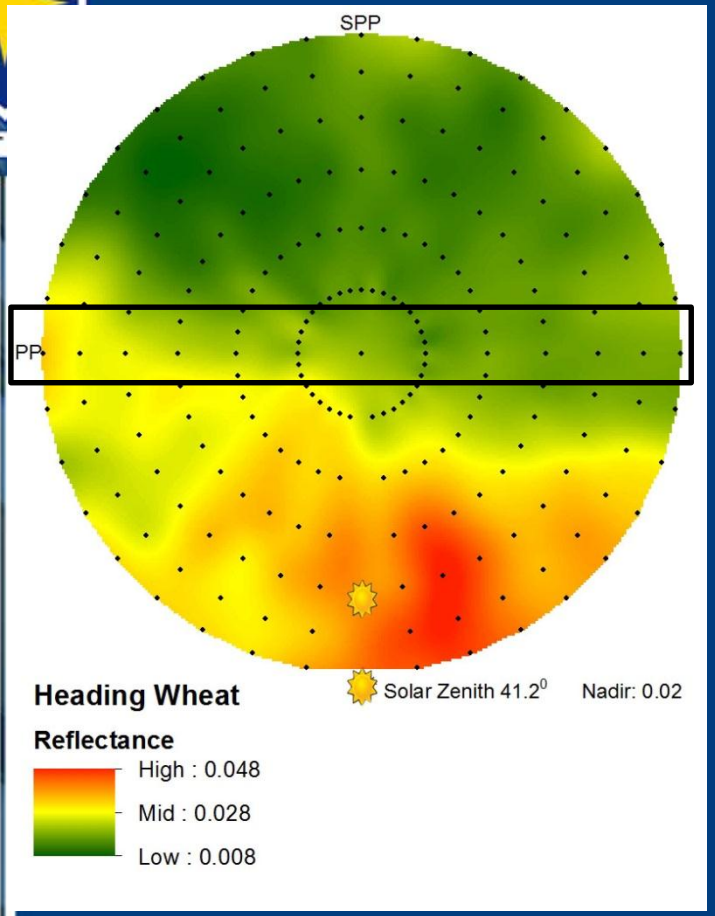
Reflectance 670nm



- SPP
- PP
- Asymmetry
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ANIF 870nm