Precision application of nitrogen

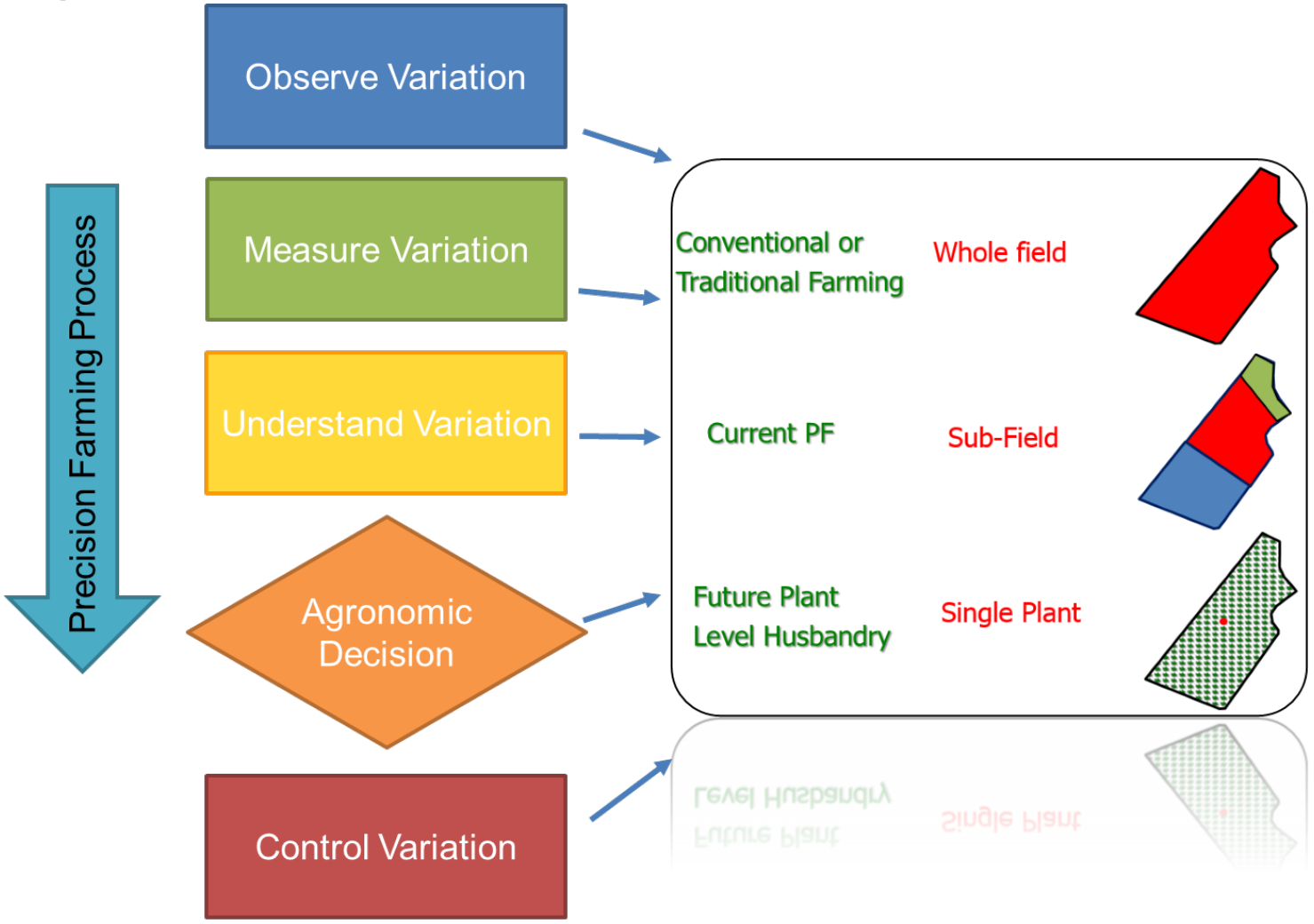
Kit Franklin
Senior Lecturer - Agricultural Engineering
Principal Investigator – Hands Free Farm

Precision Agriculture

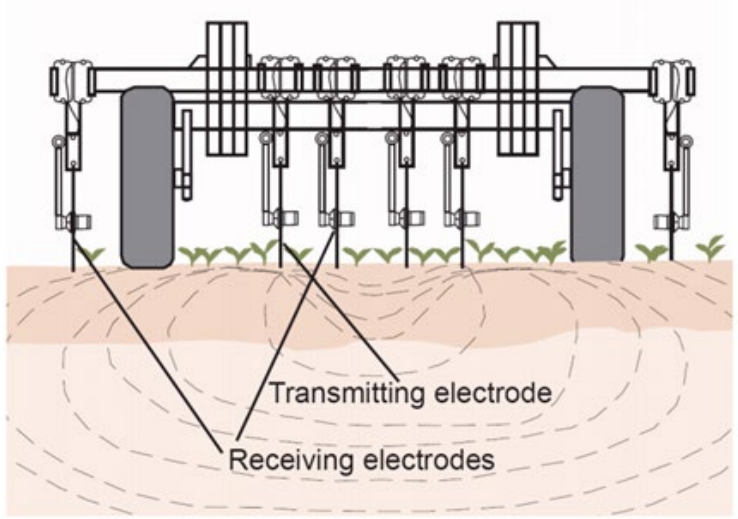
Managing variation:

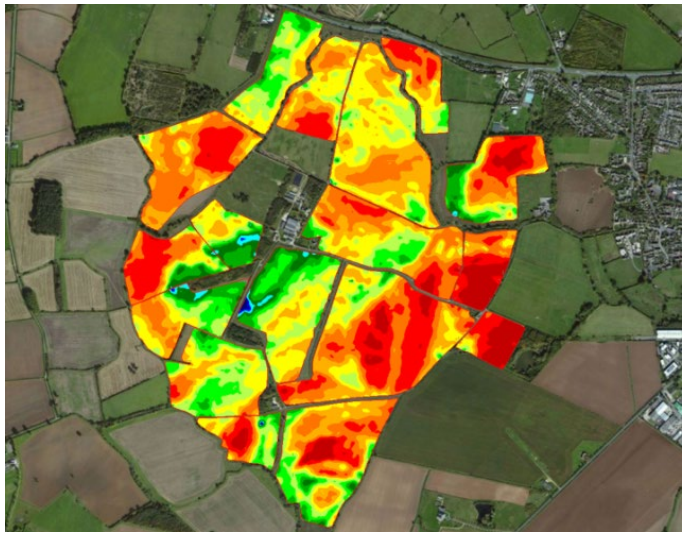
- Right Thing
  - Right amount
- Right Place
- Right Time
- Right Way

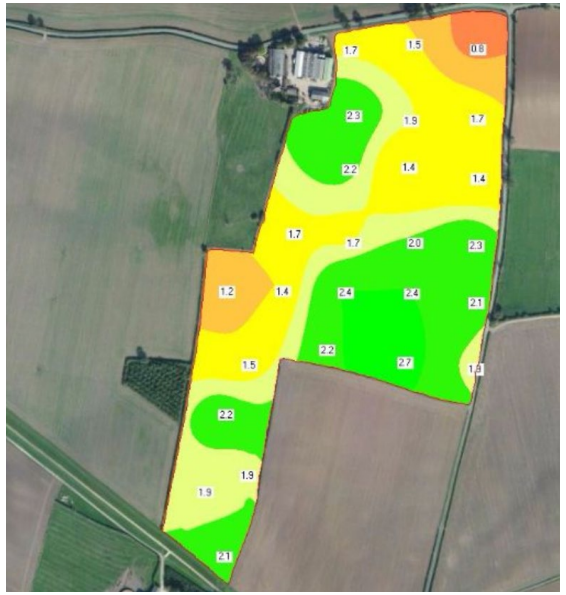
Minimising inputs & increasing sustainability: Environmental, economic and social

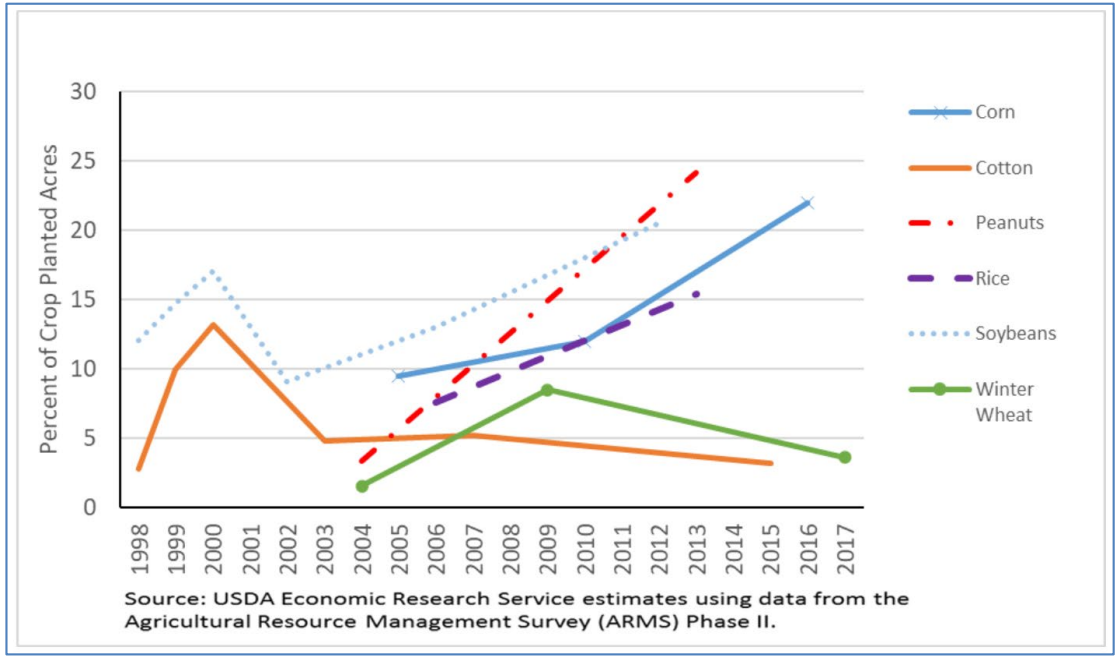


Background information – soil maps



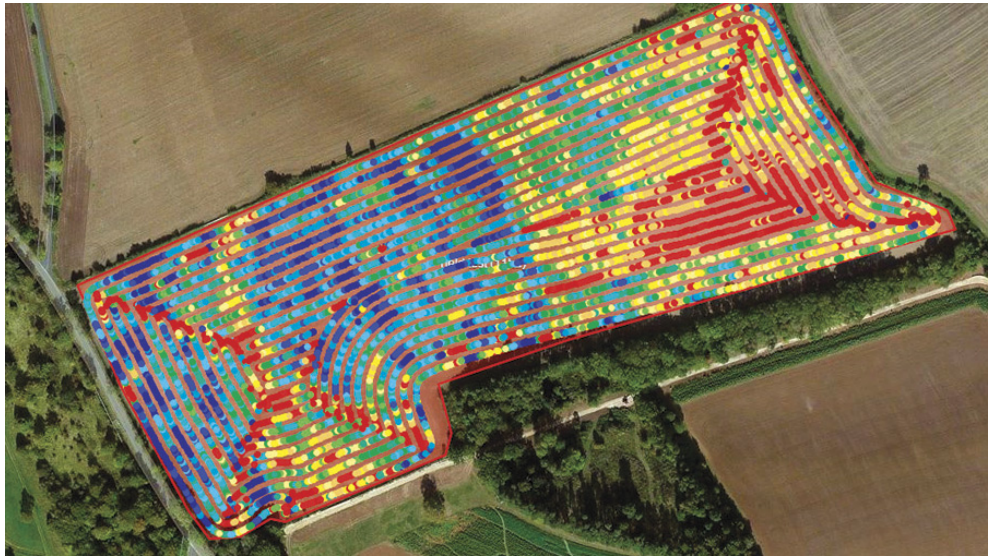


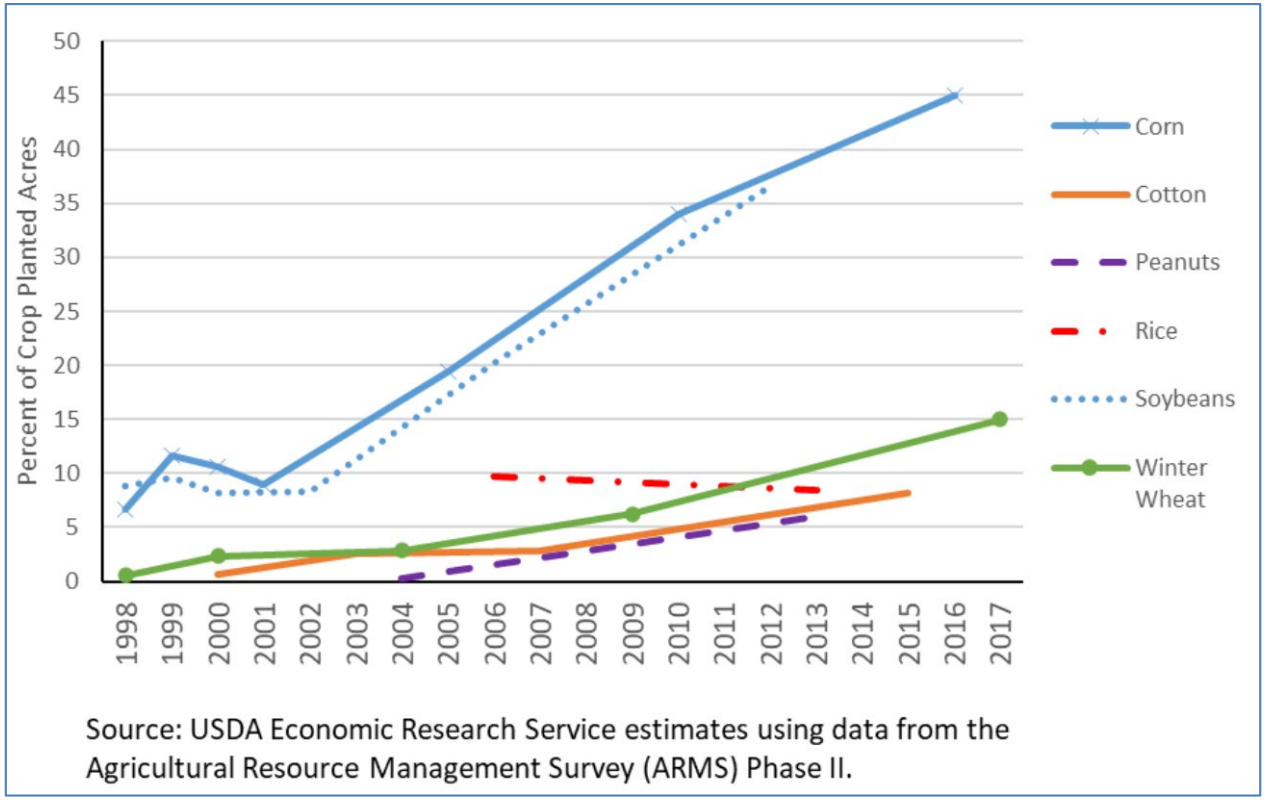




Source: Farm Types and Precision Agriculture Adoption: Crops, Regions, Soil Variability, and Farm Size - Global Institute for Agri-Tech Economics

Background information – yield maps





Source: Farm Types and Precision Agriculture Adoption: Crops, Regions, Soil Variability, and Farm Size - Global Institute for Agri-Tech Economics

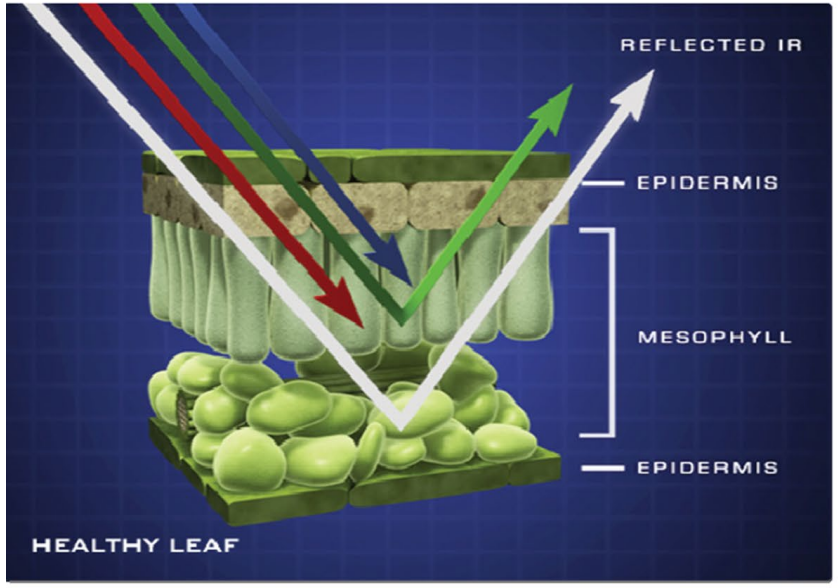
In growth sensing – fundamentals

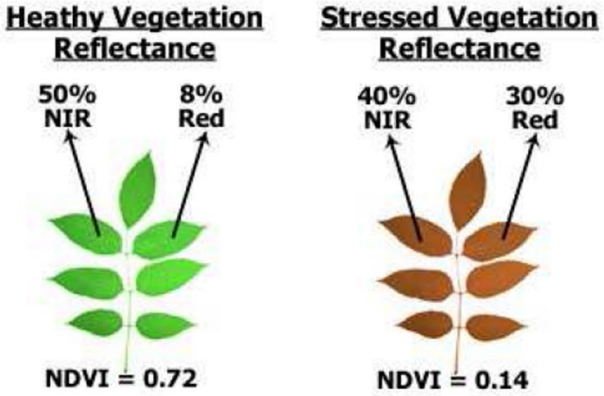
Utilising multispectral sensors to capture pixel images of specific non visible electromagnetic wavelengths.

Non visible spectral response can then manipulated to identify growth trends.

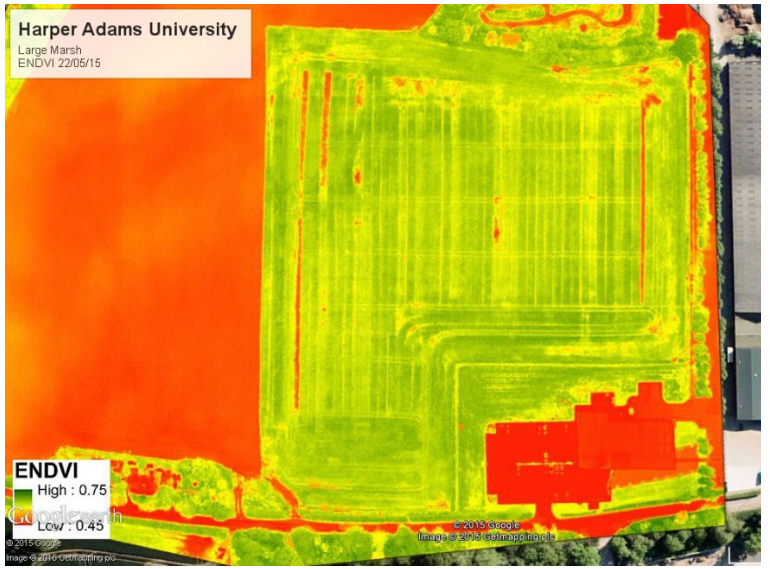
Trends are often plotted as images using “false” colour scales.

NDVI uses Red and Near Infrared to create a 0-1 scale of “health”





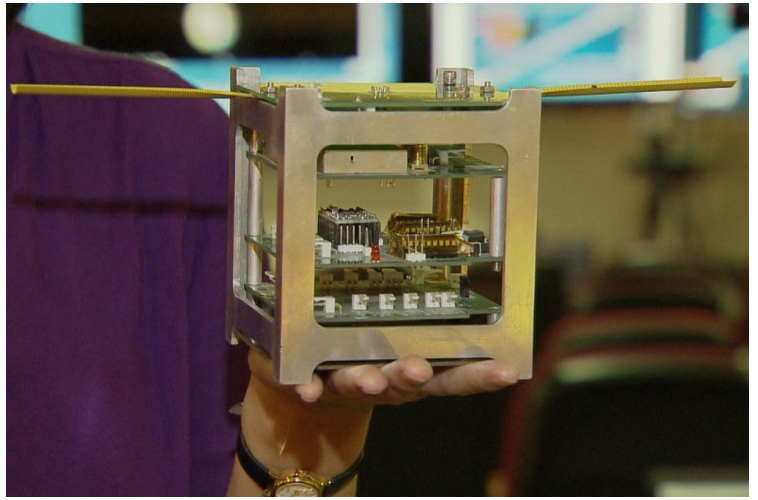
$$NDVI = \frac{NIR - Red}{NIR + Red}$$



Satellite sensing

- Full field cover
- No extra work load
- Multispectral capability
- Limited resolution – 10m
- Limited images available

  satellite passes – 10 days x2 - clouds
- Radar developments to measure crop density/height through clouds
- New “cube” satellites promise improved coverage



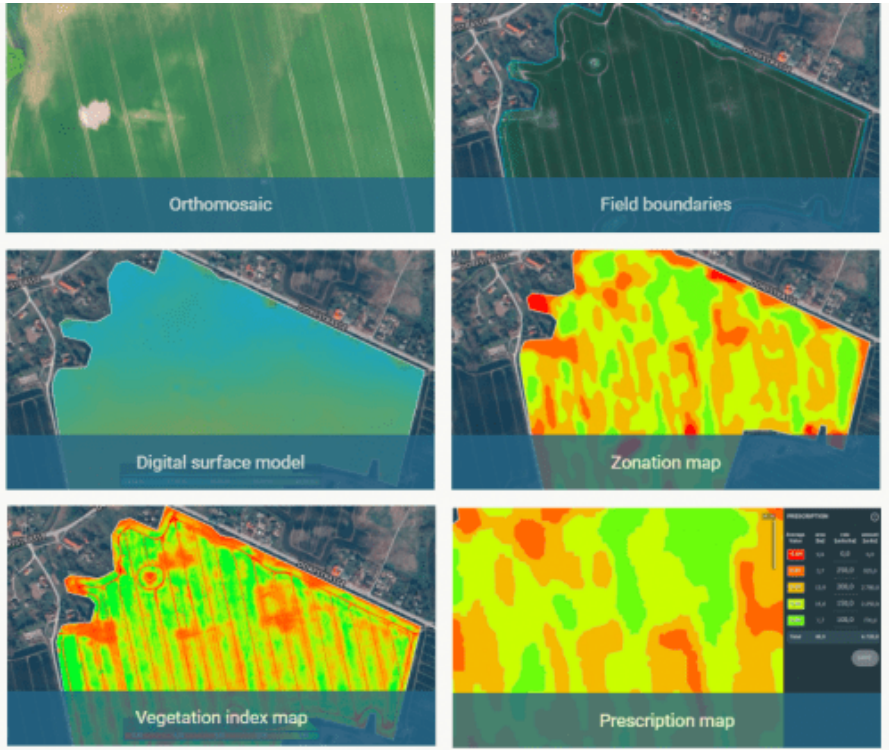
USA retail: 67% have access to Satellite/aerial imagery for internal dealership purposes

USA adoption: estimated 31% of land area is managed using Satellite or Aerial Imagery

Source: 2020 PRECISION AGRICULTURE DEALERSHIP SURVEY - Purdue University

UAV & Drone sensing

- Increased resolution <10mm possible
- Images when wanted
- Sub cloud cover operation
- Extra work load
- Legislation and licencing
- Large amounts of data to process (80% overlap)
  - Significant improvements made
- Cost c£5500



USA retail: 42% have access to UAV or drone for internal dealership purposes

USA adoption: estimated 12% of land area is managed using UAV or Drone Imagery

Source: 2020 PRECISION AGRICULTURE DEALERSHIP SURVEY - Purdue University

Tractor mounted sensing

- On the Fly rate adaption
- No extra work load
- Low coverage – in relation to boom width
- Average of current viewpoints
- Low resolution output – boom width
- **N savings** of **c10%** from case studies
- Research shows marginal yield increase 2-4%
- UK costs: £23k or c£4k annual subscription
- UK sales c250

USA retail: 13% have access to Chlorophyll/greenness sensors mounted on a pickup, applicator or tractor

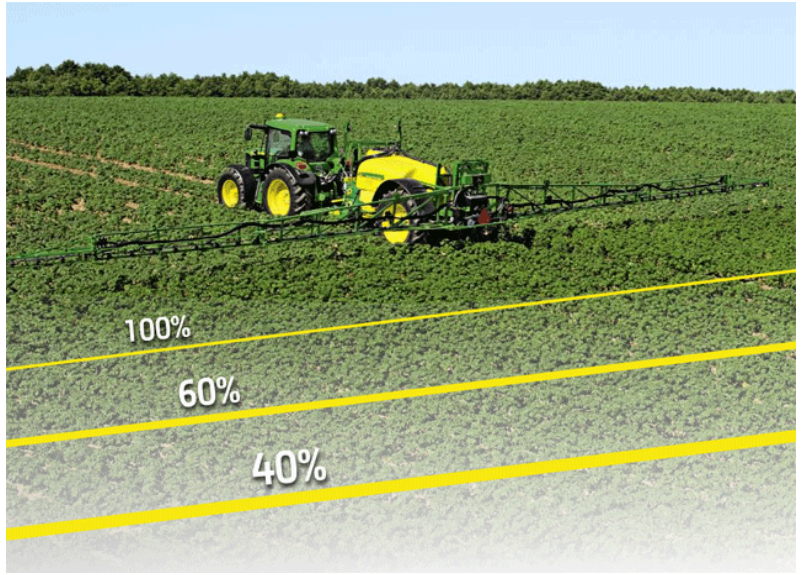
USA adoption: estimated 5% of land area is managed using Chlorophyll/Greenness Sensors for N Management

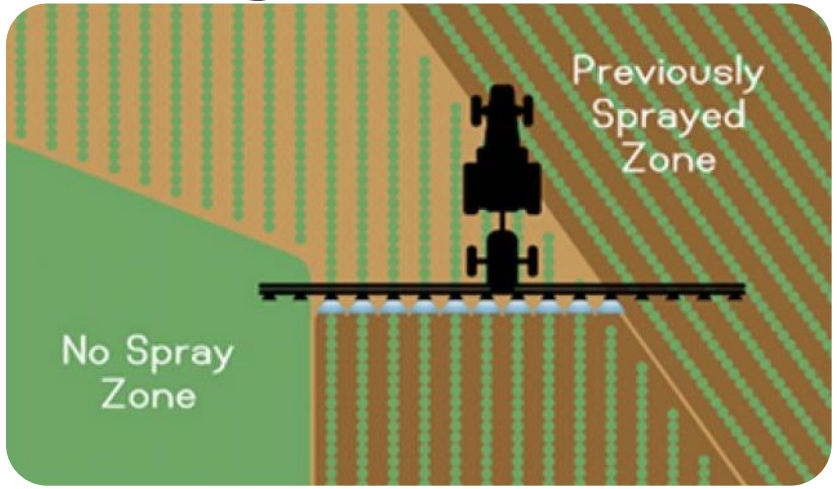
Source: 2020 PRECISION AGRICULTURE DEALERSHIP SURVEY - Purdue University

GNSS precision application technologies

Variable Rate application and Auto-Section control

- Resolution limited
- Incremental savings
  - 5-10% Guidance
  - 5-10% ASC
  - 5-10% VRA





USA retail: 81% have access to GPS guidance systems with automatic control (autosteer) for fertilizer/chemical application

75% have access to Auto sprayer boom section or nozzle control

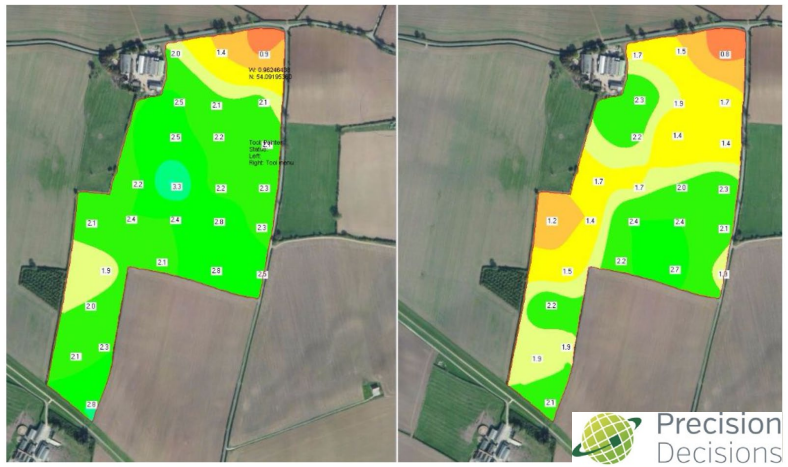
USA adoption: estimated 62% of land area is managed Sprayer Section Controllers

estimated 57% of land area is managed VRT Fertilizer Application

Source: 2020 PRECISION AGRICULTURE DEALERSHIP SURVEY - Purdue University

Organic application control

Variable rate example results



Sampling results for 2017 P after VR application of P as a result of Sampling results for 2014 P index. Although some balancing remains to be done in the NE corner of the field the remainder of the field is much more even.

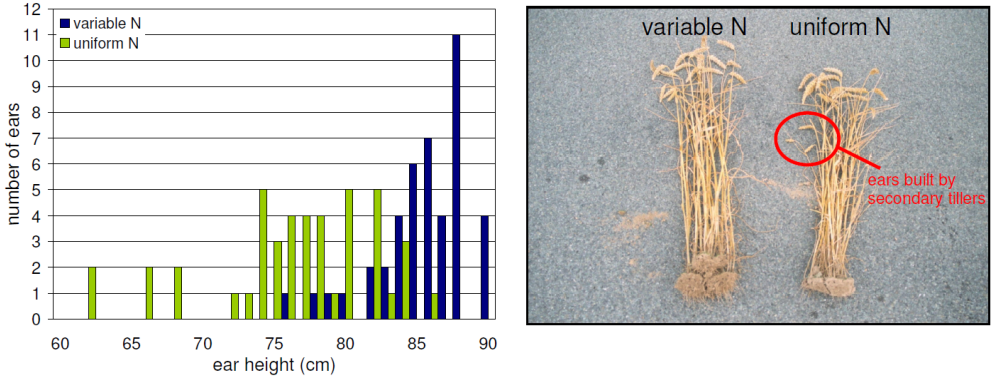
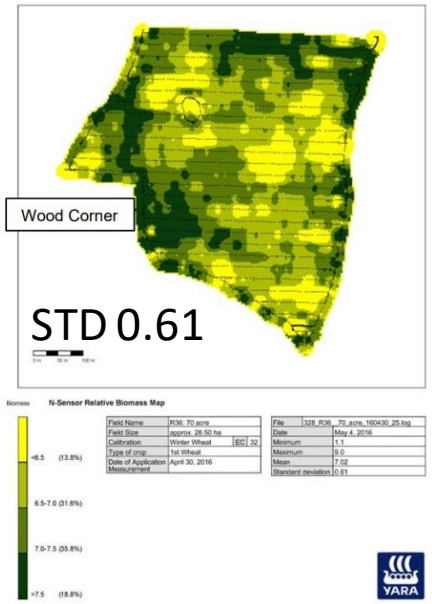
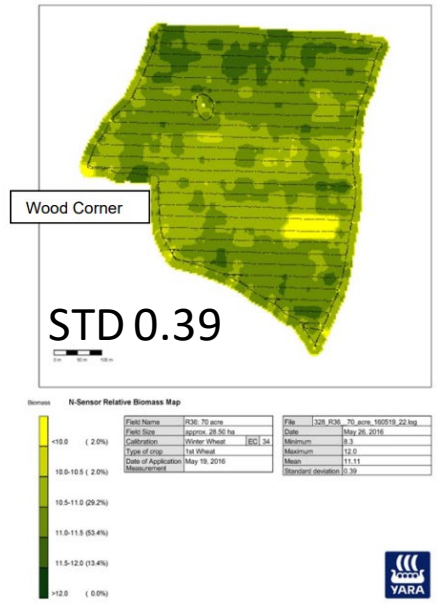


Figure 7: Effect of variable rate N fertilization on crop homogeneity, Fahrenwalde 2004, hybrid cultivar.

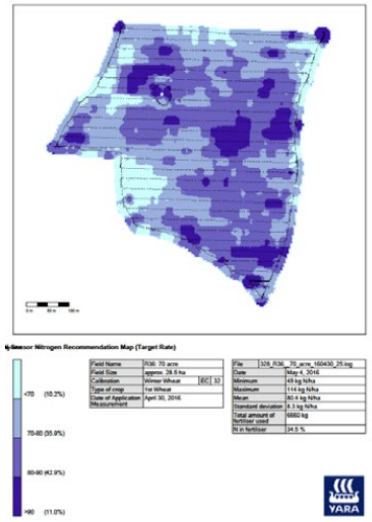
Source: Effects of N-Sensor based variable rate N fertilization on combine harvest – Research Centre Hanninghof, YARA International

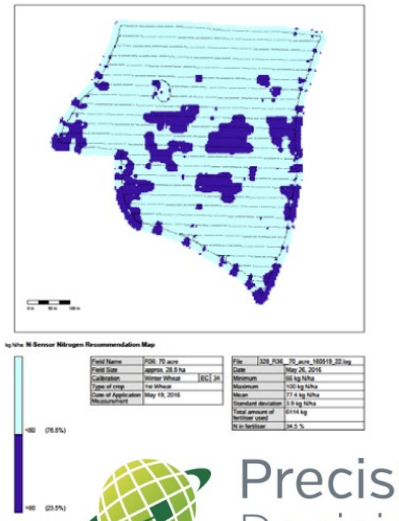




Field R36 – Wood Corner. Biomass Map 1, WW 30-04-16

Biomass Map 2, WW 19-05-16





Precision Decisions

Precision limitation – opportunity for autonomy