The Eastern Ontario Crop Conference
(Kemptville, Ontario)

Precision Agriculture
The World of Common Sense

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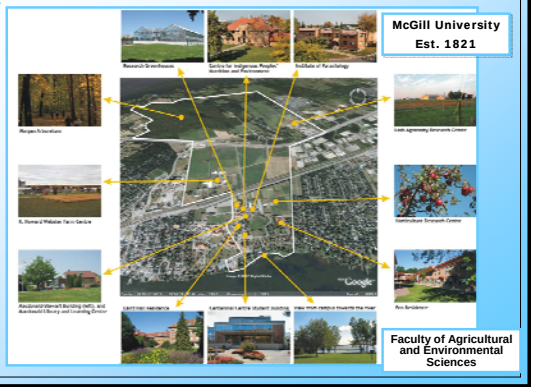
February 10, 2015

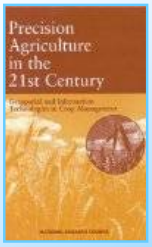
McGill

Macdonald Campus



Precision Agriculture and Sensor Systems Team

- Development of Proximal Soil and Plant Sensing Systems
- Geospatial Data Processing and Management
- Practical Implementation of Precision Agriculture



"Precision agriculture is a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production."

National Research Council, 1997

WIKIPEDIA
La enciclopedia libre

- La agricultura de precisión es un concepto agronómico de gestión de parcelas agrícolas, basado en la existencia de variabilidad en campo.

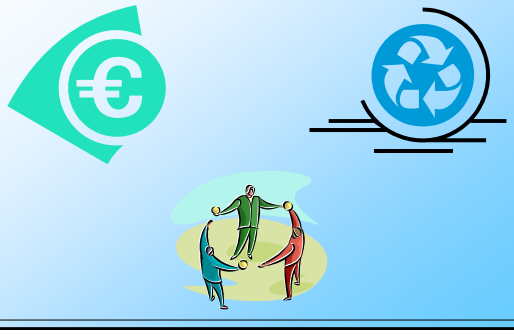
October 5, 2012

WIKIPEDIA
The Free Encyclopedia

- Precision farming or precision agriculture is a farming management concept based on observing and responding to intra-field variations. Today, precision agriculture is about whole farm management with the goal of optimizing returns on inputs while preserving resources.

October 5, 2012

Goal



Object

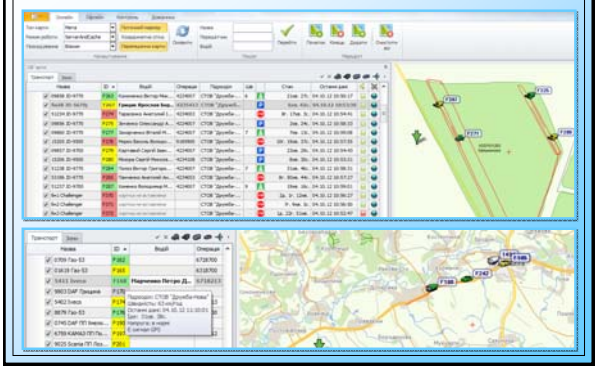
System Approach

System Approach Implementation

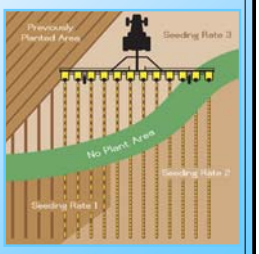
- Conservation tillage
- Machinery use logistics and tracking
- RTK-level auto-guidance
- Automatic section control
- Yield mapping
- Soil electrical conductivity mapping
- Remote sensing (aerial/satellite)
- Soil sampling and analysis
- Band fertilizer placement
- Variable rate nitrogen management
- Variable rate P and K management
- Variable rate seeding

Machinery Tracking

Real-Time Equipment Monitoring

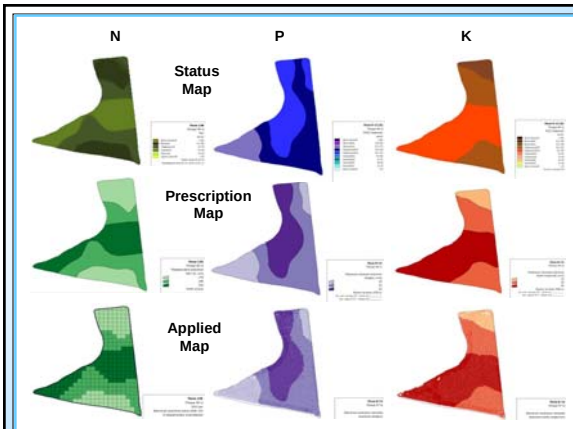


Planting with VRT Seeding and Individual Unit Control



Variable Rate Technology

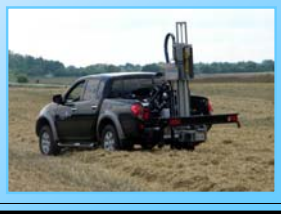
Application Quality Control

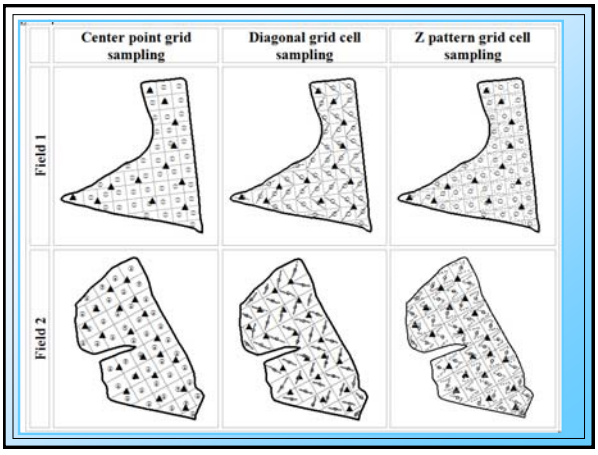


Georeferenced Soil Sampling

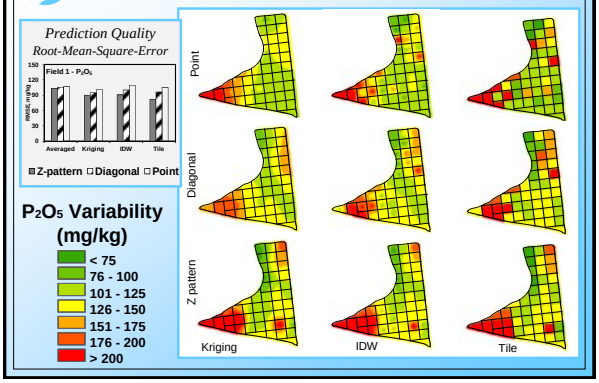
Sampling depth –

0-30 cm and 30-60 cm

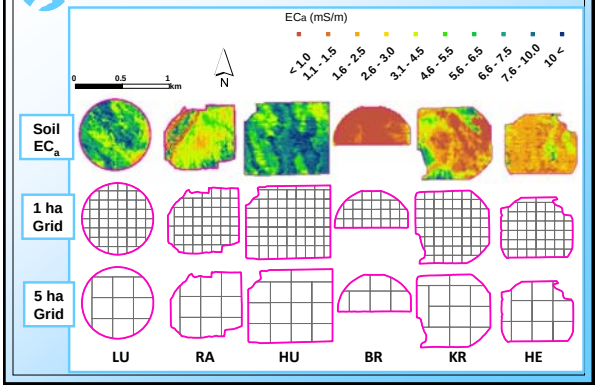




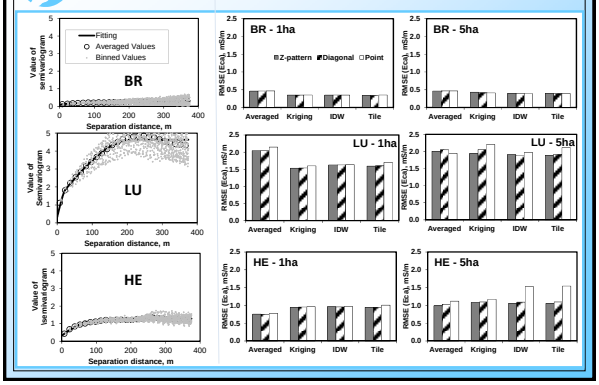
Sampling Study



Simulation Study

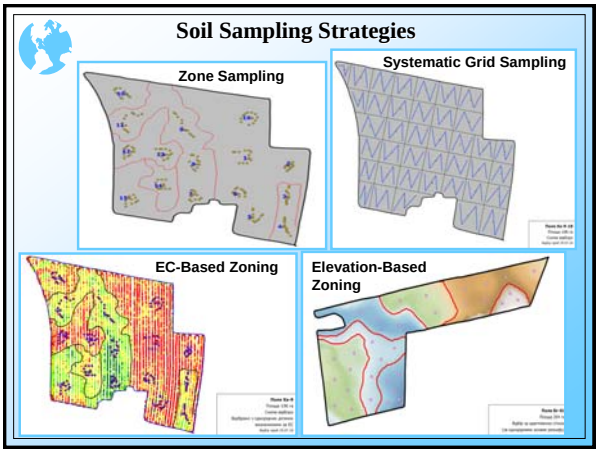


Simulation Study Results

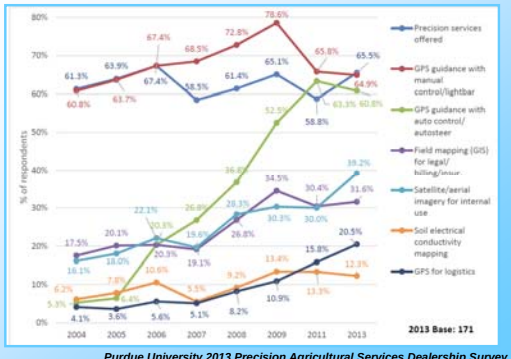


Soil EC and Field Elevation Mapping

Soil Sampling Strategies

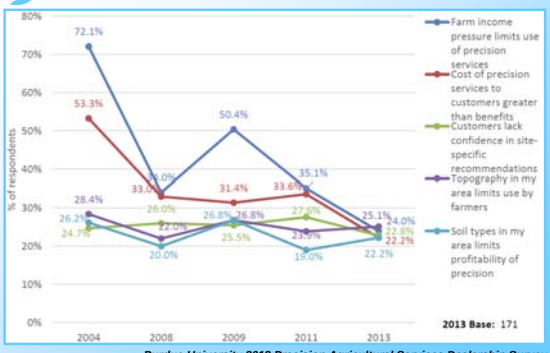


Precision Agriculture Adoption



Purdue University 2013 Precision Agricultural Services Dealership Survey

Cons of Precision Agriculture



Purdue University 2013 Precision Agricultural Services Dealership Survey

Source of Profitability

Profitability = Increased Revenue – Additional Cost

+

- Inputs Saving
- Yield Gain
- Yield Quality Improvement
- Environmental Control
- Record Keeping

-

- Capital Investment
- Time Investment
- Potential Risk
- Insufficient Knowledge

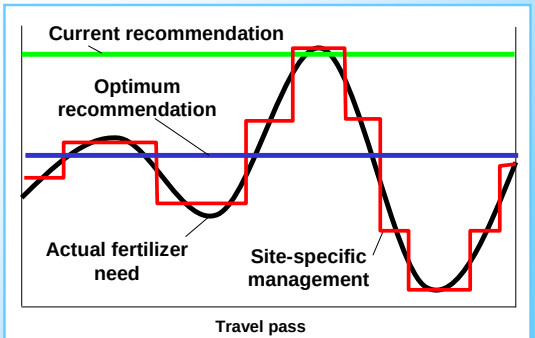
Why Variable Rate Technology?

- It is obvious that skipping, overlapping or placing agricultural outputs outside the cropping area should be avoided
- 4R nutrient stewardship
  - Right fertilizer source
  - Right rate
  - Right time
  - Right place

Return on Investment

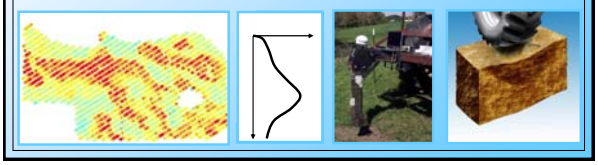
System Changes	Quality Control and Logistics	Variable Rate Technologies
> $50/ha/year	$20-100/ha/year	< $50/ha/year

Source of Savings



Tillage

- No-till if possible
- Strip-till to localize main soil treatments
- Spot tillage of compacted areas
- Variable depth tillage in response to the depth of a hard pan



Seeding

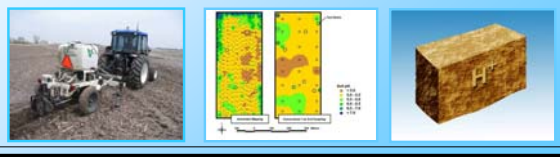
- Change rate to account for differences in water availability
- Change depth to optimize emergence
- Change the hybrid in response to local environments

Water

- Field landscaping and drainage
- Control water table
- Optimized irrigation scheduling
- Variable rate irrigation

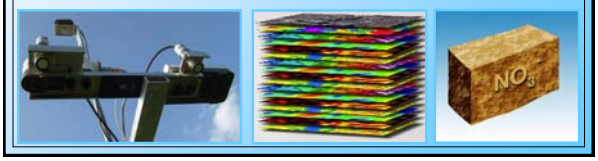
Liming

- More lime is needed for low pH soil
- No lime should be applied to neutral or alkaline soil
- It takes extra lime to raze pH in soils with high buffering capacity



Nitrogen

- Apply when it is needed
- Account for all possible credits (predictive)
  - Potential for mineralization
  - Yield history
  - Residual N
- In season management (reactive)
  - Feed the crop under N stress
  - Do NOT feed the crop under a different type of stress



Potash and Phosphate

- Band placement
- Relevance to past management
- Historic crop removal
- Mapping local needs

Organic Fertilizers

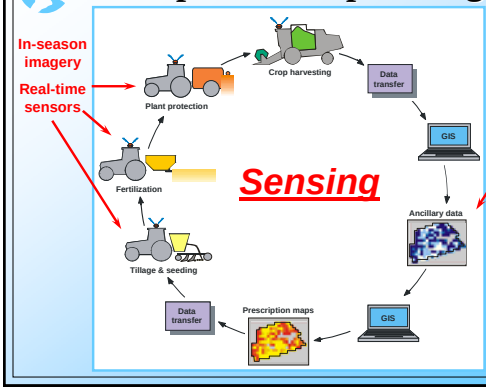
- Avoid environmentally risky areas
- Nutrient balance in certain cases
- Improved logistics

Herbicides

- Change the rate according to the quantity of weeds
- Change the product according to the species
- Change the rate according to soil carbon

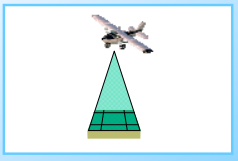
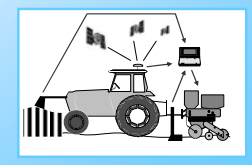


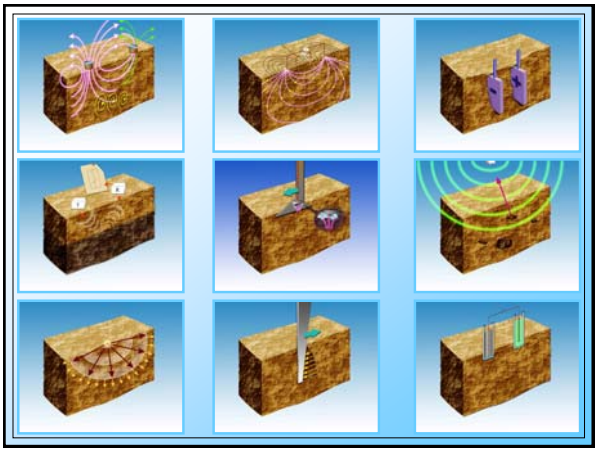
Site-Specific Crop Management

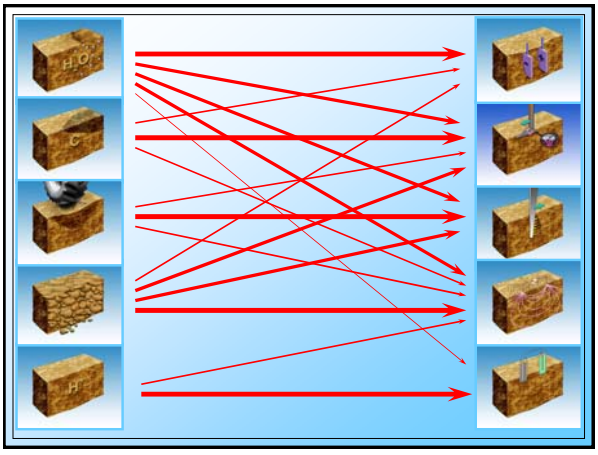


Sensing in Precision Agriculture

- Remote
  - Satellite
  - Aircraft
  - UAV
- Proximal
  - On-the-go
  - On-the-spot
  - Profiling

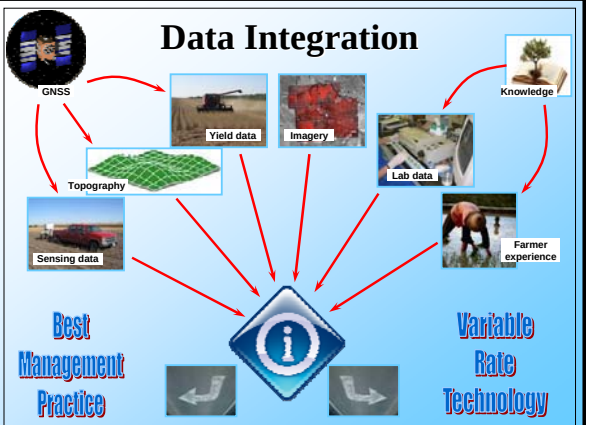







Sensor Fusion

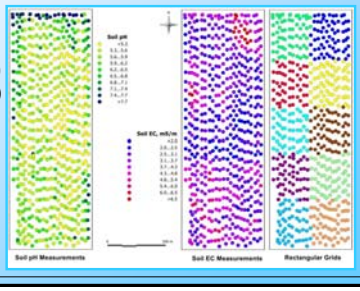
Data Integration



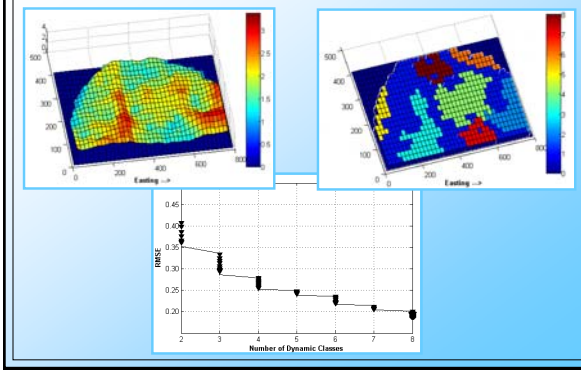
Site Specific Calibration

$$OF = \sqrt[5]{S_{opt} \cdot D_{opt-pH} \cdot D_{opt-EC} \cdot H_{cr-pH} \cdot H_{cr-EC}}$$

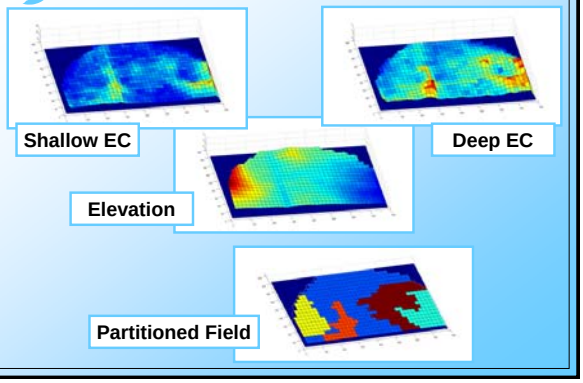
- S-optimality
- D-optimality (soil pH)
- D-optimality (soil EC)
- H-criteria (soil pH)
- H-criteria (soil EC)



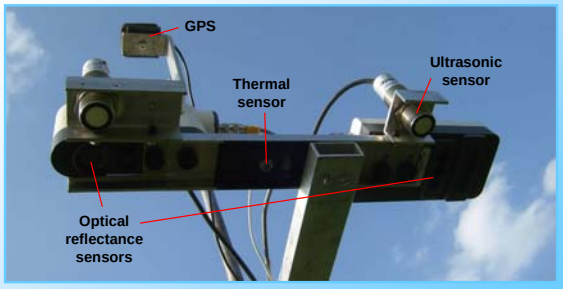
Spatial Data Clustering



Multiple Input Data Layers

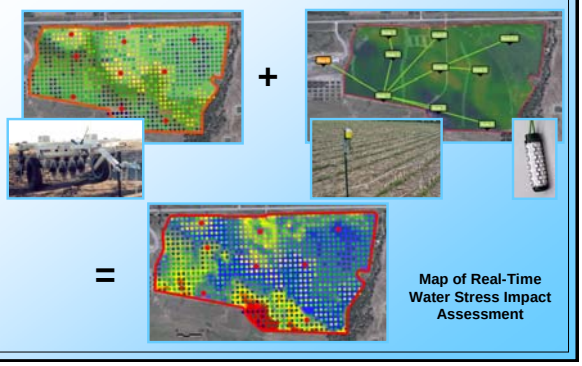


Crop Canopy Sensing



Aerial Imagery

Wireless Sensor Networks

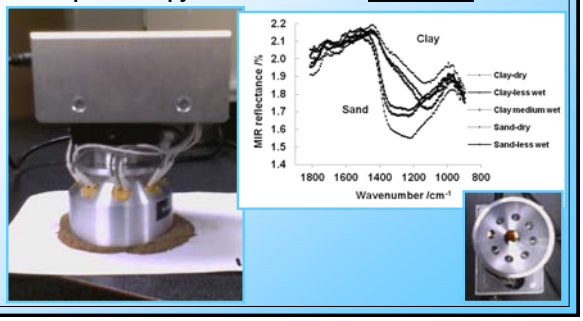


Soil Profiling Sensors

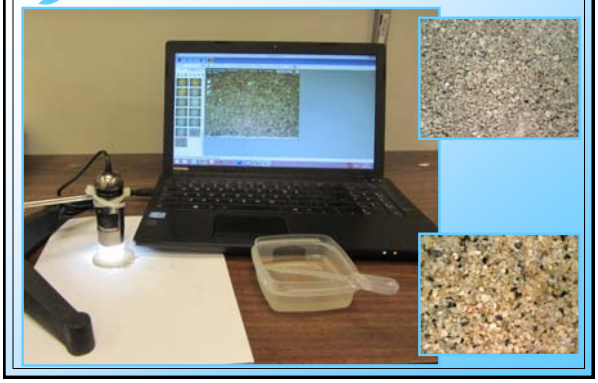
On-the-Spot Analyzer

MIR Spectroscopy

Diffuse Reflectance Variable Filter Array Mid-Infrared (MIR) spectroscopy - 2780-5096 nm or 5500-10800 nm

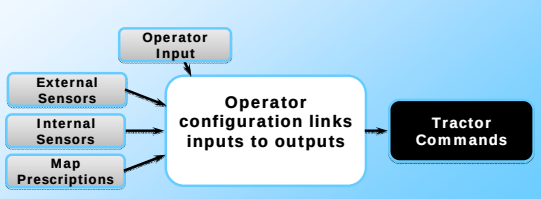


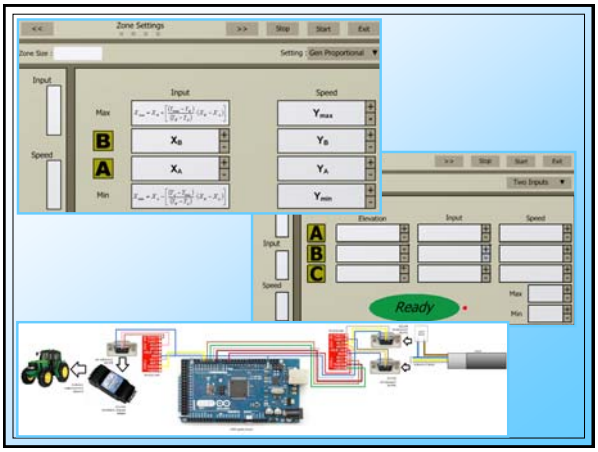
In situ Microscopy



The Smart Tractor Concept

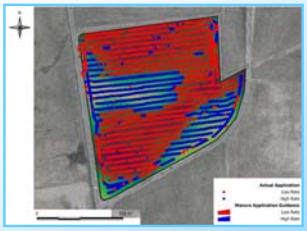
- Match tractor operation with local conditions according to operator-defined rules or direct operator input
- Use of internal or external sensors to replicate appropriate operation settings

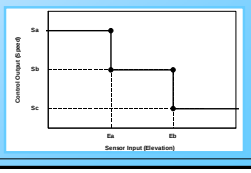




Stage Control

Variable Rate Liquid Cattle Manure Management

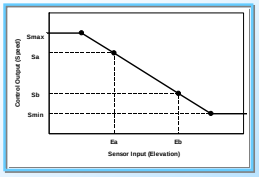


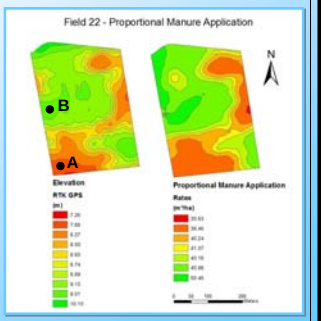


Allowed environmentally safe discharge of additional 30 % (150 m³) of liquid manure in this 11.1-ha alfalfa field

Proportional Control

Variable Rate Liquid Cattle Manure Management

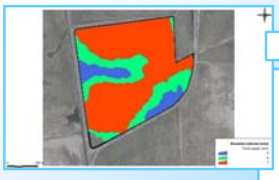




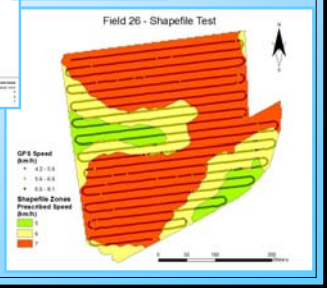
Allowed environmentally safe discharge of additional 20 % (80 m³) of liquid manure in this 12.4-ha corn field

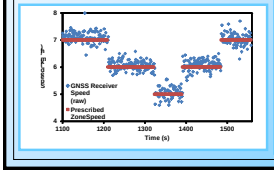
Map-Based Control

Variable Rate Liquid Cattle Manure Management

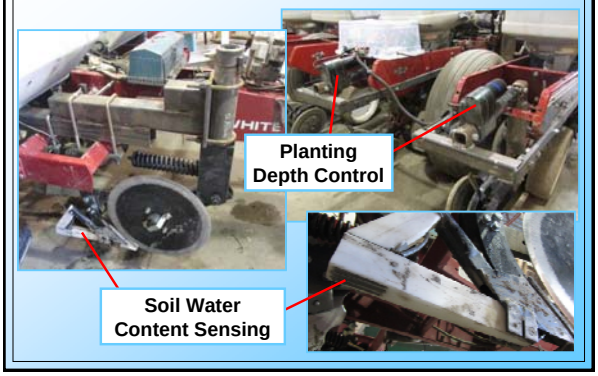


Input Shape File

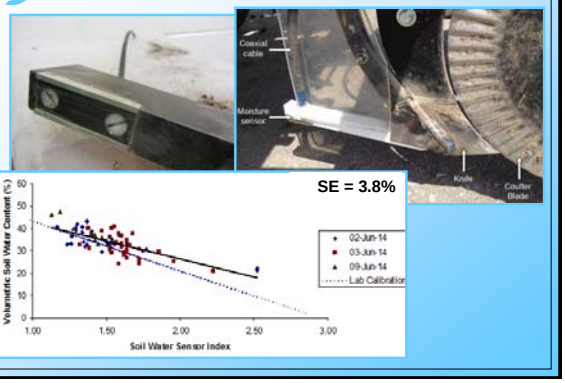




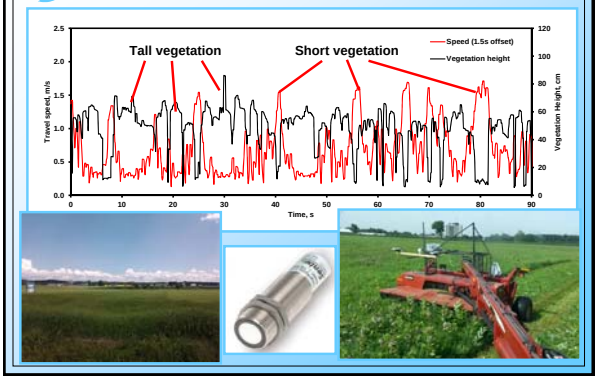
Variable Depth Planting



New On-Line Soil Moisture Sensor



Crop Height Tractor Speed Control



Computer Vision Guidance

Water Quality Assessment

There is no such a situation where precision agriculture does not work. There are many instances where promoted solutions are not appropriate for solving a given set of problems, or are not executed correctly.

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