Future of Farming: From Precision to Decision

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Agribusiness is changing

Farming = Multi-tasking

If farmer does this right, farmer will optimize inputs & yield and maximize profits

Solutions
Solution to what?

Soil
Water
Crop
Machinery
Pest
Weather
Labor
Land
Genetics
Livestock
Ecology
Cold chain
Supply
Investment
Storage
Food safety
Education
Market
Pollination
Gender equity
Safety
Diseases
Weeds
Tradition
Manure
Neighbors
Age
Succession
Fertilizer
Innovation
Harvesting
Climate change
Spatial variability
Quality
NDVI
NBI
Yield
LAI
Canopy
Temperature
Plant population
Infestation level
OM
P content
K content
N content
pH
Texture
Soil EC
Bulk density
Soil water content
Yield potential
Management zone
Speed
Engine performance
Fuel consumption
Machine health indicator
GPS
Humidity
Precipitations
Wind speed
Air Temperature
Soil Temperature
Weed infestation
Crop ET
Market value
Input cost
Fuel cost
Water
Water
Crop
Crop
Soil
Soil
Weather
Data
Technology
BIG DATA

It will get complex… before it gets easy
How do you do precision agriculture?
One field, one farm at a time....

Why do we need complex solutions?

Big Four Tractor...
steering device consisted of a small pilot wheel

...which runs along in the furrow ahead of the engine and is connected with the front axle.

When was the first auto-pilot system invented?
- 2002
- 1998
- 1962
- 1938
- 1908

Mercer and Hall (1911)

Variability!!

At the regional scale

At the field scale

Spatial variations in soil often translate into variations in crop yields. Variability at different scales:

- **At the regional scale:**
  - Spatial variations in soil often translate into variations in crop yields.
  - Variability!!

- **At the farm scale:**
  - Only 36% of the fields fall within 10 bu/A of the mean.

- **At the field scale:**
  - Under-fertilized: 24%
  - Over-fertilized: 8%
  - Mean: 182.5 bu/A
  - >192.5 bu/A: 40%

Yield Map

Pixels = Average

8% Under-fertilized

40% Over-fertilized

Mean: 182.5 bu/A

>192.5 bu/A: 40%
Farming the data... adding value

• Precision farming is not only about farming the land... it's also about Farming the data!!

• Adding value... foster adoption

“A sub-region of a field that expresses a homogeneous combination of yield limiting factors”

Management Zones

In Colorado, we developed four techniques of delineating management zones

1. Bare soil imagery
   Soil organic matter
   Moisture content
   Other stable soil properties (bulk density, texture, compaction, etc)

2. Field topography
   Elevation map
   Grain yields are correlated with topography
3. Farmer’s experience

Management Zones...

The three data layers

- Aerial Imagery
- Topography
- Farmer’s experience

are stacked as GIS layers to delineate the zone.

Traits such as dark color, low-lying topography, and historic high yields were designated as a zone of potentially high productivity or high zone.

Delineating management zones...

Mean grain yield across MZs

Up to 46% reduction in N loadings without impairing grain yields

Source: Koch, Khosla, et al. 2004

Precision Manure Management

Suggestions from growers...

- Could we site-specifically apply animal manure to improve soil quality, productivity of low management zones?
- Disposing manure is a significant challenge
- Precision manure management sounded like an opportunity
Manure applied 1 month before planting. Average daily temp. 40°F

Mineralization rate analysis was conducted in a lab at a constant 60°F

Growers typically apply 10 - 20 tons/ac of manure once every three years


Thank you
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