Precision Agriculture

GPS/GIS Applications for Farming Systems

Alabama Farmers Federation
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Topics

Overview of PA

Guidance Systems

Variable-Rate Technology

Auto-Swath

Final Thoughts
Topics

Overview of PA
Guidance Systems
Variable-Rate Technology
Auto-Swath
Final Thoughts
“Two Main Ways of Saving and Making Money”

Growers and Agronomist across the south are focusing on two money maker musts for 2009. The first is to soil test and only use the precise amounts of fertilizer that your crops require. The second is planting only the best variety for your farm of each crop you plant.
History of Precision Ag

Data Collection

Steering Control & VRA

Implement Control

1992

1997

2002

2007

1992

Courtesy of Darr

1997

2002

2007
# PA - Adoption Rates

<table>
<thead>
<tr>
<th>Component</th>
<th>Percent adopting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
</tr>
<tr>
<td>Yield Monitor</td>
<td>31.7</td>
</tr>
<tr>
<td>Precision Guidance (light-bar or auto pilot system)</td>
<td>31.6</td>
</tr>
<tr>
<td>Georeferenced grid soil sampling</td>
<td>26.5</td>
</tr>
<tr>
<td>Satellite GPS receiver</td>
<td>26.1</td>
</tr>
<tr>
<td>Boundary Mapping</td>
<td>23.6</td>
</tr>
<tr>
<td>Variable Rate Application of Lime</td>
<td>22.2</td>
</tr>
<tr>
<td>Variable Rate Application of Phosphorus</td>
<td>19.6</td>
</tr>
<tr>
<td>Variable Rate Application of Potassium</td>
<td>19.5</td>
</tr>
<tr>
<td>Aerial or Satellite Field Photography</td>
<td>17.3</td>
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<tr>
<td>Variable Rate Application of Nitrogen</td>
<td>10.7</td>
</tr>
<tr>
<td>Variable Rate Seeding</td>
<td>8.1</td>
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<tr>
<td>Variable Rate Application of Herbicides</td>
<td>7.1</td>
</tr>
<tr>
<td>Georeferenced field scouting for insects, pests, or disease</td>
<td>6.6</td>
</tr>
<tr>
<td>Georeferenced field scouting for weeds</td>
<td>6.3</td>
</tr>
<tr>
<td>Variable Rate Application of other Nutrients</td>
<td>5.7</td>
</tr>
<tr>
<td>Variable Rate Application of Pesticides</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Percent who have adopted one or more of above</strong></td>
<td><strong>54.2</strong></td>
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</table>
Current PA Trends across US

• **Machine Control**
  – Autoguidance and Lightbars
  – Auto-swath control
  – Strip tillage, fertilizing, and planting
  – Implement control on sloped fields

• **Input Management**
  – Precise fertilizer and pesticide application
  – Variable-rate seeding

• **Solutions for information management**

• **Demand for high-level GPS accuracy** (few inches)
Payback for Precision Ag Systems

• Cash Methods
  – **Reduced pass-to-pass overlap** with guidance systems
    • decreases input use & field passes
  – **Reducing headland overlap** with automatic section control reduces input use.
  – **Improved crop yield** response from accurate input placement (fertilizer rate, seeding rate, etc.)

• Non-Cash Methods
  – Reduced operator fatigue
  – Better data and decision management
  – Identify yield limiting problems
Field variability – how can we manage it?
Specify management goals.
Question: Can we meet the target goal?
Use precision ag to increase profits

Address field variability so that your PROFIT map reflects a positive return!
Topics

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Guidance Usage

- Planting
- Spraying
- Spreader/applicators
- Tillage
- Harvesting
Types of Guidance

2 Types of Systems:

1. Lightbar or Parallel Tracking
   - Operator still drives machine
   - Lightbar provides feedback on proper positioning reference

2. Autoguidance or AutoSteer
   - Machine drives itself
   - Operator only turns machine around, then lines up on next pass before engaging**
Lightbars

- Simple
- Fairly precise
- Reliable
- Economical
- Easy to move

Courtesy of John Deere, Mid-Tech, Raven, and Trimble
Terrain Compensation
Roll Example

Position without TC
Corrected position by TC
Roll Angle
GPS Antenna

Precision Ag Team
Alabama A&M and Auburn Universities
Autosteering Technology

- Electronic controls override standard steering valves.
- Steering decisions are made via initial driver input (AB line establishment) and GPS position information.
- Electronic processor unit calculates precise steering angle and passes command along to the steering valve.
RTK Technology

Base station corrects GPS signal based on its known locations.

Base station sends corrected GPS signal via radio or cell phone to rover unit mounted on tractor.

**Correction Signal**
Correction data is placed on the internet.

Phone/modem connects to internet to receive correction.

CORS Station
Traditional Base vs. CORS

**Traditional Base Station**
- 6-8 mile radius
- Line of sight
  - Have seen smaller radius in AL due to terrain
- Each brand typically has its own base station

**CORS**
- 20 mile radius (approx.)
- Cell phone coverage required
- Compatibility:
  - Ag Leader
  - AutoFarm
  - Leica
  - Trimble
  - TopCon
Cost of Accuracy

**Guidance system**
$2,995

**Guidance + Assisted Steer**
$6,500

**RTK guidance + Base Station**
$45,000
Implement Guidance
Implement Guidance

• Trimble Truetracker
  – AgGPS 252 and NavController II mounted on implement (in addition to on tractor)
  – Orthman Tracker IV, actually assists in steering the implement
Implement Assist: iTec

• John Deere product

• Intelligent Total Equipment Control
  – Use with AutoTrac
  – Assists with:
    • Headland turns
    • Helps position machine for next pass
    • Raise/lower mounted implements
    • Engage/disengage PTO functions
    • Ground speed changes
Harvest Guidance

• AutoTrac Row Sense – Combine
  – John Deere
  – Sensors in corn head communicate with AutoTrac
  – Allows for more precise steering, particularly in poor conditions (weeds, down corn)
  – Allows combine to operate at more consistent speed
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Directed Soil Sampling

**Grid**
- Typically 2.5 acres
- Assess field variability
- Minimum knowledge
- More samples = more $
- Labor intensive

**Zone**
- Approx. 10-20 acres
- Time and knowledge required to create
- More set-up time required
Directed Soil Sampling
What is VRT

• *VRT = Variable-Rate Technology*

• Any technology that enables the **variable-rate application** of agricultural inputs,

OR

• Technology which permits **precise application control** of inputs
Uses of VRT

Inputs

- Nutrients / Fertilizer
  - N, P, and K
  - Micronutrients
- Pesticides
  - Herbicides
  - Insecticides
  - Fungicides
- Lime
- Seeding
- Tillage
- Irrigation
VRT Implementation

1. Map-based – prescription maps
2. Sensor-based
   – Real-time crop or field assessment controlling input application
   – Further development in AL before adoption
Basics of How VRT Works...

Map-Based System

- DGPS
- Map
- Controller
- Applicator
- Output

Map-Based System

Precision Ag Team
VR Control System

Computer, Controller and Software

DGPS Receiver

Hydraulic Valve and Motor

Metering Device
Sensor-Based VRA System
Example Sensor-Based System

Senses NDVI – Plant Health

Images courtesy of NTech Inc.
Spinner-Disc Speed Control

RESULTS:

- Spinner disc control improves material distribution by up to 17%.
- Recommended for variable-rate application.

Precision Ag Team
As-Applied Maps

ILLUSTRATES:
1. Field traverse
2. Actual rate applied

PROVIDES:
1. Electronic verification
2. Used of future analyses and decisions.
Benefits of VRT

**Economics**
- Increased input efficiency - apply only what is needed
- Could reduce overall amount of inputs used
- Improved in-field equipment efficiency
- Improved crop yields through optimal input use

**Environmental Stewardship**
- Minimize over-application of inputs thereby reducing the risk of pesticide and fertilizer runoff or leaching into water sources,
- Reduce application in environmentally sensitive areas
Topics

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- Guidance Systems
- Variable-Rate Technology
- Auto-Swath
- Final Thoughts
No Auto-Swath Control

Compromise not spraying vegetated waterway and cropland.
Overlap Example w/out Auto-Swath
What is Auto-Swath Control (ASC)?

- Sections or individual nozzles or rows are turned ON and OFF automatically.
- Reduces overlap areas on headlands and application in unwanted areas (waterways, etc.).

**Required Components:**
- DGPS receiver
- Controller with software capable of auto-swath
- Appropriate control mechanism (valve, solenoid, etc.)
Benefits of Auto-Swath

• Improved application efficiency & accuracy
• Reduced overlap thus reducing overall input costs
• Improved environmental stewardship
• Reduced crop damage from over-application
• Optimized operator efficiency
• Reduce operator fatigue
Auto-Swath Study

• 2 to 10% input savings per pass across field
  – AVG: 4.4 %
  – MIN: 1.0 %
  – MAX: 10.0 %

• Savings depending upon shape and size of fields.

• GPS and correction impacts performance

• Payback period: < 2 yrs

➢ Increased field efficiency (additional savings)
Overlap Reduction (%)... 

Technology becomes more precise (auto-nozzle /row control) or as equipment becomes larger.

Increases when increasing control resolution: (5 booms → auto-nozzle)

Increases with the size of planter: (8 → 24 rows)
Cost Saving Results

- Average savings of $4.83/ac
  (sprayer: 5 boom sections, planter: 12 rows, no precision N application)
- Savings increase to an average of $8.36/ac if ASC for N fertilizer
- Highest savings in *irrigated corn* if precision N-application implemented: ($11-13/ac)
- Savings of up to $25/ac can be attained.
Model to Estimate Savings

Development of a simple index:
1. Based on field geometry
2. Estimate overlap savings

Section Control - 5
\[ y = 0.039\ln(x) \quad R^2 = 0.87 \]

Nozzle Control
\[ y = 0.054\ln(x) - 0.203 \quad R^2 = 0.90 \]
Concerns - Dynamic Response

Transition time when Boom turned OFF

Lag Time

Transition time when Booms turned back ON

Lag Time

Pressure (psi)

Time (sec)

Position 1
Position 2
Position 3
Position 4
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Autonomous Vehicles / Robots

Deere’s Concept Tractor

Carnegie Mellon - DEMETER

Ag Ant
Paradigm change...

- Man as a power source.
- Man in control of a power source.
- Man removed from the control loop.
Final Thoughts

• *Guidance systems makes sense*
• *Precision sampling is a start*
• *VRT and Auto-Swath Technology*
• Development of PA extension material
  – Management tools and current information
  – [www.aces.edu/timelyinfo](http://www.aces.edu/timelyinfo)
• PA technology will be a tool to assist with management especially in the future.
Final Considerations

• Buy products that are compatible with multiple operations
• Understand the time requirement of precision ag systems and know when to outsource activities to consultants
• Develop long-term PA implementation plans to help with purchasing decisions
• Talk to specialists to determine the level of GPS accuracy required for your operation
• AL NRCS EQIP program
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