Precision agriculture is much more than adopting technology, it’s about whole farm management with the goal of optimizing returns to input and preserving resources!

Discussion for Today

• Our Motivation
• Overview of Alabama Precision Ag Program
  – Focus
  – People
  – Funding
• Research projects and results
• Value of Precision Ag

Field Conditions

Crop Fields:
  o Not square
  o Size varies (20 to 200 acres)

Trends for Ag Equipment

• Time conducting field operations is critical to farmers (ac/hr)
• Equipment size (increasing)
  – Sprayers: 90 or 120 foot wide
  – Planters: 60 to 80 foot wide
  – Harvesters: 35 to 45 foot wide
• Field speeds: 3 to 20 mph (12-18 mph)
• Machine automation
  – Technology to automate machine functions
  – Accurate input management
  – GPS provides the essential sensor for today’s ag equipment but must be match to field operations.

Management Considerations

Curvilinear Travel
Avoid mistakes
- Accurately plant - critical step for the entire season.
- Maximize field usage

What is the value?

Alabama Precision Ag Program

Team Goals
1. Generate timely (unbiased) information to help farmers’ decisions related to Precision Ag
2. Increase precision ag awareness and benefits using online venues (website and social media) and participation in international activities.
3. Promote agriculture through extension and education efforts.

Alabama Precision Ag Program

Team Members
- 5 Auburn University faculty (Biosystems Engineering, Agronomy & Soils, and Ag Economics)
- 3 Research Associates
- 7 graduate students
- Extension Agronomy Team (6)

Alabama Precision Ag Program

Funding
- USDA (various sources)
- USDA-NRCS (cost-share programs)
- Alabama Commodity Groups (check-off funds)
- International Plant Nutrition Institute
- Alabama Cooperative Extension System
- College of Agriculture

We partner with industry but research is not financially supported.
Facilities

- 4 primary experimental farms in Alabama
- Research: agronomic and technology
- Education capabilities: host groups and conduct trainings & workshops (hands-on)

RESEARCH PROGRAM

GOALS
- Develop technology to accurately and uniformly apply inputs (nutrients, pesticides and seed)
- Evaluate technologies to understand limitations and needed improvements
  a. Technology development has outpaced understanding and research
  b. Can limit the resolution of site-specific management (SSM): minimum management size

Recent Precision Agr. Survey

- Over 85% of Precision Ag Practitioners indicated their operation has been more profitable.
  - Average input savings per acre
    - $19/ac for corn
    - $18.50/ac for soybeans
    - Up to $39/ac for cotton
  - Fertilizer savings $4 to $13 per acre depending on crop.
- Top benefits of PA Technology
  - Ability to apply chemicals and fertilizer where needed
  - Greater profitability due to lower input costs
  - Identification of poor producing areas of their fields

Average Savings for Precision Ag Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Percent Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS-based Guidance</td>
<td>10%</td>
</tr>
<tr>
<td>Variable-Rate Application (ASC)</td>
<td>7%</td>
</tr>
<tr>
<td>Automatic Section Control (ASC)</td>
<td>5%</td>
</tr>
<tr>
<td>TOTAL AVERAGE</td>
<td>22%</td>
</tr>
</tbody>
</table>

NOTE: Data based upon Auburn studies. Savings could be higher or lower depending upon many production factors.

Quality of life (happier at the end of the day)
Today, we are not purchasing GPS receivers, we are buying technology with integrated GPS/GNSS.

Question: What positioning technology provides the accuracy level for my operation and what is its reliability?

- ability to expand on its capabilities

GPS Correction Services

- Global Positioning System (GPS)
  - ~24 satellites orbiting the Earth
  - Offers worldwide navigation reference
- Correction services
  - Trying to “correct” for systemic errors
  - Offered by:
   - Public
   - Private entities
- Accuracy Levels:
  - Sub-meter
  - Decimeter
  - Centimeter (RTK)
  - Essential to machine-guidance operations

Dynamic Accuracy

Year-to-Year

- No testing standard - open to interpretation
- Short-term accuracy
  - Requires “stable” satellite geometry (~15 min)
  - Also referred to as pass-to-pass accuracy (P2P)
- Long-term accuracy
  - Relative to a “surveyed truth”
  - Also referred to as year-to-year accuracy (Y2Y)
  - Matching required accuracy to field operations

Approximate positioning accuracies between various GPS correction services

<table>
<thead>
<tr>
<th>Correction Service</th>
<th>Pass-to-Pass Accuracy</th>
<th>Potential Range of Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAAS</td>
<td>± 6 to 13 inches</td>
<td>± 4.7 ft</td>
</tr>
<tr>
<td>Sub-meter</td>
<td>± 6 to 13 inches</td>
<td>± 2.3 ft</td>
</tr>
<tr>
<td>Decimeter</td>
<td>± 2 to 6 inches</td>
<td>± 1.7 ft</td>
</tr>
<tr>
<td>RTK</td>
<td>± 1 inch</td>
<td>± 1 inch</td>
</tr>
</tbody>
</table>

Selection of GPS Accuracy

Pass-to-Pass vs. Long-Term

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Advancing Science & Technology

Site-Specific Management

- As-applied map
- Grid-based Rx map

$29/ac savings on fall applied fertilizer compared to traditional fixed-application.

How to Implement Precision Ag?

Implementation achieved through Management Zones or Grids

Important Point:
- There is no "best" method for developing management zones.
- Any method is better than the traditional uniform approach if field variability exists.

Site-Specific Management (SSM)

- Precision Ag fundamentally requires matching inputs to a need(s)
  - If a part of a field requires more fertilizer, apply more
- Common sense ideas, but how do you implement them on the farm or in research?
  - Farmer knowledge of the land and past management needs to be an input layer

Prescription (Rx) Maps

Images courtesy of Dr. Scott Shearer and Ellis Farms
Yield Monitoring
Building Knowledge

Crop performance in a spatial context

Understand
- Variability
- Nutrient removal
- Data for improving nutrient management (Variable-rate Application)

Yield Variability

That which can be changed
- Fertility, seeding, etc.

That which must be managed
- Soil physical properties

Production Monitoring

- Identifying the effects of various products and agronomic choices.
  - Seed varieties
  - Seed treatments
  - Fertilizer rates
  - Seeding rates
- Strip tests within several fields
  - Split planter trials
  - Change rates with each pass
- Use yield maps to verify response

Implementation Strategy
Building on Knowledge

Site-Specific Management

Wheat (Prior to liming) pH Map

Revealing Suspected Variability

Wheat Yield Map
Soybean Yield Map
Corn Yield Map
Site-Specific Management
Correcting Issues
Wheat Yield (Prior to liming)
Wheat Yield (After liming)

Seeding Prescription Map
Primarily Corn
Simple Approach
• Higher seeding rates under the pivot versus outside
• Simple approach with not need for data.
More Advanced Method
• Higher seeding rates under the pivot versus outside.
• However, yield data and farmer knowledge allowed for further tuning rates based on field variability

Zone or Grid Changes over Time...
• Zones / Grids must be analyzed, evaluated and adjusted over time (8-10 years)
• Not static
  – Need to re-assess and possibly change
  – Develop revised management strategy
Possibilities
• Grids or zones could be combined if similarities develop
• Zones could be split if more variability arises
• Zone shapes and sizes can be altered
• Could move from grids to zones

Our Focus
• Start simple and take steps (takes time)
• Adaptive Nutrient Management
  – Use yield monitors to document field variability and compute crop removal (annually)
  – Use precision soil sampling to evaluate soil fertility levels and changes

Ag. Sprayer – Liquid Application
• Larger sprayers (90, 120 ft)
• Irregular field boundaries and varying terrain
• Time (ha/hr)
• Environmental concerns
  – Follow product label
  – Preservation of conservation structures

Precision Technologies for Sprayers
Ag. Sprayer - Liquid Application
• Larger sprayers (90, 120 ft)
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• Time (ha/hr)
• Environmental concerns
  – Follow product label
  – Preservation of conservation structures
Automatic Section Control
Example during Herbicide Application
- Automatic ON/OFF of sections on application equipment
  - GPS-based technology
  - Sections turn OFF previously treated areas or unwanted areas
- Reduces 1) overlap and 2) application in unwanted areas (waterways, buffer strips, etc.)

Overlap Reduction Technologies
- Adjacent Passes
  - Overlap occurs at boom ends
  - Mitigated with guidance systems
- Headland or Point Rows (turnaround)
  - Overlap occurs across the boom
  - Mitigated with automatic section control

Difference with Technology
Manual Errors
- Overlaps (blue)
- Skips (red)
ASC Errors
- Overlaps reduced (blue)
- Skips eliminated

Overlap represented in blue.

Reduction in Overlap
Manual versus Automatic Section Control
- Savings depends on field
- 5% average savings
- High adoption

Sprayer Off-Rate Errors

Flow Dynamics with Sprayer Plumbing
- Extended time for nozzle flow to stabilize
Sprayer Setup Considerations

**Automatic Section Control**

- Distribute boom sections evenly
  - Minimize overlap
  - Consistent response for rate controller
- Place boom shut-off valves close to spray section.

**VARIABLE-RATE NITROGEN Sprayers**

Available Nozzle Technology

**Flow rate measurement**

Results

**Variable-Orifice Nozzles**
On-the-Go Crop Sensors

Integrating Crop Sensors and Yield Monitor Data

- We know that the response to N varies spatially across the field.
- We also know that response to N varies each year.
- Can we incorporate other information (yield monitor data) that we have to aid nitrogen decisions?
- Use yield monitor data to determine yield potential zones and crop sensors to determine seasonal N needs.

Crop Sensor Studies

- Nitrogen application in corn and wheat
- Weed pressure mapping
- Defoliant applications
- Stress, damage and variability in crops

RESULTS:
1. Input algorithms need to be regionally specific.
2. Can be used for fine-tuning seasonal nutrient management

Value of Precision Ag?

- Convenience
- Data can be knowledge
  - Input savings
  - Enhancing nutrient management (address variability)
  - Documentation / certification

Precision Ag technologies simultaneously enhance production efficiency and environmental stewardship.

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