Using Precision Ag and New Technologies to Manage Crop, Irrigation and Livestock to Positively Impact Water Resources

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Precision Ag Technologies for Pest Management
Current Technology Description in the NRCS CSP Program

- Use of GPS is required to document application and site-specific compliance with all label requirements for controlling non-target application.
- Utilize one or more of the following techniques to reduce the total amount of chemical applied and reduce the potential for delivery of chemicals into water bodies:
  - Precision guidance system which reduces ground or aerial spray overlap to less than 12 inches
  - Variable rate technology (VRT) which allows rate of pesticide application to dynamically change for site specific applications
  - “Smart sprayer” technology which utilizes automatic sensors and computer controlled nozzles to turn individual nozzles on and off


- “GPS” refers to the U.S. satellite constellation
- Some antenna/receivers can accept signals from the GLONASS (Russian) constellation
- The antenna position is critical, it relates to where coverages will be recorded/compared
- GNSS accuracy can be improved through adoption of correction services

- For improved accuracy, two important concepts are related to:
  - Correction signal delivery method
    - Radio
    - Cellular
    - Satellite
  - Source or type of correction signal
    - WAAS
    - Additional frequency bands (L1/L2/L2C)
    - Real-time kinematic
  - Distance to the correction source will greatly affect accuracy

- The stationary nature of base stations (year to year) is one factor that helps deliver high accuracy GNSS
- We can improve both short-term accuracy (reported by industry) and long-term drift (not often reported)
- Every 6 miles from a base station can add nearly 1” to accuracy estimates
- The moral of the story is that most GNSS is fairly accurate for a single field operation...if we’re talking days to weeks to years...RTK may be necessary for repeatability
Automated Guidance Systems

• Automated guidance accuracy depends heavily on GNSS systems
• Even lower grade correction (WAAS) may provide very good pass-to-pass accuracy within a field for a short period of time...
• Over time, accuracy will degrade though and higher accuracy correction services may be required
• For example, controlled traffic essentially requires RTK level accuracy for year-to-year operations

Automated Guidance Systems

• Light bars, steering wheel assist and integrated hydraulic steering are three currently available options
• Control systems can offer a variety of field path tracking lines or curves...potentially very useful in terraces
• Reductions in pass-to-pass overlap and operator fatigue are two benefits of these systems
Automatic Boom Section (on/off) Control

- **Automatic Boom Section Control** combines GNSS data and GIS analysis in real-time.
- The location (GNSS), width, and status of each individual section are tracked as the sprayer traverses the field and stored as georeferenced polygons.
- Internal logic checks to see if that section is in an area that has been previously sprayed (or not).

- Control logic from the computer is used to automatically actuate boom manifold valves.
- These valves distribute flow to groups of nozzles (control sections).
- The five boom section valves (bottom right) were mapped to the five control sections shown above (actual coverage polygons in green).
Map-based functionality for Automatic Section Control

- Many operators do not utilize the full functionality of ASC systems
- **Map-based control** allows for identification of ‘no-spray’ zones within fields or at field boundaries
- Boom sections or nozzles will shut off automatically

Three methods can be used to identify no-spray zones

- No-spray zones and boundaries can be created in a GIS or FMIS program and uploaded to the monitor
- The operator can create these on-the-go during field applications by identifying which end of the boom they will track around zones
- Boundaries could be mapped using external GNSS (maybe with ATV) and imported into software
Map-based functionality for Automatic Section Control

- In this actual example, the left bank(s) of nozzles have shut off as the sprayer crosses into a grassed waterway

Map-based functionality for Automatic Section Control

- As-applied data can verify where sprayer coverage occurred (and rates)
- Not several locations below where the sprayer traversed no-spray zones (grassed waterways)
Automatic Nozzle (on/off) Control

- **Automatic Nozzle (on/off) Control** operates in the same basic way as ASC
- Individual nozzle solenoid valves are placed on each nozzle body (in place of check valves)

Payback for Automatic Boom or Nozzle (on/off) Control

- Payback on sprayers (and other implements) can depend on the number of control sections
- Field shapes and sizes on the farm also can greatly affect the reduction in overlap
- Once we hit individual nozzle control, errors will be 1% to 2% of field area
Payback for Automatic Boom or Nozzle (on/off) Control

- The table below shows actual over-application documented from four sprayers in the Kentucky case study.
- The manual vs. 7 ASC system was essentially before and after adoption of ASC.

<table>
<thead>
<tr>
<th>Sprayer control system</th>
<th>Boom width (ft)</th>
<th>Over-application (% of field area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual-5 section</td>
<td>80</td>
<td>14.5</td>
</tr>
<tr>
<td>ASC-7 section</td>
<td>80</td>
<td>5.7</td>
</tr>
<tr>
<td>ASC-9 section</td>
<td>80</td>
<td>4.7</td>
</tr>
<tr>
<td>ASC-30 section</td>
<td>100</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Applications Beyond Spraying Systems

- Applications of map-based section/nozzle control extend well beyond spraying.
- Liquid nitrogen applicators can utilize essentially the same technologies.
- Aerial applicators can input field boundaries for shutting off boom outside of target fields.
- Dry spreaders can use map-based functions to reduce overlap at field ends.
- Planters utilize row clutch control to eliminate overlap.
Advanced Technologies for Spray Application Control

- **Automatic boom height control** is helpful for reducing potential spray drift during field applications.
- Pattern uniformity is also improved.
- Sensors along the boom adjust boom height to achieve a desired set point (typically 20” or 30”)

![Image: Teejet](image)

Advanced Technologies for Spray Application Control

- **Pulse Width Modulation** nozzle control valves for turn compensation systems are commercially available for minimizing off-rate spraying.
- Individual nozzle solenoid valves are ‘pulsed’ (i.e. pulse width modulation) at high frequencies to vary flow rates across the boom.
- The on/off pulsing is quantified as the ‘duty cycle’ which has a linear, directly proportional relationship to flow.

![Image](image)
Advanced Technologies for Spray Application Control

- John Deere, Raven Industries, and Capstan Ag Systems all have PWM turn compensation solutions
- These can help mitigate off-rate errors when turning is necessary during field applications
- Most self-propelled sprayers have turning radii less than half the boom width!

Rate control can be improved with these advanced spray application systems using PWM nozzle valves

An example from liquid N application shows significant improvements in rate control

16.5% of as-applied values are within +/-10% of the target rate
75.5% of as-applied values are within +/-10% of the target rate
Advanced Technologies for Spray Application Control

- **Direct injection systems** keep the chemical and carrier (water) separate on the sprayer
- Mixing and lag times are still a challenge, but reduced risk of improper batching of chemicals is a huge benefit

Advanced Technologies for Spray Application Control

- **See and spray technologies** are on the market
- Weedseeker essentially utilizes a **vegetation index** (NDVI) to open an integrated nozzle valve and spray weeds (green)
- Compared to blanket applications, potential is high for reductions in chemicals if weed pressure varies across a field
- Requires a sensor every 20” across boom...very expensive
Advanced Technologies for Spray Application Control

- See and spray technologies are on the market
- Blue River Technologies (recently purchased by Deere) uses machine vision to identify weeds
- Herbicides are only applied in short bursts to target weeds and not crops
- Currently viable in specialty crops...Deere will likely work to expand into row crops

How to Plan and Certify Variable Rate Nutrient Management

Questions?

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