Automated Prototype Variable Rate Sprayer for Spot Application of Agrochemicals

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Grasses and Weeds

Site-specific - Agrochemicals can:
✓ Reduce agrochemical use
✓ Increase input use efficiency and farm profitability
✓ Decrease environmental pollution

Bare spots: 30%-50% of total field area

Soil and crop variability

Wild Blueberry fields need to be managed site-specifically using VRT, Sensors, Controllers, DGPS, Digital photography,....
Our solution – A variable rate sprayer

• Technology that automatically senses weeds
  – Activates specific nozzles only when necessary
  – Real-time detection versus GIS and prescription maps
  – Work developed with wild blueberry industry but many possible applications
Boom width = 20 ft
Boom sections = 8, each = 2.5 ft
Boom height = 30 in.
Each section = one ultrasonic
8-channel computerized controller
DJ *Land Manager II* controller
Look-Ahead Feature

Bulb

Canon FS100 digital camcorder
### Look-Ahead Delay Time Calculations

<table>
<thead>
<tr>
<th>Trial</th>
<th>Weed sensing time</th>
<th>Nozzle open time</th>
<th>Difference</th>
<th>Average look-ahead delay time (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.30</td>
<td>6.33</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10.033</td>
<td>10.10</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>13.866</td>
<td>13.933</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>17.33</td>
<td>17.366</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>20.466</td>
<td>20.533</td>
<td>0.067</td>
<td>0.054 sec.</td>
</tr>
</tbody>
</table>
Flow Rate Measurements (Dickey John Land Manager II)
**Flow Rate Measurements (Dickey John *Land Manager II*)**

**DJ Settings @ 20 gal/acre**

<table>
<thead>
<tr>
<th>Flow rate (litre)</th>
<th>All 8</th>
<th>1</th>
<th>1,2</th>
<th>1,2,3</th>
<th>1,2,3,4</th>
<th>1,2,3,4,5</th>
<th>1,2,3,4,5,6</th>
<th>1,2,3,4,5,6,7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured</td>
<td>36.9</td>
<td>12.0</td>
<td>13.3</td>
<td>14.9</td>
<td>18.6</td>
<td>18.9</td>
<td>18.9</td>
<td>18.6</td>
</tr>
<tr>
<td>DJ Controller</td>
<td>37.4</td>
<td>11.7</td>
<td>13.3</td>
<td>15.2</td>
<td>19.0</td>
<td>19.4</td>
<td>19.6</td>
<td>19.0</td>
</tr>
<tr>
<td>Difference (%)</td>
<td>1.4</td>
<td>2.5</td>
<td>0</td>
<td>2.0</td>
<td>2.1</td>
<td>2.0</td>
<td>1.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Video - VR Sprayer Testing in Hay Field
VR Sprayer Evaluation in a WBB Field (Goldenrod)
Water Sensitive Papers in Uniform and VR side of the field
Real-Time Kinematic-DGPS

Base Station

DGPS Rover
Weed and Spray maps (Goldenrod)
Chemical Saving with Spot-Application

Test Tracks

<table>
<thead>
<tr>
<th>Track 1</th>
<th>Track 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable (L/ha)</td>
<td>Uniform (L/ha)</td>
</tr>
<tr>
<td>Weed area (%)</td>
<td>VR Saving (%)</td>
</tr>
</tbody>
</table>

Graph showing chemical saving with spot-application on test tracks.
Customized Software for Weed, Bare Spot and Plant Detection

Up to this point, all work was done with ultrasonics to prove the controller. All new work is with imaging technology.
Sheep sorrel, Fescue Grasses, Moss and Spray Maps

Before

After

- W.S. Papers
- Weed Patches
- Keolin Spray
- Field Boundary

0 5 10 20 30 40 Meters
John Deere 6430 Tractor and MS P1135E Sprayer
Cost Analysis - Conventional vs Spot-Specific
(for one application only)

- Target: Sheep Sorrel
- Chemical: Kerb
- Area sprayed = 300 acres
- Assume weed cover = 20%
- Application cost = $180/acre
- Total cost (Uniform application) = 300 X 180 = $54,000
- Cost of Spot- application = $10,800
- Chemical cost saving with spot- application = $43,200 or $144/acre

- Currently about 100,000 acres in production
  - savings of $14.4 million per application

Benefits
- Fewer trips to set water for sprayer
- Saves time (10 hours) + fuel, and labor
- Less impact on ENVIROMENT
Additional cost of converting to VR sprayer (4 wheeler prototype):

- Computerized variable rate 8-channel controller (Controller + Sensors/Cameras + GPS) = $3,700
- Dickey John *Land Manager II* controller (Controller + GPS + linear flow control valve, flow meter) = $3,500
- Wiring, etc. = $300
- Total cost = $7,500.00

**Tractor prototype:**
Commercial sprayer ($11,000) + VR modifications ($15,000) = $26,000
Technology advantages

- Easy user-friendly setup on a touch screen- no complicated switches.
- Wireless convenience- setup is possible some distance from the controller.
- Automatic compensation for changing ground speed – no need to manually readjust sensors.
- Manual speed input is possible in case there is GPS signal outage.
- Adjustable front and back buffers for precise overlapping of agrochemical applications on targets.
- Accurate placement of agrochemical.
- Cost-Effective – (Topcon, Green seekers, Holland Scientific)
• Precise application of pesticides reduces agrochemical use
• Lowers pressure on environment
• Reduces operating costs to producers
• Open new markets as only spraying the weeds
  – MRL (Maximum Residue Limits) is very important in many markets (e.g. Japan and Germany)
  – The technology sprays the weeds and not the fruit
• Identify the products we have
  – Software, consulting, design/redesign, customization
• Identify market potential – multiple uses
• Identify potential licensees
  – Doug Bragg Enterprises and Bragg Lumber is very interested
• Identify method of commercialization
• Other? – help from Innovacorp to commercialize