ENERGY EFFICIENT IRRIGATION

SEMI-ANNUAL
REPORT FOR THE PERIOD ENDING OCTOBER, 1999

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Technical Progress Report

This report briefly describes project activities for this reporting period.

A. Integrated System Test

Developed a test measurement system for the integrated variable rate water application test. This test is designed to measure the ability of the system to turn off irrigation water over non-farmable area and to variably apply irrigation water to designated portions of the field.

The Integrated System Test measurement setup and watering pattern is presented as Attachment A – Integrated System Test Setup and Measurement.

Field marker and water measuring device layout is also shown in Attachment A – Integrated System Test Setup and Measurements.

The test was scheduled to take place during the last phase of the potato growing season. However, growing conditions and weather patterns resulted in the grower making decisions which precluded the test. The test is rescheduled for the Spring of 2000, as soon as practicable after the threat of system freeze up and when it is necessary to water the current crop.

B. Technical Barrier

Accuracy of the Electronic Compass was determined to be inadequate for sufficient control of pivot operations. The compass inaccuracy is not due to compass inaccuracy but the inability to complete a full compass calibration in accordance with manufacturers specifications. Simply put, the compass requires at least one complete (360°) rotation of the system. Full rotation would provide for automatic compensation for systematic magnetic influences through the complete span of system travel.

Minimum time for a typical center pivot is approximately 13 hours. This length of time is an unacceptable calibration constraint. An additional consideration is that many center pivots do not complete full circle rotation. The center pivot being used for development rotates only 270°. A complete electronic compass calibration is not physically possible.

Resolution of this technical difficulty is the use of a mechanically driven encoder. The encoder is an existing part of many center pivot systems and has repeatable accuracy sufficient for the application.
Advantages of the use of the encoder instead of the electronic compass are:
• Proven technology
• Already used on many center pivots, users are familiar with their operation.
• Robust, able to withstand conditions of the harsh environment.
• Comparable to the electronic compass cost.
• Installation is straightforward. Mounting components are available from irrigation equipment manufacturers.

When it was determined that the solution to the compass calibration problem was use of an encoder, delivery time for the encoder adversely affected project schedules.

C. Weather Station and Soil Moisture Sensor Installation

A weather station was installed in the vicinity of the project to monitor and record meteorological conditions throughout the growing season.

The following parameters were recorded hourly:

- Evapotranspiration
- Relative Humidity
- Vapor Pressure
- Wind Direction
- Total Rain Fall
- Air Temperature
- Dew Point
- Wind Speed
- Wind Std. Deviation
- Avg. Solar kW/m-2

These parameters are useful in development of the irrigation model.

Eighteen soil moisture sensors were strategically placed throughout the field. Sensor location was determined by field conditions including soil type, elevation, slope, aspect, ridge and swale characteristics. Location of soil moisture sensors is shown in Figure 1.

Several soil moisture locations contained two sensors. One sensor was placed at a depth of 8 inches to monitor moisture at the root level. A second sensor was placed at a depth of 20 inches to provide indication of excessive watering.

Data gathered from these sensors is useful when compared with plant growth and meteorological conditions for development of the irrigation model.
D. Market Assessment

A Market Assessment was completed by New Horizon Technologies. We continue to identify market niches as identified by the assessment.

The Energy Efficient System is able to vary the application rate of water in accordance with user specifications. One of the application rates is zero. This capability is of interest where large areas of unfarmable ground are under the center pivot.

Figure 2, Existing Center Pivot Operations, shows examples of existing center pivot operations with large areas of unfarmable ground beneath the pivot.
Figure 2
Existing Center Pivot Operations

- Unfarmable Area

Pivot #1
Pivot Coverage: 86 Acres
Unfarmable: 17 Acres

Pivot #2
Pivot Coverage: 63.5 Acres
Unfarmable: 23.5 Acres

Pivot #3
Pivot Coverage: 72 Acres
Unfarmable: 11 Acres

Pivot #1 Savings - $6579.85
Pivot #2 Savings - $9096.67
Pivot #3 Savings - $4257.55
Table 1, Southeastern Idaho Crop Cost Russet Burbank Potatoes, describes specific input costs for the three center pivot operations shown in Figure 2.

<table>
<thead>
<tr>
<th>Input</th>
<th>Product</th>
<th>Cost ($/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>Water Delivery Cost</td>
<td>$40.00</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>Phosphate-Line Injection</td>
<td>$5.80</td>
</tr>
<tr>
<td></td>
<td>Nitrogen-Line Injection</td>
<td>$40.00</td>
</tr>
<tr>
<td>Pesticide</td>
<td>Eptam</td>
<td>$16.20</td>
</tr>
<tr>
<td></td>
<td>Sencor</td>
<td>$20.63</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Bravo</td>
<td>$32.18</td>
</tr>
<tr>
<td></td>
<td>Dithane</td>
<td>$5.24</td>
</tr>
<tr>
<td>Prowl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matrix</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fumigant</td>
<td>Vapam</td>
<td>$115.00</td>
</tr>
<tr>
<td>Water Rot</td>
<td>Ridomil</td>
<td>$45.00</td>
</tr>
<tr>
<td>White Mold</td>
<td>Roval</td>
<td>$45.00</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Asana</td>
<td>$7.00</td>
</tr>
<tr>
<td></td>
<td>Monitor</td>
<td>$15.00</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>$387.05</strong></td>
</tr>
</tbody>
</table>

1 University of Idaho, College of Agriculture Publication Southeastern Idaho Crop Costs and Returns Estimate, EBB4-Pol-97 - Russet Burbank Commercial Potatoes

2 Interview Local Fertilizer/Chemical Dealer

Table 2, Gross Savings Calculations, shows the projected cost savings for each example pivot.

<table>
<thead>
<tr>
<th>Center Pivot</th>
<th>Pivot Acres</th>
<th>Unfarmable Acres</th>
<th>Crop Cycle Gross Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivot 1 – Figure 2</td>
<td>85</td>
<td>17</td>
<td>$6579.85</td>
</tr>
<tr>
<td>Pivot 2 – Figure 2</td>
<td>83.5</td>
<td>23.5</td>
<td>$9095.67</td>
</tr>
<tr>
<td>Pivot 3 – Figure 2</td>
<td>72</td>
<td>11</td>
<td>$4257.55</td>
</tr>
</tbody>
</table>
Attachment A – Integrated System Test Setup and Measurement

Previous testing demonstrated the ability to exclude the unfarmable areas from the irrigation pattern. The Integrated System Test includes both exclusion of unfarmable areas and variable rate water application capabilities. Sections of the field have been selected for variable water application.

The test pattern and measurement layout is shown in Figure 1, Integrated System Test Measurement.

To assist with observation of the test, large numbered labels have been placed on the pivot at the center of each watering ring. Flags will be placed at transition points in the field within each pivot ring where the watering rate will change. These changes will be noted by test observers as the pivot progresses across the field.

Rain gages will be evenly spaced within each variable rate segment to measure the watering rate and also evaluate the watering pattern.

Rain gages will be placed on either side of the variable rate test segments. These gages will be placed 60 feet from either side of the edge of the watering ring segment. These rain gages will measure the rate of change of transition from one watering rate to another.
Figure 1
Integrated System Test Measurement

- Variable Rate Water Area
- Zero Rate Water Area
- Water Rate Change Point
- Rain Gage Location