DOE/GO/10399-5

DOE/EE/10025-1

ENERGY EFFICIENT IRRIGATION

SEMI-ANNUAL
REPORT FOR THE PERIOD ENDING OCTOBER, 1999

ROY N. CHIAPPINI

NORTHWEST PRECISION AG, INC.
169 NORTH 600 WEST
BLACKFOOT, IDAHO
83221-5566

DATE PUBLISHED: JANUARY 2000

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY
Under Cooperative Agreement
No. DE-FG36-99GO1399

10399

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

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 manufactures 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 straight forward. 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	• Air Temperature
• Relative Humidity	• Dew Point
• Vapor Pressure	• Wind Speed
• Wind Direction	• Wind Std. Deviation
• Total Rain Fall	• 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.

Figure 1
Soil Moisture Sensor Locations

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

Table 1, Southeastern Idaho Crop Cost Russet Burbank Potatoes, describes specific input costs for the three center pivot operations shown in Figure 2.

Table 1
Southeastern Idaho Crop Cost Russet Burbank Potatoes ^{1,2}

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

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 2
Gross Savings Calculations

Center Pivot	Pivot Acres	Unfarmable Acres	Crop Cycle Gross Savings
Pivot 1 – Figure 2	85	17	\$6579.85
Pivot 2 – Figure 2	83.5	23.5	\$9095.67
Pivot 3 – Figure 2	72	11	\$4257.55

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.

Attachment A

Figure 1
Integrated System Test Measurement