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VARABILE RATE PIVOT IRRIGATION

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Abstract

Variable rate irrigation has the potential to increase crop yield and quality while saving water. During the past three years we have field tested variable rate pivot irrigation systems on four commercial farms and on two experiment station sites. This system delivers water to each area within a field as needed, rather than a blanket rate or rates defined in wedges. Initial studies indicate that water use efficiency gains of 7% to over 20% are reasonable to expect from this system. Yields and management efficiencies have increased as a result of better water placement. System parts run approximately $5,000 for a 100 acre pivot.

Introduction

Efficient water use is critical for the development of both rural and urban communities. Many states are currently developing management plans for water use within and between states. In the nation's irrigated agricultural regions, agricultural water use is often estimated at 50% of total water consumed. New irrigation application tools, when coupled with sensing systems, water management strategies, and water efficient crops promise to improve water use efficiencies and water quality.

Many irrigated agricultural fields have highly variable soils. This variability often ranges from the very sandy to the poorly drained. Current pivot irrigation systems are not capable of varying the rate of water application to meet the needs of the plants on different soil types. This results in over applying or under applying irrigation water to the crop. In doing this, the positive economic and environmental impact of irrigation will be less than if the water could be more precisely applied.

Materials and Methods

Resulting from a public and private sector partnership a simple, cost-effective way to vary irrigation rates within a field has been developed and tested. The engineering concept is to deliver water to each area within a field as needed, rather than a blanket rate or rates defined in wedges. This system integrates GPS positioning into a control system which times (seconds on per minute) individual or groups of nozzles off and on according to soil and crop needs in that part of the field, rather than every area getting the same rate. In doing so the system avoids off target water applications like roads, waterways and non-cropped areas, boggy spots, and overlapping pivot areas. The variable rate irrigation system retrofits on existing systems. The major components of the system include:

- programmable controller / software / user interface screen
- Asco air control valves (24 VDC actuated)
- Bermod flow control valves (air actuated)
- Nelson pressure control valves
- quick-change dual flow rate spinner nozzles
- air compressor / reservoir tanks
- DGPS receiver (for end-tower position/angle).

Results and Discussion

In 2002 and 2003 we collected detailed information on three test pivots located in three different areas of Georgia. In Screven County, Georgia the 87 acre pivot field saved 1,790,000 gallons of water. In Colquitt County the variable rate irrigation system saved 3,560,000 gallons during the 2002 growing season by just controlling the end gun and last section of the 162 acre pivot. Near Arlington, GA the 30 acre pivot saved 1,680,000 gallons with the variable rate system. Saving from other systems is detailed along with the irrigation control map in the accompanying figures.

The savings potential for any field is easily calculated. An FSA aerial image can be used to establish field size, watering zones and end gun control areas. ecause this technology will be there year after year, the water savings will reoccur every year the system operates. Water application records, easily retrieved from the pivot controller, help document actual water saving.

We have documented increased yield, often due to planting and harvesting efficiencies due to each field area receiving the right amount of water, boggy areas less, sandy areas more, roads and waterways none. Cropping patterns in the field can be optimized, you don't have to farm a pivot in half or quarter circles any more. Also we noted that by enabling the pivot to cover the field at optimum speed (variable speed control allows pivot to move quickly over boggy spots and waterways and will slow down over the sandy spots, rather than running them twice) has reduced the time needed to water a field. Boggy spots are less boggy, aiding tillage and spraying operations.

Summary

During the past three years we have field tested variable rate pivot irrigation systems on four commercial farms and on two experiment station sites. This system delivers water to each area within a field as needed, rather than a blanket rate or rates defined in wedges. Initial studies indicate that water use efficiency gains of 7% to over 20% are reasonable to expect from this system. Yields and management efficiencies have increased as a result of better water placement. System parts run approximately $5,000 for a 100 acre pivot.

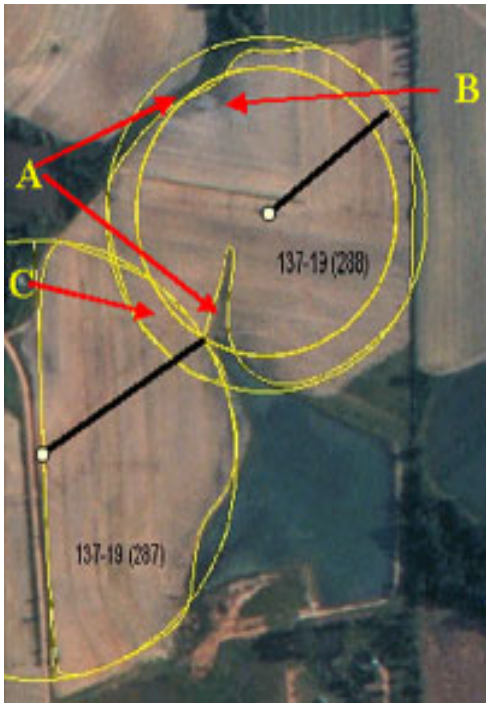

Figure 1: The new tools better place water where, when needed and at the exact needed rate. Off target water applications like roads, waterways and non-cropped areas (A), boggy spots (B), or overlapping pivot areas (C), as shown in this aerial photo are reduced or eliminated.

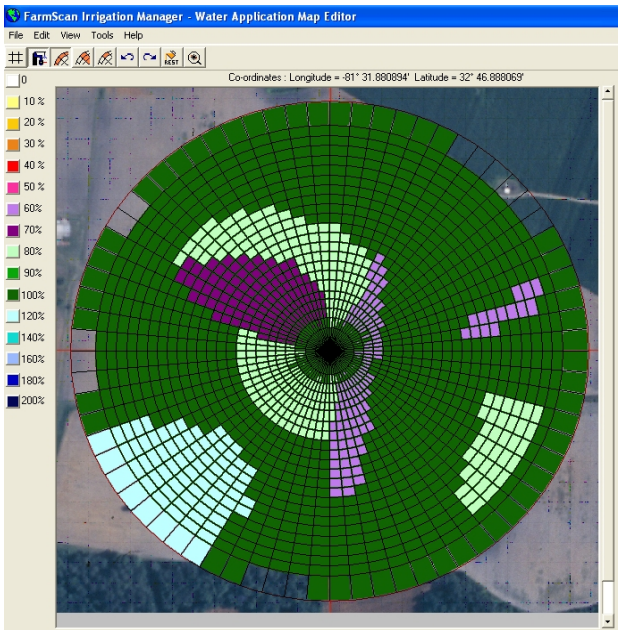

Figure 2: Every field is different. Some fields will save a great deal of water, others less: For example in this 32 acre field in Colquitt County, the variable rate irrigation system controls on all sprinklers and the end gun. A 36% water savings or 14,154,000 gals over 5 years is achieved by putting less water on the lower part of the field that tends to remain wet.

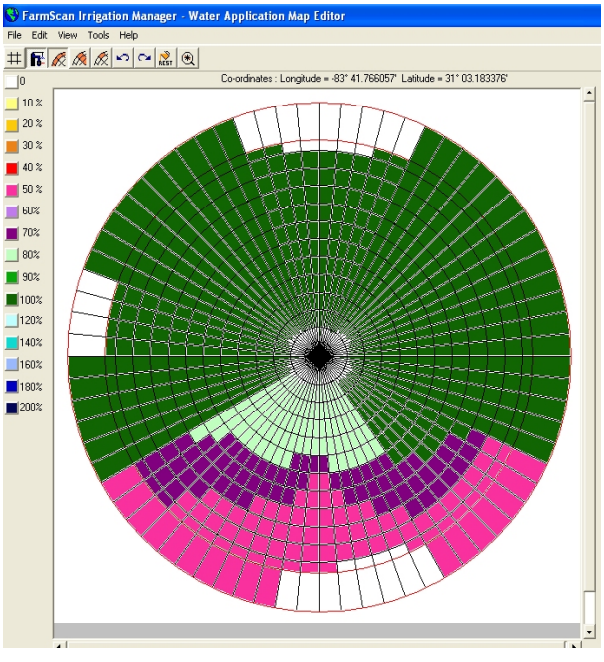

Figure 3: In this 87 acre field in Screven County the variable rate irrigation system controls on all sprinklers and the end gun. Some zones require extra water due to the sandy nature of the soil, some areas less due to their topography and soil type. Overall the system yields a 7.5% savings or 7,100,000 gallons over 5 years (using 8 irrigations of 1 inch as a base).