CONSERVATION INNOVATION GRANTS
Final Report

Grantee Name: University of Georgia	
Project Title: Demonstration & Evaluation of Precision Pivot Irrigation Control To Optimize Dairy Waste Application	
Project # NRCS 69-3A75-7-119	
University of Georgia Account # 2521 RF 327174	
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Period Covered by Report: 1 October 2007 - 1 April 2011	
Project End Date: 23 September 2011	

Project Background

In Georgia (GA), there are approximately 290 dairies in operation producing some 1.4 billion pounds (lbs) of milk annually. At a farm gate value of $296M/yr, dairy ranks 8th in GA's commodity rankings. Waste management at these dairies is a major concern of operators as dairy animals produce about 12gal. of manure (feces & urine) per 1000 lb average live weight per day. Because manure contains all 13 of the essential plant nutrients, many dairy operators use center pivot (CP) irrigation systems to land apply waste to nearby fields and pastures. It is estimated that in GA there are between 50-75 dairies that use CPs for waste application.

Georgia law requires that no wastewater be discharged into "waters of the state" (i.e., streams, wetlands, ditches, etc). The Georgia Department of Natural Resources' regulations require a "setback" for any dairy with more than 700 mature cows. The rule, 391-3-6-.21 Animal (Non-Swine) Feeding Operation Permit Requirements, states "*A setback shall be maintained of 100 feet between wetted areas or waste disposal areas and drainage ditches, surface water bodies, or wetlands. As a compliance alternative, the owner may substitute the 100 feet setback with a 35 feet wide vegetated buffer where waste disposal is prohibited*." This requirement means that operators should not apply waste material on top of or near environmentally sensitive areas like wellheads, surface waters (drainage ditches, wetlands, streams, etc.), grassed waterways or where it can be easily washed into these sensitive areas. Meeting this requirement has proven difficult if not virtually impossible since the natural topography of the land requires most CP irrigation systems to cross drainage ditches, waterways, and/or sometimes streams or wetlands. An estimated 25% or more of waste-applying CPs in Georgia pass over some type of sensitive area.

If these CP systems are to be used to apply animal waste, something must be done to either contain or filter the outflow from these ditches before they enter surface water or to keep the system from applying waste while it is passing over the ditch. Currently, operators have no easy

means of automating a CP such that application in these environmentally sensitive areas can be avoided. Operators must physically travel to the control panel of a waste-applying CP, and then either reverse travel direction when approaching a “setback” zone or shut off waste water being pumped to the system as the system traverses the “setback” zone. This substantially limits the useable area under many CPs that apply waste and requires considerable time/effort by the operator. Ditches or wetlands rarely match up with the radial nature of the CP system, and it is impractical to turn off the entire irrigation mainline while it is crossing the ditch. Operating around these sections could conceivably require the irrigation mainline to be turned off 25% or more of the circle and would make it economically unfeasible to use. Figure 1 illustrates an example of the impact of “setback” zones on an area potentially useable for waste application.

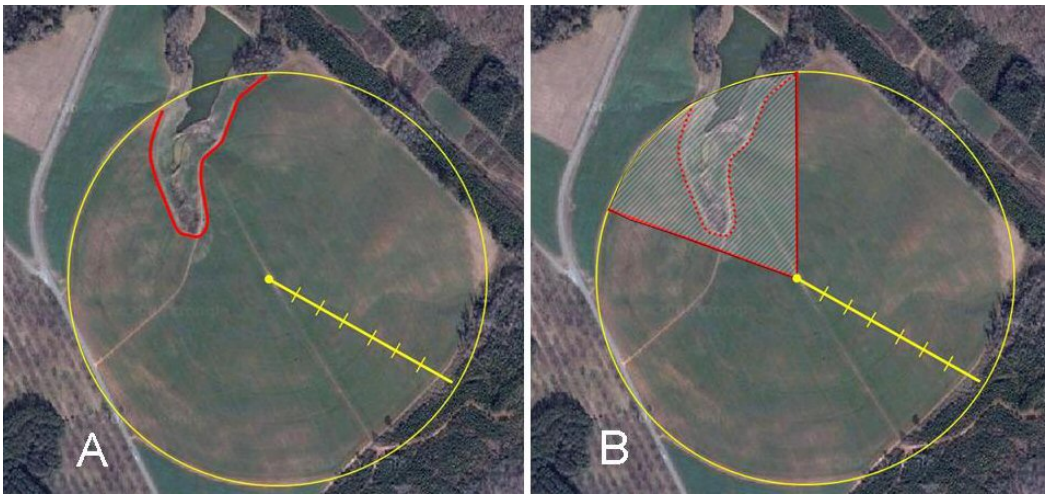

Figure 1. Example of field with environmentally sensitive area. A shows the area delineated in red. B illustrates the effect of "setback" zones on allowable application area.

A potential solution to the problem of no waste application in “setback” zones is installing control hardware that will allow the user to selectively turn on and off different sprinkler sections of a CP as it passes over these “setback” zones. Thus, allowing portions of the CP to be used safely for waste application on areas outside the “setback” zones while sections directly over “setback” zones are off (not applying waste), thus, allowing waste to be applied on the majority of the field and still maintaining a safe buffer around any ditches, streams, or other environmentally sensitive areas. An additional benefit of this technology is it can be used to vary the rate of application of manure fertilizer on different parts of the field, thus more accurately and efficiently manage the cropping system being irrigated and potentially increase profitability.

The University of Georgia (UGA) Precision Agriculture Team developed a prototype method for differentially applying irrigation water to match the precise needs of individual sub-field zones. Recognizing that water is the major yield determiner in nearly all agricultural settings, the original interest lay in varying application rates from a precision crop production (agronomic) viewpoint. However, it was quickly apparent that a method for varying irrigation across a field could also lead to substantial water savings and could be used to limit application in environmentally sensitive areas in fields. The method is referred to as Variable-Rate Irrigation (VRI).

The UGA VRI system, which easily retrofits on existing CP systems, integrates GPS positioning into a control system which cycles individual sprinklers or groups of sprinklers OFF and ON (seconds ON per minute) and varies travel speed to achieve desired rates within management zones. In doing so, the system also avoids off-target water applications onto roads, waterways and non-cropped areas (like "setback" zones), boggy spots, and overlapping pivot areas. The pivot covers the field at optimum speed, as 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. Poorly drained spots are less boggy, aiding tillage and spraying operations. A water application map, developed on the user's desktop PC, is loaded into the controller's memory and directs the control system to achieve desired rates. Figure 2 illustrates a typical water application map.

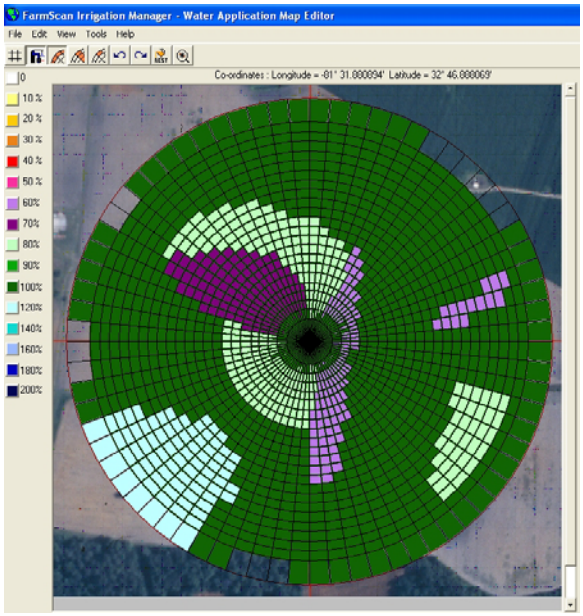

Figure 2. VRI water application map.

The UGA VRI system has been field proven after extensive, initial testing on 6 prototype installations. In 2004, the VRI system was commercialized by Hobbs and Holder, LLC., of Ashburn, Georgia. That same year, the UGA Precision Agriculture Team was fortunate to receive a Conservation Innovation Grant: "Demonstration of Variable-Rate Irrigation for Water Conservation and Application Optimization", which, by providing a 75/25 cost share, allowed for installation VRI systems on producer-owned CP systems in GA, South Carolina, and Arkansas. The grant has also allowed for demonstration of the use, benefits, and effectiveness of VRI for irrigation management, water conservation, and optimal application efficiency. USDA-NRCS EQIP funding in numerous states has also provided cost-share monies for VRI installations. VRI is now commercially available through Advanced Ag Systems Inc. (Dothan, AL). To date, well over 100 VRI systems have been installed, primarily on row-crop and turf CP systems. These systems have proven to be reliable and effective, saving an average of 15% of the irrigation water normally applied in non-VRI mode.

Figure 3. Control valve for CP sprinkler under VRI control.

Figure 4. CP with VRI controls turning off certain sprinklers as sensitive areas are passed.

VRI has the potential to give dairy operators the ability to fine tune their waste water application, avoiding the environmentally sensitive "setback" areas as the CP makes its way around the field. Obviously, VRI will not be the solution for every dairy. However, it can be the best answer in many situations. Increasing pressure on dairy operations will soon come in the form of tightened regulations that assure that cropping systems make efficient use of manure nutrients.

Project Objectives

The objectives of the proposed project were:

1. Install Variable Rate Irrigation (VRI) precision control systems on suitable producer-owned CP irrigation systems that apply dairy waste water over fields with environmentally sensitive "setback" areas.
2. Demonstrate the use, benefits and effectiveness of VRI precision controls for limiting waste water application in environmentally sensitive areas in fields as well as for varying the rate of water and nutrient application on different parts of the field.
3. Inform and educate stakeholders and policymakers as to how VRI precision controls can play a role in benefiting the dairy producer as well as the environment.

Summarize the Work Performed During the Project

Before VRI installations on commercial, private dairy CP systems, the team retrofitted the conventional CP irrigation system pivot on the UGA Tifton Campus (research dairy) with the precision/VRI controls. This CP system is used to apply dairy waste to the cropped farm land adjacent to the research dairy facilities. The purpose of the installation on the UGA farm was to

test the technology using dairy effluent, as opposed to "clean" water application, before any on-farm installations were done. The team looked at performance of metal and plastic control valves at each sprinkler. The control hardware and software was also thoroughly tested. After a few initial tweaks by the vendor, the VRI system on this pivot has functioned properly.

The team made site visits at sixteen (16) CP irrigation systems at dairies in Georgia and Florida to determine suitability of the CP systems for VRI controls. Seven VRI systems on six dairies located throughout the state of Georgia (Brooks, 2 in Burke, Morgan, Grady, Putman Counties) and 1 in Florida (Suwannee County) were cost shared for VRI installations. The CP systems not selected for inclusion in this project were in Bacon, Decatur, Lee, Macon, Mitchell, Sumter, and Wilcox counties in Georgia and Lafayette County in Florida. Since the project did not target any specific region of the states there was the added benefit of providing multiple opportunities for disseminating the information gained from this project.

Nine 'major' workshops and/or field days throughout Georgia were held to showcase and demonstrate VRI controls for CP systems. Numerous other small or impromptu meetings with dairy farmers were held.

Project members are continuing to work to with the farm managers to ensure they feel comfortable using the software and making any desired changes to the application maps. The team has worked with the vendor to develop initial VRI maps for each of the VRI installations.

Grant Expenditures

Grant payments received:
As of the end of the project, $407,166 of the grant funds have been utilized (100% of funds).

Has there been a change of in-kind partners or contributions to the grant? If so, are there contributions with in the 25% of the 50% match of non-federal funds?
There were no changes and the in-kind match was fully meet.

Benefits or Results Expected and Transferability

Dairy operators will benefit in several ways from installation of VRI on their waste-applying CP systems. The local/regional environment will also benefit from the use of VRI on such CP systems – which impacts the good of society as a whole.

Operators

- potential to apply waste water over larger land areas
- optimized water application
- enhanced crop production
- becoming 'pro-active' in waste water management

Environment

- no wastewater discharged into "waters of the state"

• runoff reduced as water application is optimized for soil types/slope
• wastewater not over-applied where adjacent pivots overlap
• helps preserve habitat for wildlife, fish, shellfish and other biota

Since the waste-applying CP systems in Georgia are the same as pivots used throughout the U.S., benefits from this project are **directly transferable to other regions** of the U.S.

Environmental Impacts

The purpose of this project was to retrofit waste-applying CP systems with VRI controls to enable waste to be applied on the majority of a field while giving a safe buffer around any ditches, streams, or other environmentally sensitive areas where waste should not be applied. Additionally, the VRI controls will allow the operator to vary the rate of application of manure fertilizer on different parts of fields with varying soil types, topography, and crop needs, including eliminating double application in overlap situations, thus more accurately and efficiently manage the cropping system being irrigated. The potential environmental impact of this project will be the reduction or elimination of wastewater from entering "waters of the state" by either direct application or runoff.

Results and Conclusions

Grant Accomplishments—Products:

During the course of the grant, site visits for sixteen (16) CP systems on fifteen (15) dairy farms were conducted and seven (7) VRI cost share systems were installed (6 in Georgia and 1 in Florida). In addition, the team had one installation on the UGA Tifton Campus. This installation was initially used to help troubleshoot the conversion of the technology from the use of "clean" water to effluent water. There has also been a significant advancement in the amount of awareness of the VRI technology. VRI is now known nationally (for use on both row crops and diary pivots). Major center pivot manufacturers are now offering their own versions for such technology.

Recent Environmental Protection Agency (EPA) inspections on Confined Animal Feeding Operations (CAFO) in the Southeast have resulted in enforcement actions and significant fines. One dairyman in Georgia spent several hundred thousand dollars to appease EPA and has not yet completed his settlement requirements. One of the violations found was that he was not following the buffer requirements defined in his nutrient management plan. This operation uses center pivot irrigation systems to apply lagoon effluent to cropland. Some fields contained drainage ditches which in the nutrient management plan required 35 ft buffers on both sides of the ditches. Since this land was under center pivot, it was not possible to remove the required buffer areas from land application. The producer wanted to solve this problem by installing tile drains and filling in the ditches. EPA did not agree to this solution stating that the ditches were waters of the US and could not be destroyed. A settlement agreement was negotiated with EPA

which included fines and a supplemental environmental project (SEP) to conduct educational activities and install Variable Rate Irrigation (VRI) control systems on his center pivots.

There are many benefits to using VRI. For example, this Georgia dairyman will be able to continue to apply his manure nutrients and keep land in production under his existing center pivot systems. VRI may also be a viable option on other operations that have land under pivots which have areas where reduced or no manure application is needed. However to achieve the required buffer width around sensitive areas, application amounts on adjacent land segments will also likely need to be reduced.

Education and Outreach:

A paper brochure (Fig 5) explaining VRI and its applicability to dairy waste was printed and widely distributed.

Field Days and Workshops that included discussion of VRI:
July 2008, Colbert County Alabama. Over 250 attended.
June 2009, UGA Tifton Campus. Approximately 75 in attendance (see Figure 6).
June 2009, UGA Stripling Irrigation Research Park Field. Over 100 in attendance.
July 2009, Morgan County Georgia. Approximately 50 in attendance.
July 2009, Macon County Georgia. Approximately 25 in attendance.
February 2010, Savannah Georgia. Approximately 150 in attendance.
March 2010, Macon County Georgia. Approximately 25 in attendance.
July 2010, UGA Tifton Campus. Approximately 150 in attendance.
April 2011, Morgan County Georgia. Approximately 30 in attendance.

In addition to these specific field days and workshops, the team took advantage of numerous opportunities to discuss VRI applicability to dairy CP situations with dairy farmers as they interacted with them on dairy visits, at livestock events, at professional dairy meetings, and at other events such as the Sunbelt Ag Expo.

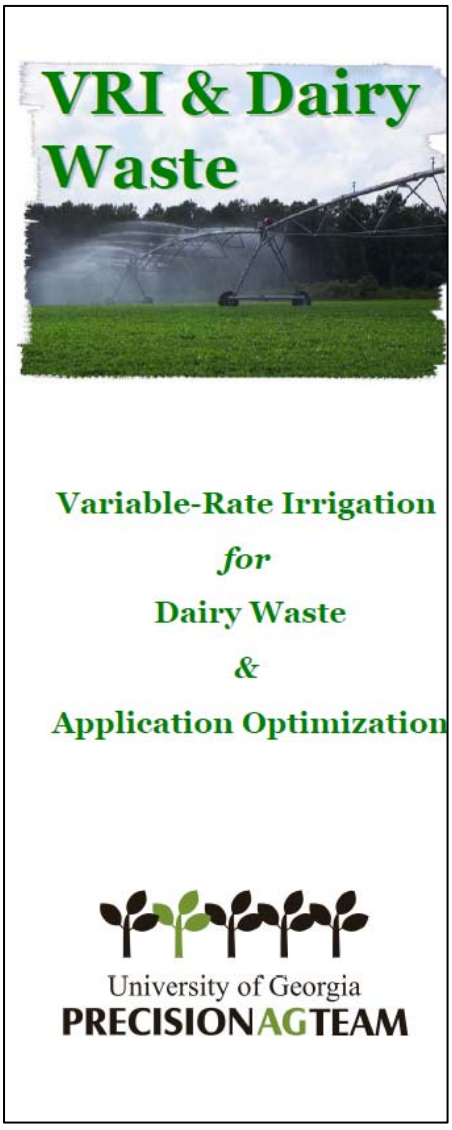

Figure 5. CIG project brochure.

Lessons Learned:

Some of the lessons learned from carrying out this CIG project for demonstration and evaluation of VRI for CP application of dairy waste include:

• Dairy operations are very cost sensitive.
• The dairy industry continues to be in flux.
• It's all about the MILK.
• Care and performance of livestock is highest priority – dealing with waste is a low priority.
• Dairy farmers are very dedicated to their profession.
• Most dairy farmers are keenly aware of environmental regulations.
• Some dairy farmers are pro-active in dealing with regulations, some are reactive only.
• CP systems that apply waste behave quite differently than CP systems applying fresh water only.
• Dairy effluent will clog sprinklers, valves, orifices, etc. if the opening is too small.
• Most dairies are moving to having "big guns" on their CP systems instead of spray nozzles.
• If using VRI to keep CP waste water out of environmentally sensitive areas, there will likely be less of the field watered due to the physics of water delivery (sprinkler wetted diameters) that must be accounted for.

Figure 6. Field day on UGA Tifton Campus showcasing VRI for dairy waste. Center pivot in background is fitted with VRI controls.

Cost-Share

In accordance with the Environmental Quality Incentives Program (EQIP) and CIG grant agreement provisions:

A. A listing of EQIP-eligible producers involved in the project, identified by name and social security number or taxpayer identification number;

   Brooksco Dairy (EIN # 58-2361966) (one system)

   Grady Ranch, LLC (EIN # 27-4848010) (one system)

   Harmony Grove Dairy Farm, LLC (EIN # 58-2600550) (two systems)

   Shenandoah Dairy, Inc (EIN: 58-1765694) (one system)

   L. Harvey for Sunrise Dairy (SSN: 258-81-0756) (one system)

   WDairy, LLC (EIN # 37-1560719) (one system)

B. The dollar amount of any direct or indirect payment made to each individual producer or entity for any structural, vegetative, or management practices. Both biennial and cumulative payment amounts must be submitted.

   Brooksco Dairy - $20,205.00

   Grady Ranch, LLC- $17,700.00

   Harmony Grove Dairy Farm, LLC-$22,997.00

   Harmony Grove Dairy Farm, LLC-$16,750.00

   Shenandoah Dairy -$13,800.00

   L. Harvey for Sunrise Dairy-$15,640.00

   WDairy, LLC - $12,029.40

C. Self-certification statements indicating that each individual or entity receiving a direct or indirect payment for any structural, vegetative, or management practice through this grant is in compliance with the adjusted gross income (AGI) and highly-erodible lands and wetlands conservation (HEL/WC) compliance provisions of the Farm Bill are available upon request.