STATUS OF GEORGIA'S IRRIGATION SYSTEM INFRASTRUCTURE

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INTRODUCTION

For many years, the Georgia Cooperative Extension Service (CES) has worked to track Georgia's irrigation infrastructure so that it could provide education, service and research programs for farmers who irrigate. The Georgia Irrigation Survey has been conducted at intervals of one to three years since 1970, most recently in 2004 (2004 data not compiled at time of printing). The Extension unit of the Biological & Agricultural Engineering Department sends this survey to the Extension agent in each of Georgia's 159 counties who is responsible for agriculture and natural resources programs. This individual fills out the survey form based on his knowledge of agricultural practices in his/her county. The forms are then returned to the Extension engineering unit where the data is compiled and distributed. Basic information from the survey has included irrigated area and irrigation amounts for each major crop. Types of irrigation systems, water sources, and pumping plant power sources have also been enumerated, but little to no information was collected about repairs, changes, or upgrades made to the irrigation systems. Summaries of these surveys have been shared with the irrigation industry by means of the Irrigation Journal's annual survey of irrigation in each state.

A new opportunity to define the state's irrigation systems was created when the state began to regulate water withdrawals for irrigation. In 1988 Georgia's Groundwater Protection Act and Surface Water Quality Control Act were amended to require those who made withdrawals for agricultural irrigation to obtain permits from the Georgia Environmental Protection Division (EPD). During the next 10 years nearly 20,000 permits were issued. Farmers were asked to supply information about their pumps and wells, but they were not asked to describe their application systems. Unlike municipal and industrial users, agricultural users were exempt from water metering and reporting. This left EPD with names of permitted irrigators and general locations of their withdrawals but little to no information about how and when the water was used. They did stipulate limits on pumping rates (described in gallons per minute) and maximum irrigated area (acres), but no field verification was conducted. As water planning issues grew in importance, EPD turned to the CES for assistance in obtaining more specific answers to the questions "How much, when, and with what equipment?"

A statewide irrigation monitoring program was established for Georgia by UGA scientists and CES. A two percent sample of existing EPD-issued irrigation permits was randomly selected for monitoring of agricultural irrigation withdrawals. That total number was based upon estimates of monitoring costs versus available resources, but in a large population a 2% randomly selected sample would not be considered unreasonable. Selected participants were asked to participate voluntarily and most agreed. The monitoring program was conducted over a 6-year period (1999-2004) to make certain that drought years would be encountered and that crop rotation would also be "cycled through the sample population".

The approach for the monitoring program, which became known as Ag Water Pumping (AWP), included monthly field visits to each of more than 800 irrigated fields. Project personnel recorded crops grown, systems in use, and accumulated hours of operation. Since flow rates were measured on each system under normal operating conditions, they were able to determine volumes of water removed from surface and ground-water sources. This timer approach eliminated the need for, $1000 each, up-front meter installation and allowed AWP to get accurate answers in a short time period. Current water use was recorded by type of irrigation system, source of water, type of crop and time of year in both severe drought years and in moderately wet years. Using the random sample of existing water users in combination with the survey information should allow projections for future water needs to be made with computer models. In addition to water use data, wells, pumps, and irrigation systems were documented. These descriptions detail the status of irrigation system infrastructure in Georgia - the subject of this paper.

CES Survey of Irrigation Systems

Georgia is among the top ten states nationally in area under irrigation by sprinkler systems (Table 1). Triennial CES surveys in Georgia show the total irrigated area in the state has gone through two growth periods (Fig. 1). From 1975 to 1980, there was a very rapid increase in irrigation as high commodity prices and competition led to a rapid

Table 1. Sprinkler-irrigated area in those U.S. states with the greatest sprinkler area.

State	Irrigated Area (ac)*
Nebraska	5,150,000
Texas	4,050,000
California	2,792,000
Idaho	2,584,300
Kansas	2,402,287
Washington	1,625,000
Georgia	1,362,835
Colorado	1,351,000
Montana	1,215,500
Missouri	671,400
Florida	667,000

Source: Irrigation Journal, January/February 2001

increase in irrigation even though the period was not marked with significant droughts. The ability to install center pivots that required little field labor encouraged this trend. In the early 1980's, farm prices collapsed, and little new irrigation was installed. By the mid 1980's summer droughts became more common and more serious. Bankers began to demand better protection for crop loans, and labor became less available in rural areas of the state. Since that time a second, steady annual increase in irrigated area has occurred in Georgia.

The CES surveys have also documented shifts over time in the preferred irrigation systems (Fig. 2). During the rapid growth period of the late 1970's both center pivots and travelers were being purchased. Since the 1980's relatively few travelers have been purchased, most of those as replacements. These systems required too much time and labor to set up, and labor has remained scarce on

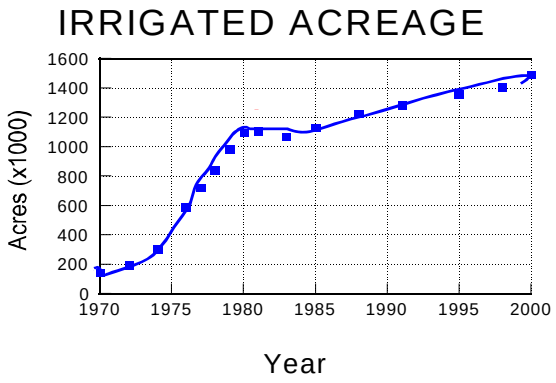

Fig. 1. Total irrigated area in Georgia as reported in CES Irrigation Surveys. Figures include drip and microirrigation, as well as sprinkler irrigation.

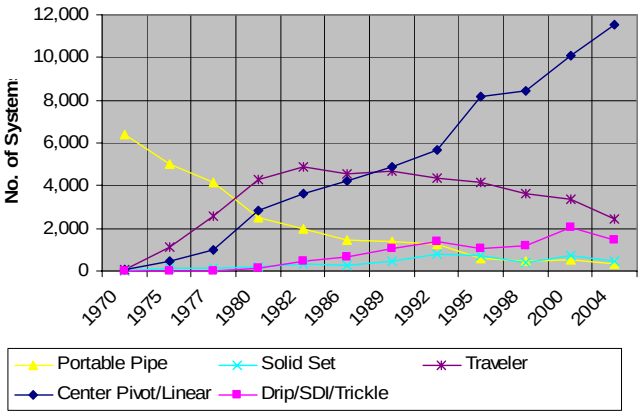

Fig. 2. Number of irrigation systems by type as reported in CES Surveys.

Georgia farms. As we observed during the Ag Water Pumping study, many of those traveler systems remained unused much of the time. Center pivot systems, however, continued to increase in numbers. Solid set systems made up the remainder of Georgia's sprinkler-irrigated land. Most were used in pecans and other permanent orchard crops or in athletic fields and golf courses that are considered agricultural water use by EPD in most of the state.

Besides the sprinkler systems, a slow and continuing growth has occurred in drip and other micro-irrigation systems. Many of the drip systems have been installed as alternatives to solid-set sprinklers in pecans; others are new vegetable production systems with drip under plastic mulch. In recent years, drip irrigation has been installed under center pivot systems or in replacement for them as vegetable production continued to increase in South Georgia. Maintaining the center pivot in these fields may permit growers to rotate among non-vegetable crops in order to suppress weed and disease problems, or farmers may be hedging their bets and maintaining future options as they retire the units in favor of drip irrigation.

The CES Survey showed that by 2000 about 75% of the irrigated area in Georgia (1,120,000 ac) was being irrigated by 9,600 center pivots. Other sprinkler irrigated acres (methods) included 3,350 travelers irrigating 242,000 ac and 460 solid set systems providing irrigation on 31,000 acres.

AWP Monitored Irrigation Systems

While the CES surveys provided valuable insight to the irrigation infrastructure, the Georgia EPD wanted detailed information on annual water use from a selection of its agriculture permit holders. In the process of selecting and describing the irrigation systems used with these permits

and in our monthly return visits to each system over the past 5 to 6 years, we have gained considerable understanding of Georgia's irrigation infrastructure. The infrastructure is both complex and dynamic.

Center Pivot Systems

As noted in the CES survey, the vast majority of irrigation systems in the state were center pivots (Table 2). Of the monitored 604 systems connected to 448 permitted withdrawal points, 86% were permanent or portable (towable) center pivots. This discussion will concentrate on center pivots since they constitute such a large majority of the systems. Table 2 also points out that, even in drought years, center pivot systems are not always used. Market share among sampled pivots in Georgia was as follows: Valley, 44.7%; Lindsay (Zimmatic), 30.5%; Lockwood, 10%; Reinke, 8.0%; Rainbow, 2.3%; Gifford Hill, 1.4%; TL, 1.1%; Raincat, Pierce, and unknown made up 2.0%. Georgia's center pivots are aging. Almost 45% are 15 years or older; 32% more than 20 years; 17% are over 25 years old. Almost all of these systems were operated each year (Table 2), indicating the remarkable durability of the pivots and their ability to be maintained and upgraded. About 10% of the pivots were portable (towable) units at the time that the statewide sampling was started. Because of work involved in moving the units, there was a greater tendency not to use some of the fields irrigated by portable pivots each year (Table 2). In some cases the pivots themselves were not used at all in some years.

Throughout the 6 years of the study, farmers continued to modify and upgrade their irrigation systems. When permanent center pivots were replaced, it was usually in conjunction with property changes, land clearing, or smaller pivots being replaced by large units. Portable pivots were also changing. Usually a farmer chose one of the multiple riser points and permanently locked down the portable pivot. A new pivot was installed for the other riser point.

Despite the added aggravation for operation of part-circle center pivots and the higher per acre cost of these systems, 34% of Georgia's pivots could not be operated full circle. Additionally, 23% of portable pivots could not operate in full circle on at least one riser point. Fence rows, property boundaries, ponds, wetlands, utility poles, roads and buildings, as well as other pivots, created obstructions that prevented the full circle operation. Forests were also common in the non-irrigated section, but usually they were in conjunction with some other obstacle. Clearing of forests and sometimes riparian areas and drainage ways were common in pivot areas, even when these could not be planted with crops.

About 18% of systems were still equipped with high pressure, high angle impact sprinklers. Of these, almost a third have been installed on systems younger than 15 years. Low pressure, low angle nozzles are more common; 59% of pivots were equipped with them. About 24% of systems in our sample were equipped with sprays on top, while only 1% were equipped with sprays on drops.

WATER APPLICATION INFORMATION

Throughout the period of this study, irrigation systems were changed. Traveler-irrigated fields were reconfigured and drip systems were installed as vegetable production began on previous row-crop fields. Portable (towable) center pivots were locked in one position and a new permanent center pivot was added at the second riser. Older, often smaller, pivots were replaced by new pivots, and wooded borders were cleared to expand the coverage of pivots that had been operated in a part circle mode previously. In one case a center pivot was idled and drip irrigation installed in its field. The tendency of these changes was to increase water use by shifting to systems that have higher average water use or to increase areas irrigated by the monitored withdrawal source.

A comparison of the water amounts obtained is shown in Table 3 for crops grown in Georgia. Not all crops were statistically represented by the monitoring project in 2000. Crop year 2000 was chosen because that is one year that both CES water use estimates and monitored water use were available. Water application amounts are in agreement for most crops that had representation in the monitoring project.

Table 2. Average number of irrigation systems by type in the random sample monitored during statewide sampling 2001 to 2003, and the percent of those monitored systems or fields that applied no irrigation applied during each year.

Irrigation System Type	Ave. No. in sample	00	01	02	03
		%	%	%	%
Perm. Center Pivot	474	2	4	8	11
Port. Center Pivot	48	11	9	6	19
Traveler	38	25	54	60	75
Drip	18	0	11	16	20
Set Sprinklers	26	6	4	3	13

Table 3: Water Applied in 2000

Crop	Inches Applied* (# sites)	Inches Applied**
Corn	13.6 (33)	14.1
Cotton	8.6 (148)	11.6
Peanuts	8.6 (104)	11.2
Tobacco		7.4
Soybeans	6.2 (24)	6.0
Small Grains		4.4
Vegetables - Sprinkler		10.5
- Drip	***	12.6
Pastures		7.5
Apples		6.0
Blueberries		8.9
Peaches	***	7.2
Pecan - Sprinkler	12.4 (9)	13.8
- Drip	4.2 (11)	12.8
Field Nursery	***	35.5
Vineyards	***	13.0
Turfgrass		18.3
Greenhouses	***	14.2
Golf Courses	***	31.6
Athletic Fields		
All Other Crops		7.6
Statewide Average	9.4 (385)	9.7

* Information was obtained from Ag Water Pumping program sample monitoring on 32,416 acres.
**Information was compiled from estimates supplied by county Extension agents.
***Not listed since small sample size could reveal individual data.

SUMMARY DISCUSSION

Even though Georgia receives a relatively abundant amount of annual rainfall, the patterns of rainfall are very inconsistent, particularly during the summer growing season. Consequently, irrigation is increasingly being viewed as a necessary input for profitable agricultural production in Georgia.

Irrigated acreage in the state has increased more than ten-fold since 1970, but indications are (Fig. 1) that future growth will occur at a much slower pace. Increasingly, farmers are using more efficient methods of irrigation which should help improve the effectiveness of the irrigation water applied.

The amount of irrigation water applied will vary tremendously from year to year and from crop to crop depending on the amount of rain received in the agricultural areas during the growing season. Estimates of yearly average water applications agree with monitored results and indicate that annual irrigation water use fluctuates between 100 and 300 billion gallons. Higher irrigation use will generally occur during periods of lower than normal rainfall. Since this typically coincides with periods when water tables are naturally low, this may present an interesting challenge in managing the states water resources. A second problem that arises is the unit of measurement for agricultural water use. In some areas of the nation agricultural water use is expressed in area-depth units (i.e. acre-feet) but in Georgia the units of water measurement have traditionally been volume per unit of time (i.e. million gallons per day-MGD). This has slowed communication efforts between agencies and commodity groups but should improve in time. Thus far, relatively few conflicts have occurred, and have typically been isolated incidences during extremely dry years.

The project had 644 permits monitored with 854 fields (sites). Or, on average, about 1.33 fields per permit. The total monitored acres were 75,448. These numbers more than satisfy the 2% target stated earlier. The number of center pivots monitored was 726 or 84% of the sites monitored. This number agrees with the survey information presented earlier and gives confidence to the survey information.

Other summary information obtained about the monitored center pivots included:

- The average pivot age is 13 years with 40% older than 15 years.
- Only 61% of those were able to make a full circle.
- 99% of pivots used end guns;
- 40% with operational end gun shut-off.
- 10% of pivots are towed among fields
- 88% of all pivots had improved energy and application efficiency sprinkler packages.
- 80% of the old pivots have been converted
- 40% had spray nozzles on top of pivot
- 15% had sprays on drop tubes

From the monitored sites we determined that most Georgia pivots have already been converted to low angle impact, low pressure sprays on the pivot pipe, or sprays on drop tubes.

Sprinkler irrigation systems, in particular, center pivots; are aging. Most owners have made improvements related to sprinkler packages but more expensive and in-depth changes will be needed in the future as the basic infrastructure (pivot pipe and towers) ages.

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