#21 Final 2003

NATIONAL PEANUT BOARD/SOUTHEAST PEANUT RESEARCH INITIATIVE
FINAL REPORT FOR WORK DONE UNDER RESEARCH AGREEMENT

Report Due Sept 30, 2004

INSTITUTION: University of Georgia

PROJECT TITLE: Water harvesting: Improving On-farm Ponds with Selective Runoff and Off-Season Pumping

RES. AGR. NO.: 25-21-RF324-214 PROJECT LEADER: Dr. Jim Hook

EXPIRATION DATE: June 30, 2004

SPRI CONTACT: Emory Murphy NPB CONTACT: Stephen O'Brien

Final Report
WATER HARVESTING: IMPROVING ON-FARM PONDS WITH SELECTIVE RUNOFF AND OFF-SEASON PUMPING

Southeastern Peanut Research Initiative

GEORGIA: **James E. Hook** (PI) Crop & Soil Science

Study Objectives and Approach

Farm ponds have long been a reliable water source for livestock, on-farm fishing, and recreation. They are effective in supplying irrigation in emergencies during drought years. However, farm ponds have not been well developed and evaluated as full season irrigation supply systems. Commonly, farmers start with limited irrigation from ponds. As their irrigation experience and expectations increase, they expand the pond dimensions or add groundwater during the season to refill the pond between irrigations.

New water legislation promises to make access to groundwater more difficult in several areas of the Southeast Peanut Belt. Georgia has suspended new permitting for groundwater withdrawals for irrigation in 41 counties already and, given proposed changes to Georgia water law, is likely to make those freezes permanent in some areas. Access to surface water from flowing streams is also likely to remain limited, primarily because of fears on reduction in summer low flow conditions. Meanwhile other proposed changes would bring withdrawals from farm ponds under regulatory control. These changes prompt us to examine the potential of expanded irrigation from farm ponds, particularly by capturing and retaining runoff.

Results

The prime goal of this project was to initiate new studies on water resources available for irrigation. With the funds from this project, we were able to assemble data on pond locations, high resolution aerial imagery for identifying additional ponds, and software for calculating watershed responses to additional ponds. Additionally, several questions have been explored and background information on ponds has been assembled. They are summarized in the attached report.

Two graduate programs were initiated. The project enabled us to leverage federal and UGA funds to establish a graduate assistantship in the Crop and Soils Department at UGA. Amber Alfonso is now in her second graduate semester at UGA, and she will begin defining the scope of her research on farm ponds for irrigation during spring 2005. Warren Carmichael, a student employee of the U.S. Geologic Survey and graduate student at Florida State University, has already begun studies of ponds in a sub-watershed of the Suwannee River basin. Their work should help us better understand the potential size of irrigation systems that can be reliably irrigated from farm ponds of various surface area and depth under rainfall and evaporation. It should further define to impact of ponds on stream flow and groundwater recharge in the region.

Summary

Although about of Georgia's irrigation systems rely upon surface water, less than 20% of those can obtain water directly from creeks or rivers. Ponds remain essential for collection and storage of water for irrigation. Pond capacity, however, is frequently too small for extended drought periods. Too many ponds rely upon frequent refill from the same rains that proved inadequate for maintaining soil moisture maintenance during those droughts. Direct evaporation from pond surfaces and pond leakage further limit available water. Georgia irrigators will benefit from programs that clean out or increase depth of the ponds, that minimize erosion in the rainfall capture area of the ponds, or that modify ground cover there to increase runoff of water from non-production areas of those catchments.

Farm Ponds for Irrigation in Georgia

How much do Georgia peanut growers rely upon ponds already?

During the 1999 through 2004 Ag Water Pumping Study, 1104 peanut crops were monitored for monthly water application. During the course of those meter reading visits, the type of water supply was noted, and when the water source included a pond, an estimate of the storage capacity was made from the pond area and topography. The irrigated area of each monitored irrigation system was measured, and the portion of the field irrigated for peanuts, when only part of the field was planted in peanut, was also measured.

Almost 41% of Georgia peanuts were irrigated directly from wells. Another 41% were irrigated from surface water sources alone, and the remainder from ponds that were refilled as necessary from wells. This makes Georgia peanut production about equally reliant on surface water and ground water.

Of those that were irrigated from surface water sources, 21% pulled that water directly from flowing streams. Most of these, 88%, were streams in the Kinchafoonee-Muckalee and Ichawaynotchaway sub-basins, tributaries of the Flint River. Lee, Randolph, Sumter and Early were most reliant on flowing streams, while farmers in Calhoun, Clay, Terrell, Webster and Marion counties were also using water from streams. Additionally, several counties in the Ocmulgee basin had peanut growers who were relying upon flowing streams.

With ponds making up the primary water supply on 41% of peanut growers irrigation, and ponds refilled with wells another 18%, pond capacity is important to their reliability. Although depth soundings were not made to see how much storage volume was still left in existing ponds, estimates were made from their surface area. If you divide the volume of the pond (ac-in) by the wetted area (ac) of the irrigation systems you can calculate how many inches of water can be pumped to the field before the pond must be refilled. Over 55% of all ponds that were used alone as the irrigation source, and 70% of the ponds with backup wells stored less than 2 inches of water, if it was spread to the entire field in which peanuts were grown. Only 18% of ponds could supply 4 inches or more to those irrigated fields.

Are those farm ponds adequate to meet irrigation needs?

Irrigation to peanut started as early as April in dry years, peaking in July and August as pod-fill was most active (Fig. 1). In the driest years, such as those of 2000 and 2002, Georgia irrigators applied a total of 11 inches, on average, through their systems. In contrast, the wettest years, like 2003, they applied only 3 inches. Over the 1999 through 2004 period, average irrigation applications totaled 7 inches.

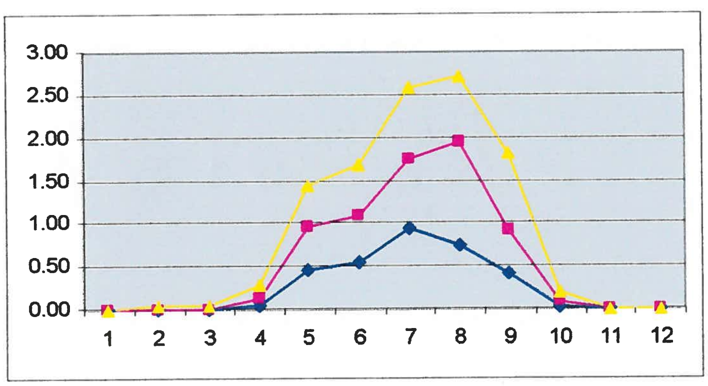

Fig. 1. Mean monthly irrigation amounts (inches) applied in the highest irrigation months (yellow, drought year), lowest irrigation month (blue, wet year) and 1999 to 2004 average (pink).

Farmers who had wells to supply their irrigation applied slightly more water that those who had to rely upon ponds. Their applications totaled 12.4, 3.5, and 7.7 inches for dry, wet, and average years, respectively. Those relying on ponds used 10.3, 2.0 and 6.1 inches for dry, wet and average years. Given the similarity of irrigation amounts, there wasn't much evidence that farmer's peanut irrigation was limited by the source of water. They used a variety of strategies to make sure that peanut had the water needed for quality nuts even in dry years.

What strategies were available to reduce risks of insufficient pond water supplies?

Although the ponds were susceptible to drying up, farmers used a variety of strategies to reduce their risks of losing their valuable peanut crop. The most important of these was to split the irrigated field, usually a pivot, into two or more fields with crops of differing economic value or time of irrigation. When a pond had limited capacity, an early irrigation crop like field corn or vegetables could be grown on part. The spring time was the mostly time that ponds could be refilled; still there was some risk that the ponds would start the peanut season partially depleted by other crops. Irrigation on spring crops would continue through late May or June with an occasional application to peanut. Then after June most of the water was provided to the peanut crop.

Besides splitting the irrigated field with an early crop, peanut often shared an irrigation system with cotton. Cotton has greater drought tolerance than peanut, and generally had a lower profit potential. If pond refilling didn't occur, irrigation could be held off the cotton until runoff refilled the supply.

Splitting of irrigated fields occurred on 50% of systems that were supplied by ponds and used for peanut production. By reducing the irrigated area, field splitting increased the number of ponds that contained over 2 inches of stored water for the peanut portion to 65% and those with over 4 inches to 32%.

How are well to pond systems used?

For many years, farmers who were commonly running short of water in their ponds, turned to groundwater for the supplementary water. When a well could be drilled with sufficient capacity to directly supply the pumping rate of the irrigation system, by-pass might be made to allow direct pumping from groundwater when the pond was low. In many cases, after the well was drilled, a permanent switch was made even though higher pumping costs might be incurred with groundwater.

But in many areas of the peanut belt, a well with sufficient pumping rate isn't feasible because of aquifer properties or drilling costs. A smaller well could be drilled that could still supplement a pond, or a pond could be used solely to hold the groundwater until it was pumped. A typical example is a center pivot that requires a pumping rate of 1000 gpm while the well could only pump 500 gpm. The well would have to run twice as many hours as the center pivot if groundwater were the only source of water. Also, additional well pumping time would be required to make up for leakage and evaporation from the storage pond.

Between the extremes of a pond used solely to hold groundwater, and ponds that rely entirely on runoff are ponds that can retain runoff for irrigation, but also water pumped when rain and runoff are inadequate to keep up with irrigation demands. For the well-to-pond systems in the Ag Water Pumping study, 71% held less than 2 inches of water, and fewer than 8% could supply more than 4 inches without refill. Clearly most of these ponds were used for storage of groundwater.

How are ponds regulated, constructed, and paid for in Georgia?

Water impoundments have been tracked with varying degrees of effectiveness by the US Army Corps of Engineers (COE), the USDA Natural Resources Conservation Service (NRCS), Georgia Department of Natural Resources (DNR), the Georgia Soil and Water Conservation Service (SWCC), and various researchers.

The COE has design and construction oversight responsibility for the largest structures in Georgia, and they operate several reservoirs that were built with federal funds for the state and region. Unlike reservoirs built in the west, none of Georgia's federal reservoirs have included agricultural irrigation in their operations mandate, and given interstate and intrastate squabbles over allocations from these reservoirs, it is unlikely that any water impounded in these reservoirs will end up on Georgia farms in the future. Although the USDI Bureau of Reclamation has construction and operation roles for impoundments for irrigation, their role has been almost exclusively used in the area west of the Mississippi River in the US. Another federal agency, the Federal Energy Regulatory Commission, has responsibility for oversight of impoundments that are used in the generation of electricity. That authority is shared with the COE and regional and local electric utility companies when the reservoir is a multipurpose structure that includes energy generation.

The Georgia EPD has responsibility for regulation of Category I dams, those whose collapse could threaten lives except for those operated by the COE. The defining laws – namely the Georgia Safe Dams Act of 1978 (O.C.G.A 12-5-370 to 12-5-385, last amended 1990) – were passed following the collapse of the Toccoa Dam in 1977. Basically, dams that have a height of 25 ft above the original stream bed or those that impound more than 100 acre-ft must be permitted or specifically exempted by EPD. EPD also has the responsibility to inspect smaller, Category II dams to see if they need to be reclassified and regulated as Category I, high risk dams. Many farm ponds fall into the Category II. They can be changed to Class I if housing or other structures with people are constructed in the emergency floodplain below the dam. Depending on their size, regulations for Category I dams requires designs engineered to retain 25 to 100% of the maximum possible precipitation. Control of erosion on dam embankments and of seepage from under and around the structures, as well as provisions for pond drainage are other provisions of the EPD regulations for ponds.

Most of the impoundments that EPD oversees fall into the classification of regional reservoirs. These are usually operated by municipalities, private companies, and/or special water authorities established by the General Assembly. Most regional reservoirs are built with a purpose of supplying water for homes and businesses, although recreation, fire control, and other uses are often included. Funding comes from a variety of federal, state, local and private sources. Water is seldom available from these for irrigation of agricultural land, except for some commercial nurseries, golf courses, and other special uses.

In addition to municipal and private impoundments built for regional water supply, there are many impoundments added to various subdivisions, neighborhoods, and commercial and private property for purposes of beautification, recreation, and/or fire protection. These are usually designed by engineers in employ of the developer and built during land shaping activities. Regulation of these dams falls under the same jurisdiction of EPD as other structures if the 25 ft and 100 acre feet limits come into play. Generally these are paid for under private arrangements.

The Natural Resources Conservation Service has traditionally been the source of pond design and construction expertise in Georgia's rural areas, whether those ponds were used for beautification, fire protection, fishing, aquaculture, livestock watering, or irrigation. NRCS (and formerly Soil Conservation Service) maintained a staff of engineers who could oversee design and construction of reservoirs built with earthen dams. The actual construction was done by private companies and, sometimes, by the land owner. These ponds were paid for by a combination of land-owner and federal money made available to qualified participants by the Farm Services Agency (and formerly by the Agricultural Stabilization and Conservation Service.) In past years there have been a variety of federal assistance programs to support development of these ponds, particularly to provide more reliability in livestock watering systems and fish production for recreation.

In addition to programs administered directly by NRCS and FSA, Georgia has seen new cost-share programs established since the 1998 to 2002 drought to encourage pond development. Unlike former programs, these have been targeted to provide water for irrigation, and they are administered by the Georgia Soil and Water Conservation Commission. The in some years, funding provided 75% cost share for up to $50,000 needed in construction of the ponds. Design and inspection were handled by NRCS who also required that an approved NRCS water conservation plan for the fields that were/will be receiving water from the impoundment and a completed GaSWCC irrigation uniformity audit be conducted on the irrigation system to be used.

There has been some confusion over these new ponds for irrigation because of the separate regulation of the withdrawal permits by EPD. First, for current pond programs, Ga SWCC required an EPD-issued permit number at the time an application was made. However, unless the planned pond was replacing a smaller one or replacing a direct stream withdrawal for which a permit existed, the new pond source will not be previously permitted. Furthermore, EPD issues only a letter of concurrence to allow construction. The permit is not issued until the pond, pump station, and irrigation system are completed.

A second source of confusion was in the request for groundwater permit. This would imply an intent to replace a well water source used for irrigation with a pond. In some cases that will be desirable, in other not. In either case, a separate permit must be issued, and the new pond withdrawal permit cannot be issued until after completion.

To make matters worse, EPD has been inconsistent in the permitting of withdrawals for farm ponds. Enabling legislation stipulates that withdrawals from farm ponds that are contained on the property of the irrigation owner do not require a permit. That language has been interpreted differently over the 16 years since agricultural water withdrawal permitting began. In 2002, lawyers for EPD decided that the loose language should be interpreted such that EPD cannot require a permit for a withdrawal for a farm pond if the source of the water is runoff that originates on the pond.

Will ponds retain their integrity over time?

Certification of NRCS pond design by its engineers, conservative designs, inspections during construction and compliance checks prior to government reimbursements have resulted in a long track record for NRCS of very useful, stable and safe ponds. Georgia Category II dams that which are found on most Georgia farm ponds do not require permits or inspections if the land owner incurs all costs, however. This means that ponds could be built with inexperienced pond builders or that short-cuts could be taken that may decrease the life and usefulness of the pond. While the land-owner and/or builder may share responsibility for damages resulting from a collapse, serious property damage and human injuries should not be as severe with farm pond collapse as with Category I dams.

Even well designed and built ponds, such as NRCS ponds, can be modified by their owners or neglected to the point that risk of failure increases. Several modifications can seriously weaken a pond dam making it vulnerable to collapse during storms, including: 1) adding collars or extensions to the spillway riser/overflow pipe; 2) lowering the elevation of the pond dam in any place for aesthetic purposes, to provide fill, or to create a surface road; 3) filling in the emergency spill-way or replacing it with an inadequate culvert pipe; and 4) cutting through the dam to replace a spillway pipe and refilling that trench. Some changes occur naturally, but they may also threaten the safety of the dam: 1) cattle grazing on the slopes of the dam or walking on its slopes to reach the water; 2) muskrats excavating burrows into the dam face; 3) erosion removing soil from slopes of the dam; and 4) trees growing on the dam or dam slopes. Some farmers modify the storage area in undesirable ways. Excavations to expand storage of the pond or to cleanout accumulated sediment may increase storage volume, but they can disturb the clay liner of the pond increasing leakage and seepage. Soil that runs off cultivated farmland or construction in the pond's watershed can quickly fill a pond reducing its storage capacity.

Tree growth along the edges of the pond is generally considered undesirable in more arid areas. Trees, especially deep rooted ones, would normally reduce transpiration (and growth) in times of limited soil water, but they will maintain it if soil water is available because of nearby ponds and canals. In the Southeast, however, the trees adjacent to ponds will probably take up less water than they save by shading the pond and blocking wind flow across its surface.

If designed for the intended use and hydrologic conditions and built according to design, farm ponds can function as reservoirs for irrigation water for many years. With minimal maintenance of the pond and cover in the watershed, the pond safety and integrity will be assured.

How many EPD Agricultural Water Withdrawal Permits have been issued for pond sources?

At the start of the Ag Water Pumping study a database was created to provide selection for random sampling with the sample number in proportion to the type of water supply. In 1999, which also corresponded to the time when permit freezes were imposed in Southwest Georgia, there were 18,883 agricultural permits statewide, 17,479 in the peanut producing counties. In those peanut counties, there were 7133 permits for groundwater, 9500 for surface sources and 484 for well to pond systems.

As simple as these categories seem, inconsistencies in description by farmers during permit application, changes and additions to permitted systems after the original permitting, and inconsistencies in permitting by EPD has left these numbers in some doubt. A permit issued as a 'well-to-pond' almost always included both a pond and a well. Except for unreported changes in the pond or well – using the well directly and leaving the pond for runoff, for example – these were accurately represented as 'well-to-pond.'

A system permitted as 'groundwater' most commonly had a well directly feeding the irrigation system. However, some wells were permitted for direct withdrawals even though in actuality they were refilling ponds. These typically had an earlier surface withdrawal permit for pond withdrawals. The permit application did not provide a mechanism for applicants to tie applications together. Additionally, other 'groundwater' permits were issued when a farmer said that the pond in a well to pond system was primarily supplied from groundwater, whether or not runoff was also collected. The affect of this inconsistence was readily apparent as we established monitoring sites. The participating farmers agreed to participate in monitoring, but the permitted site did not agree with the permit. We monitored what was at the site regardless of what a permit said.

A similar situation occurred with 'surface water' permits. Several of those that were selected actually had a permitted well and were part of a well to pond system. Again the system in place was described and used in the figures included in this report.

There was some question of how effectively permitting reflected actual pond use for irrigation. EPD lawyers have suggested that laws requiring permits for surface water withdrawal were, at least, ambiguous as regards the requirement for a permit for withdrawal from a pond that was completely surrounded by land owned by the pond owner. Nonetheless, 90% of surface water permits, 8546 out of 9500 in the peanut counties were issued for withdrawals from farm ponds or lagoons. Over 6400 of those applications specifically named a 'pond' as the source.

How many farm ponds are there in Georgia?

While it is impossible to separate farm ponds from homeowner ponds, NRCS has mapped over 68,000 man-made ponds smaller than 50 acres in South Georgia. Combined they have a storage capacity of 850,000 acre-feet assuming an average of 5 ft depth over the entire surface area of the pond. The average pond size was only 2.5 acres, a size that could only supply 12 acre-feet of storage or enough water for 1.5 inches for an average sized 100 acre center pivot.

To have a 4-inch storage capacity for a 100 acre field, a pond would have to hold 33 acre-feet – typically ponds with a surface area over 6 acres. There were only 5582 ponds of this capacity, 8% of the total.

How much water might be lost from current farm ponds by evaporation?

Farm ponds cannot deliver all of the water that is stored after a runoff event. Evaporation of water from the ponds surface approaches and can exceed evapotranspiration from a crop canopy that covers an equivalent area. By four days after a rainfall, a pond can lose as much as 1.3 inches. Over the course of a May through September peanut season, a pond will lose 30 inches of water. For a 6 acre pond this is equivalent to 15 acre-feet. This would be enough to add almost 2 inches of water onto a 100 acre pivot field.

What are some of the unanswered questions regarding ponds for irrigation?

1. How do we determine the potential size of irrigation systems that can be reliably irrigated from farm ponds of various surface area and depth under rainfall and evaporation typical through the Southeastern Peanut Region?
2. How many years the supply will fall short for any combination of pond surface area and volume, catchments area, evaporative demand, and irrigation requirements.
3. What is the potential of controlled runoff areas to enhance supply in farm ponds during the peanut growing season?
4. How much can off-season pumping of water, particularly from surface streams during spring floods, supplement useable supply during the following growing season.