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ECONOMIC FEASIBILITY OF LIMITING IRRIGATION ON COTTON IN SOUTHWEST GEORGIA

Mark H. Masters and Marshall C. Lamb
USDA/ARS NPRL
Dawson, GA

Abstract

Irrigated cotton acreage in Georgia increased from near 150,000 in 1990 to over 600,000 acres in 2000. At the same time, agricultural stewardship of water resources has been scrutinized due to four consecutive years of below average rainfall. A uniquely designed irrigation research farm was designed by the USDA/ARS National Peanut Research Lab (NPRL) to study the economic effects of limiting irrigation on cotton, peanut, corn, and other commodities. Statistically significant differences ($\alpha = .05$) were found between irrigated and non-irrigated yields for all varieties in the first two years. Significant differences among irrigation treatments varied between years. Average D&PL 458 yields for year one and two were 1110 lbs/ac, 968 lbs/ac, and 855 lbs/ac for the full, 2/3, and 1/3 irrigation treatments respectively. Average dryland yield was 401 lbs/ac. Subsurface drip irrigation performed numerically though not statistically better than overhead sprinkler in year one but was statistically worse than sprinkler irrigation in year two. Assuming price plus LDP equals $0.55/lb, per acre net returns above variable cost and land using D&PL 458 under sprinkler irrigation were $14.57, $-47.01, $-109.30, and $-159.82 for full, 2/3, 1/3, and dryland treatments respectively. Marginal revenue minus marginal cost at the full irrigation level equals $-6.25. While results are encouraging, conclusions should not be drawn from the first two years of data, as rotational differences may be evident in later years.

Introduction

The importance of supplemental water resources to the sustainability of Southwest Georgia agriculture has become increasingly apparent in recent years. Four consecutive growing seasons have been plagued by drought conditions, causing growers to rely heavily on irrigation to prevent crop failure. This, of course, exacerbated the problem of low stream flows, and brought about state actions to restrict water use throughout the state. One of the state actions was aimed at reducing agricultural water use in SW GA. Stagnant commodity prices coupled with adverse growing conditions and state policies to restrict irrigation water use affect not only individual producers but a regional economy that is based predominately on agriculture. There is little in the economics literature regarding the effects of reduced irrigation, or irrigation under constrained water resource availability, on agricultural production in the Southeast U.S. Lessons learned from our counterparts in the Western United States are helpful but not directly transferable to situations in the Southwest Georgia region due to vast differences in climate, soils, and cropping systems. The need is great for region specific research to ensure the efficient and sustainable use of limited water resources by agricultural, municipal, ecological, and other stakeholders.

Corn, cotton, soybean, and peanut constitute the major share of Southwest Georgia crop production accounting for approximately 400,000 irrigated acres in 1997. Abnormally high temperatures and below-average rainfall characterized 1998, 1999, and 2000. The average monthly precipitation during the growing season (April-Oct) was 3.39 inches, 2.96 inches, and 3.44 inches for 1998, 1999, and 2000, respectively; and the SW Georgia region is now at a deficit of about 10 inches for 2001. In comparison, the 30-year average rainfall (April-October) is 41.9 inches for the Lower Flint River Basin (Georgia State Climate Office website, 2001).

Irrigation has been a major reason for the growing strength of agriculture in Georgia. University of Georgia estimates of average gains in net revenue from irrigated and dryland crops are: cotton, $153/acre; soybeans, $106/acre; peanuts, $243/acre; and corn, $150/acre. Sweet corn, peach, pecan, and tomato producers also rely heavily on irrigation. Figure 6 shows the large increase in irrigated acreage (by crop) from 1970 to 2000. Irrigated corn, cotton and peanut acres accounted for about 75% of the total irrigated acres in 2000.

Georgia's strong agricultural production ranking is reflected in the state's export status, ranking first in the export value of poultry/poultry products, and in peanuts/peanut products; fourth in export value of cotton & linters; and in the top one-third of all states in the total value of agricultural exports. Food and fiber account for almost one sixth of total output and employment in Georgia -- the largest single sector. Thus, agriculture is important, even to a highly metropolitan state, with a population of 8.2 million, and the 4th highest numeric population growth during the past decade.

Unfortunately, this same population growth, most of which has taken place in the north half of Georgia, combined with a severe drought, has created a situation that may begin to choke off future agricultural growth. This will hit hardest in southwest Georgia, the primary crop production and irrigation region of the state. The area designated as SW Georgia accounts for 93% of the state's irrigated acres. The area on the map indicated as the Lower Flint River Basin (Figure 8) contains more than 70% of the state's irrigated acres; and irrigated agriculture is the foundation of the local economies in SW Georgia.

The contrast between irrigated and dryland production in Georgia has been examined in previous years. However, little is known about the effect limited irrigation will have on crop yields. Research at the USDA/ARS National Peanut Research Lab (NPRL) in Dawson, GA, in cooperation with the Albany State University Flint River Water Planning and Policy Center (ASU-FRWPP) and the Georgia Soil and Water Conservation Commission, began in 2001 to investigate how reduced irrigation affects six cropping systems widely used in Southwest Georgia.

Materials and Methods

A three span lateral move sprinkler irrigation system was installed during the spring of 2001 for a new broad-based irrigation research program. Pressure regulation and specific nozzle design allowed for delivery of span specific water amounts. Comparisons with non-irrigated and sub-surface drip irrigation (SDI) were conducted during the 2001 and 2002 growing season. A randomized block design consisting of three replications addressing six crop rotations was utilized. A specially designed lateral move irrigation system allowed researchers to vary the amount of water applied to crops. SDI is varied identically to the overhead sprinkler using different emitter size. Further, SDI is tested on both 3-foot and 6-foot drip line spacing. Irrigation scheduling and amount follows commonly accepted practices varying by crop (Figure 1). Span one of the system irrigates 100% of a prescribed amount. For example, if researchers set span one to apply one inch; span two would then apply 0.66 of an inch, and span three would apply 0.33 of an inch. Rainfall and irrigation data for 2001-02 are shown in Figures 2 and 3. Recommended management practices for fertility, pesticides, and harvest timing were followed. In addition, dryland plots are also maintained for comparison.

Cotton varieties tested in the first two years include D&PL 458, D&PL 451, and Stoneville 4892. The main test across all irrigation treatments (sprinkler, 3-foot SDI, 6-foot SDI, and dryland) is conducted with D&PL 458 for 2001 and 2002. Other varieties are tested only under overhead sprinkler limited irrigation treatments. Harvest is achieved using a modified John Deere two-row cotton picker. Cotton from yield rows is automatically diverted into bags while border rows and excess are harvested using the traditional basket. Collecting samples in such a way allows for individual ginning outturns improving yield estimates over assuming a constant outturn across all plots.

Results and Discussion

Overhead sprinkler yields followed *a priori* expectations each of the first two years. Maximum D&PL 458 yield was achieved under the 100% irrigation span with yield decline as water was withheld (Figures 4 & 5). Employing an ANOVA t-test ($\alpha = .05$) on collected data, no significant difference in yield was found across the 100%, 66%, and 33% treatments in 2001. In 2002, the 33% level was statistically different in yield from the 66% and 100% levels. At 533 and 214 lbs/ac for 2001 and 2002 respectively, dryland plots were significantly different from all irrigated treatments.

Sub-surface drip irrigation behaved somewhat different. In 2001 *a priori* expectations were not realized as 66% and 33% levels yielded higher than the 100% level. While not significantly different ($\alpha = .05$), the 2/3 treatments produced 141 lbs/ac above the full irrigation regime. The 1/3 level performed 87 lbs/ac higher. Moreover, 66% and 33% SDI treatment yields were higher than overhead sprinkler. Conversely, in 2002 SDI performed significantly worse than sprinkler irrigation at the 100% level and numerically behind sprinkler at the remaining levels. Three-foot spacing SDI maximized yield at the full rate while six-foot SDI peaked at the 2/3 treatment.

As overhead sprinkler irrigation is the predominant irrigation technique in Georgia cotton production, net return and marginal revenue from sprinkler test plot results is of interest. Figure 6 shows gross revenue, return above variable cost, and return above variable cost and land for all three irrigation treatments and dryland tests. Assuming gross revenue at $.55/lb, positive net returns (not including returns to management, fixed assets, and overhead) were garnered only at the 100% level. A return of $-159.82/ac was recorded at average dryland production yield. Performance was more encouraging at the margin. Figure 7 depicts the marginal revenue/marginal cost relationship. Profit maximization and optimal use of the water resource occurs where MR=MC or MR-MC=0. That is, the value of an additional unit of water should equal the cost of applying the additional unit. Figure 7 shows that a *slight* over irrigation took place at the 100% level as MC exceeded MR by $6.25/ac. This result was encouraging suggesting the irrigation scheduling system made proper use of the resource in a profit-maximizing framework.

Conclusions

Designed as a long-term project, the Multi-Crop Irrigation Research Farm will eventually lead to meaningful results. However, with only two years of data, a rush to draw conclusions would be hazardous. Rather, it is important to disseminate information gathered and compile over time a useful tool for producers. Preliminary findings suggest comparable yields are attainable with less water. Although at present, depressed price dictates maximum output is needed to cover cost of production.

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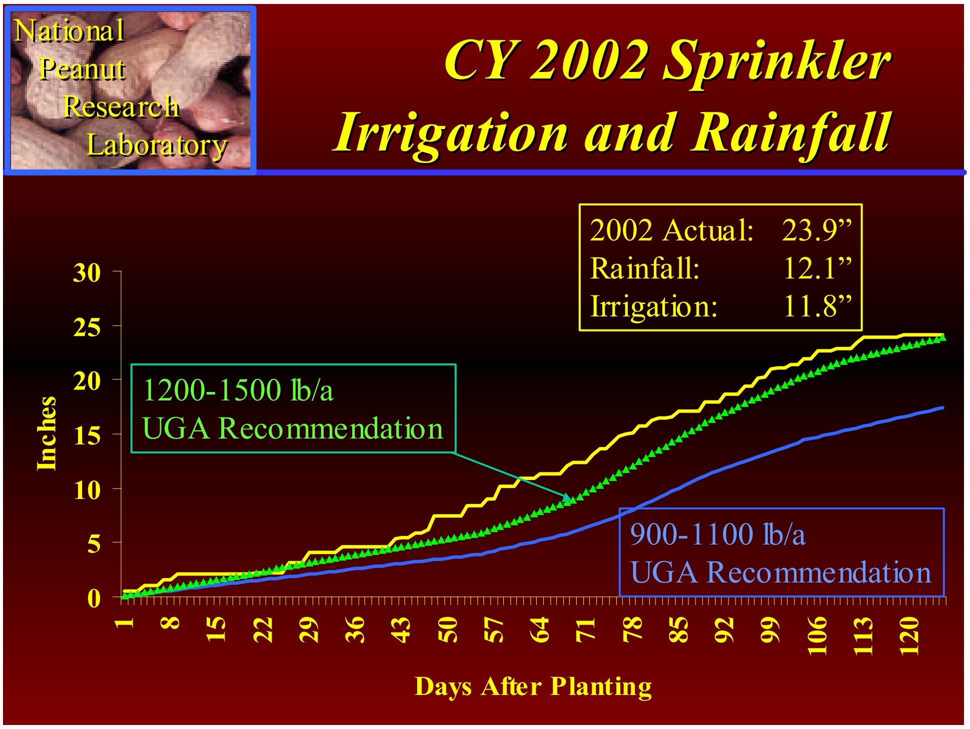


Figure 1. Cotton Irrigation Scheduling, University of Georgia Recommendations.

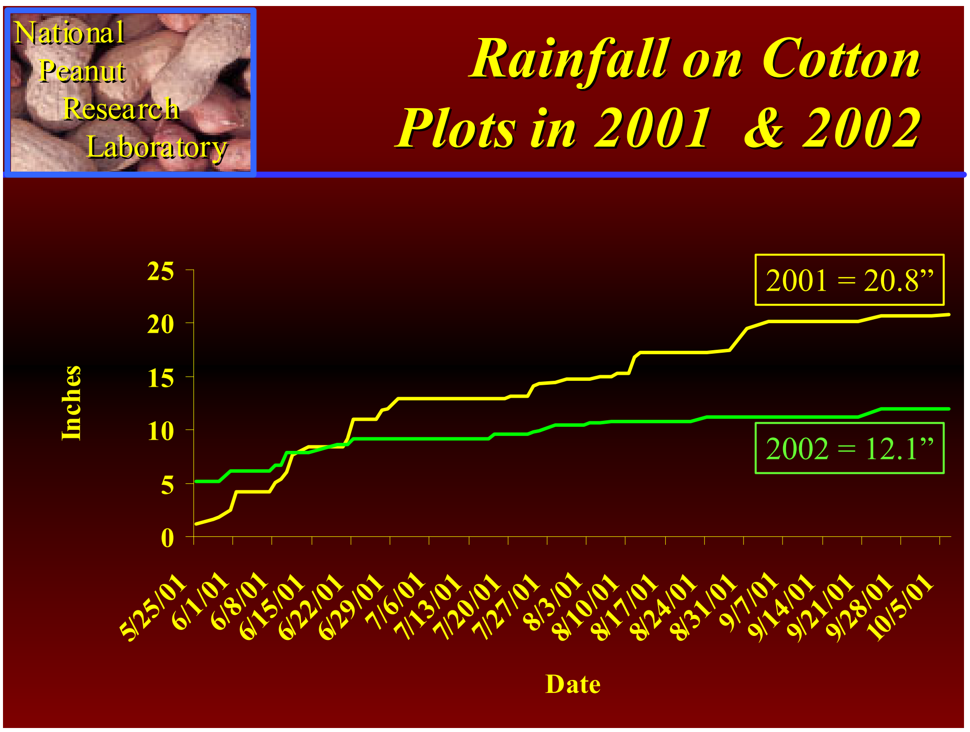
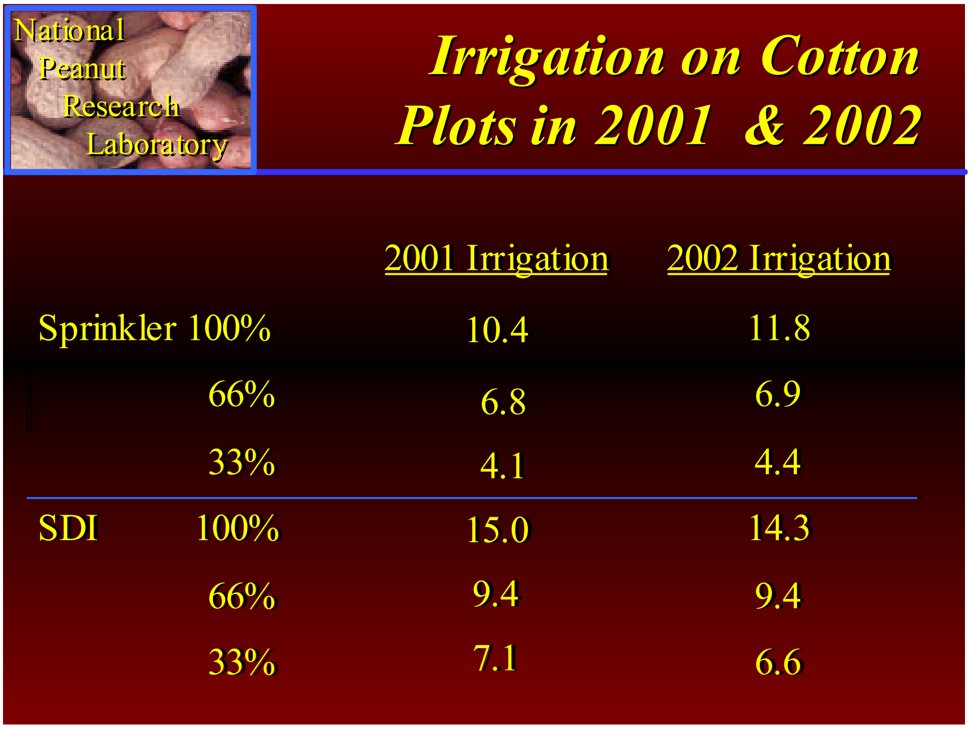


Figure 2. Rainfall Data CY 2001 and 2002.



National Peanut Research Laboratory

Irrigation on Cotton Plots in 2001 & 2002

		2001 Irrigation	2002 Irrigation
Sprinkler	100%	10.4	11.8
	66%	6.8	6.9
	33%	4.1	4.4
SDI	100%	15.0	14.3
	66%	9.4	9.4
	33%	7.1	6.6

Figure 3. Applied Irrigation Data, Sprinkler and SDI.

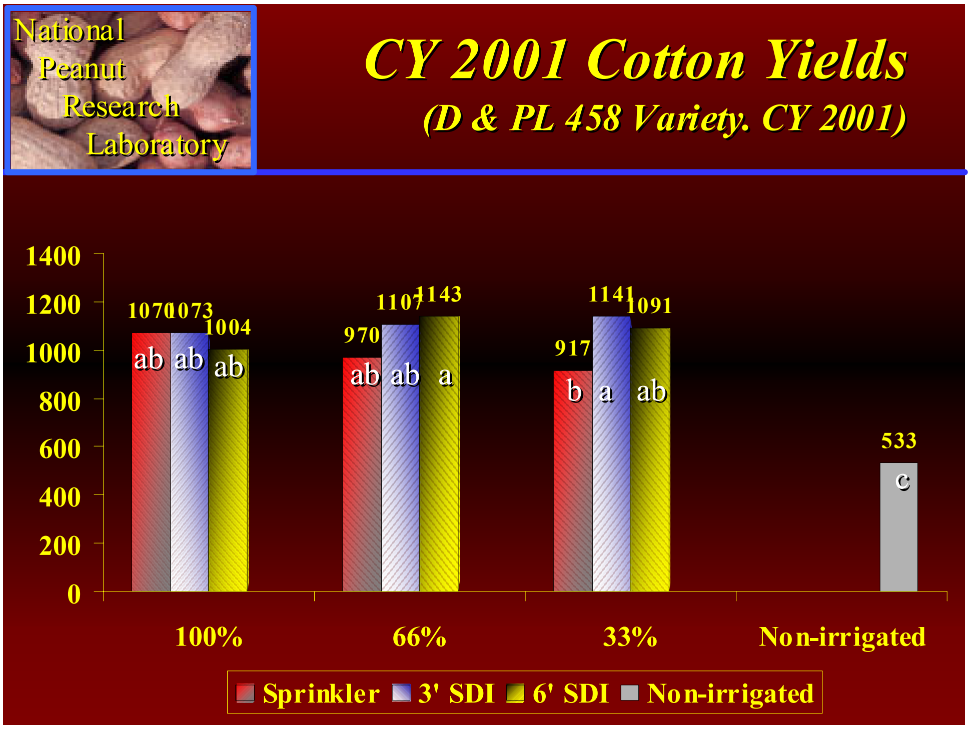


Figure 4. CY 2001 D&PL 458 Cotton Yield.

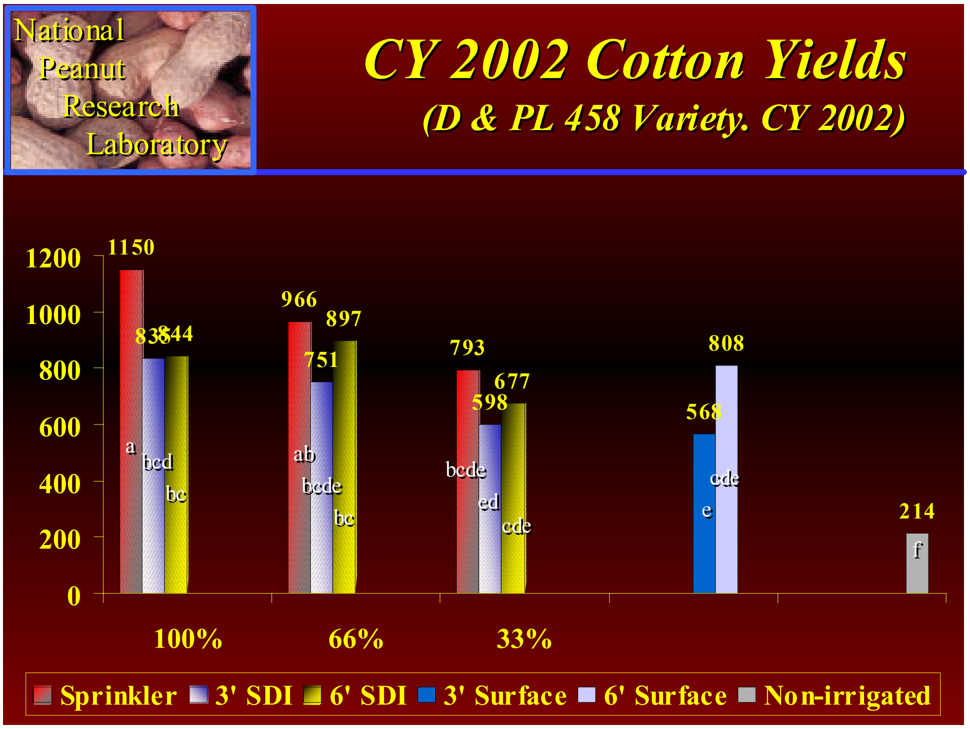


Figure 5. CY 2002 D&PL 458 Cotton Yield.

National Peanut Research Laboratory

CY 2002 Cotton Revenues & Costs

(Sprinkler Irrigation)

	100%	66%	33%	Non-irr
Gross Revenue ($0.55)	$632.50	$531.30	$436.15	$117.70
Variable Cost	$347.83	$347.83	$347.83	$238.26
Irrigation Cost	$66.60	$43.54	$26.25	
Picking Cost ($0.09)	$103.50	$86.94	$71.37	$19.26
Total VAR. Cost	$517.93	$478.31	$445.45	$257.52
NET > VAR	$114.57	$52.99	-$9.30	-$139.82
Land($100 irr/$20/dry)	$100.00	$100.00	$100.00	$20.00
NET>VAR & Land	**$14.57**	**-$47.01**	**-$109.30**	**-$159.82**

Not including returns to management, fixed assets, and overhead.

Figure 6. CY 2002 Cotton Revenues and Costs.

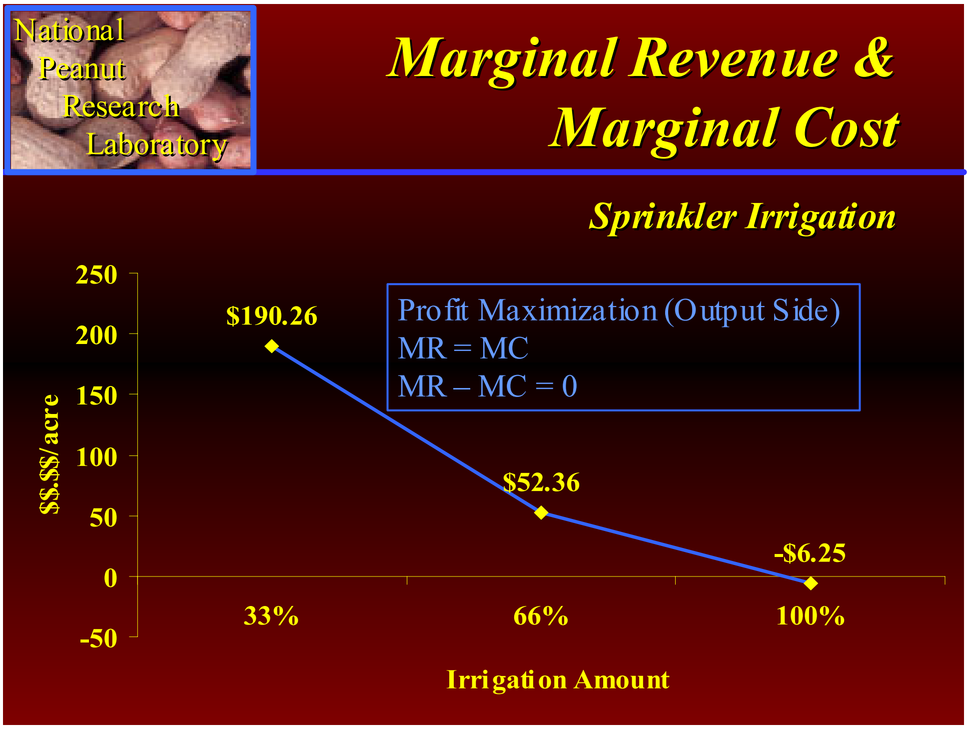


Figure 7. CY 2002 Marginal Revenue and Marginal Cost.

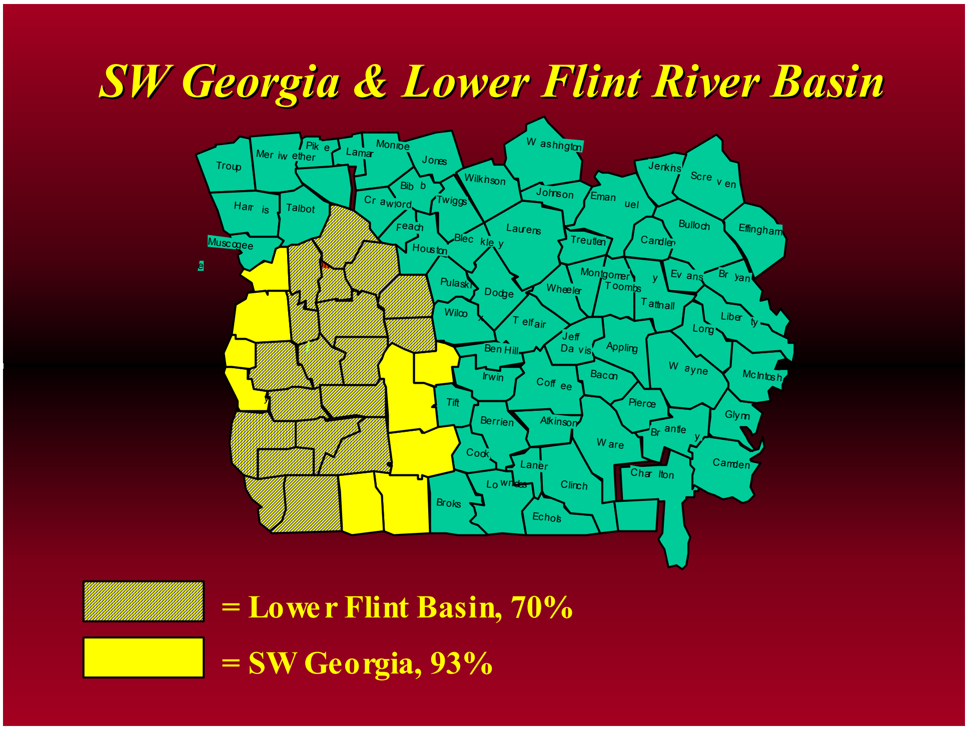


Figure 8. Flint River Basin, Southwest Georgia.