

SHALLOW GROUNDWATER AND SURFACE WATER SUPPLY

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Although the Southeastern U.S. is thought of as a high rainfall region, Van Bavel and Verlinden reported that drought was frequent for April through May (Table 1). Periods of drought could be more effectively dealt with if the soils had greater water-holding capacity, but sandy soils will not hold enough water to produce a profitable crop without rainfall during the growing season. Additionally, rainfall records in Florence for the last half century indicate very low and very high rainfalls for these crop growing months. Rainfall data for Florence, South Carolina from 1926 to 1986 shows that the mean is more or less useless. The maximum and minimum rainfall must be used to design water management systems. For example, in June the minimum rainfall is 1 inch and the maximum is 14 inches. It is during these extreme times that our designs must function properly. If rainfall is high, drainage is a must. If rainfall is low, irrigation is needed. During a year with average rainfall, an average crop can be produced without either. Thus, farmers must plan to contend with both excess water and drought, i.e., they need both irrigation and drainage.

Contribution of the USDA-ARS, Coastal Plains Soil and Water Conservation Research Center, Florence, SC

Table 1. Expected growing season drought days in 2 of 10 years in the Coastal Plains

<u>Month</u>	<u>Drought Days</u>
April	3-5
May	11-20
June	16-19
July	7-15
August	6-14
September	9-14

Most of the water for irrigation is pumped from groundwater aquifers, but the water levels in these aquifers are declining (U.S Geological Survey, 1985) (Table 2). Additionally, drought problems are often worse where drainage channels have been dug to prevent flooding during high rainfall periods. This is because lateral flow to the drainage channel causes overdrainage. Thus, farmers frequently find themselves with dry fields caused by dropping groundwater tables. Fortunately, our research indicates that proper management of the drainage channels in many areas can allow for both drainage and irrigation water supply. The alternative of obtaining irrigation water from shallow, annually-recharged aquifers connected to drainage channels not only holds promise for farmers, it alleviates anxiety from an industrial and municipal population that is also concerned about declining groundwater levels.

Table 2. Decrease in aquifer water levels from 1965-85

<u>Aquifer</u>	<u>Decrease(ft)</u>
North Carolina	
Castle Hayne	78
Cretacens	38-98
Yorktown	10
South Carolina	
Black Creek	30
Middendorf	30

Water supplies in the Southeast are shrinking, and if you thought the gasoline shortage was bad, wait until there is a water shortage. Water supplies will be even more important as municipal and industrial users require more and more water. Our legislatures are going to pass laws that restrict the use of groundwater for irrigation. Therefore, it is absolutely necessary that we develop alternative water supplies for irrigation. One way of increasing water supplies is to develop beautiful lakes on the farm. These offer fishing and other recreational opportunities in addition to the benefits for irrigation.

Developing Water Supplies for Irrigation

Traditionally, one would start a surface water supply project with the fact that about 1.25 acre-feet of stored water is needed for each acre of irrigated land. Irrigation of 800 acres, thus would require 1,000 acre feet of water (800 x 1.25) and storage equivalent to a 200-acre pond with a average dept of 5". Ten 20-acre ponds could also be used. Pond storage can be developed if the land area and depressions from channels are available. However, use of the stream channel drainage system is another way of developing an adequate water

supply.

Structures can be constructed across a channel to control the water level in the channel and to raise the water table in soil areas adjacent to the channel (Doty et al., 1984, 1986a). When the stream water level is controlled with a structure, drainage to the stream channel is reduced, and water is stored underground in the soil profile. The stream water level is controlled at a level that will provide drainage of the root zone, but the remaining water is stored rather than being allowed to flow downstream to the ocean. During high intensity or extended rainfall periods, the structure is lowered to allow the stream water level to fall and drain the surrounding land areas.

The Fabridam was installed in 1982 on Mitchell Creek near Tarboro, North Carolina. Table 3 shows how the number of irrigation systems and the amount of irrigated acreages have increased for the Mitchell Creek research site from 1980 to 1985 (Doty et al., 1986b) and reflects the results of irrigating the 800 acres with ten 20-acre ponds averaging 5' deep. Stream water level control (SWLC) controlled the water table in the watershed, and water was pumped to irrigated 808 acres from Mitchell Creek and underground storage. SWLC provided water storage to irrigate an additional 613 (808-195) acres.

Table 3. Irrigation water pumped from Mitchell Creek and acres of sprinkler irrigation, 1980-1985

Year	#System Used *			Avg. Irrig. Appl.	Area Covered/ Sprinkler Irr.	Irrig. Water Pumped from Mitchell Creek**
	CP	VG	CDSI			
				in**	acres	million gal.
1980	2	2	-	4.80	195	24.1
1981	2	3	-	6.26	292	47.0
1982	5	3	-	3.15	350	28.6
1983	6	4	1	6.89	520	95.0
1984	6	3	1	0.08	705	1.6
1985	8	4	1	3.23	808	65.3

*CP = center pivot; VG = volume gun; CDSI = controlled-drainage/subirrigation system

** Water applied to the 20-acre CDSI system was not measured.

Crop Yields

How did supplying water to crops by SWLC affect yields? The average annual yields (1982-1985) for peanuts, soybean, and corn are shown in Table 4.

Table 4. Average annual crop yields for 1982 through 1985 from Mitchell Creek Watershed

Water management treatment	Crop		
	Peanuts	Soybeans	Corn
	lbs/a	-----bu/a-----	
No SWLC*			
Rainfed	2,730b**	30c	97c
Sprinkler irrig.	4,954a	51a	137b
With SWLC			
Rainfed	3,358b	31c	123b
Sprinkler irrig.	5,009a	42b	167a

* SWLC = stream water level control.

**Yields followed by the same letter for each crop are not significantly different at the 5% level for DMRT test or LSD.

Addition of SWLC alone increased rainfed corn grain yields by 27%. Rainfed corn grain yields from the SWLC area without irrigation were not significantly lower than yields for the area with sprinkler irrigation but no SWLC. Although peanut and soybean yields were numerically higher, SWLC had no significant effects on peanut and soybean yields. Sprinkler irrigation significantly increased the yields of all crops with or without SWLC.

Economic Evaluation

An economic analysis based on the cost of the Fabridam (\$248,700), \$2/bu corn, 10% interest and paying the principal and interest off in 20 years is shown in Table 5. The cost of the Fabridam is high because it was a prototype research structure.

Table 5. Annual cost analysis of stream water level control to supply water for corn

	560 a of Rainfed/SWLC only	613 a of SWLC + sprinkler irrigation
	-----\$/a-----	
Increase return from corn yield	52	140*
Payment on dam (principle + interest)	<u>-52</u>	<u>-48**</u>
Total return to management for maintenance and irrigation	-	92
Cost of irrigation (fixed and operating) (Worm et al., 1982)	-	<u>-74</u>
Net return to management and Fabridam maintenance	0	18

* (with SWLC, sprinkler irrig. - no SWLC rainfed) 70 bu increase (avg. of 4 years) X \$2.00/bu.

**\$248,700 X 0.11746 crf for 20 yrs @ 10% interest for (808-195=613a)

Despite this, SWLC paid for the expensive Fabridam with increased rainfed corn yields over a 20-year period. Sprinkler irrigation on land with SWLC paid for the system, provided for the cost of irrigation, and provided a net return to management and Fabridam maintenance of \$18/a/yr. If the control structure could be installed for \$50,000, the net return with irrigation would have been \$57/a/yr and the net

return without irrigation \$42/a/yr or the structure could be paid for in less than 20 years. SWLC is a profitable way to manage water resources even with a Fabridam costing \$248,700.

In addition, environmental effects were noted with SWLC. A study to determine the effect of SWLC on water quality in the Mitchell Creek Watershed showed that nitrate concentration levels of 4 to 5 mg/L were entering the SWLC area in the stream flow. Nitrate concentrations were reduced to less than 1 mg/L by the time the stream water passed over the structure for SWLC downstream. Reductions in potassium concentrations were also shown. There were no changes in phosphorus concentrations with SWLC (Doty et al., 1986b).

Summary

SWLC raised water table levels in adjacent fields, which in turn increased rainfed corn grain yields by 27%. In addition, water was supplied to sprinkler irrigate about 613 acres, and corn yields were increased by 72% over nonirrigated fields without SWLC. Water quality in the stream flow improved with SWLC. Future water resource projects should use SWLC to increase the availability of irrigation water, relieve the strain on the deep groundwater aquifers, maximize yields, and improve stream water quality.

Literature Cited

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