CONSERVATION TILLAGE IN GEORGIA: ECONOMICS AND WATER RESOURCES

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Abstract. Conservation tillage affects soil quality which directly impacts producer profitability due to higher yields, and reduced labor and management inputs, equipment investments, fuel, pesticides, and harvest and processing costs. Factors that are more difficult to quantify, but that need to be taken into consideration are on-site and off-site environmental costs and benefits, including impacts on water resources. The cost of water loss from water-eroded soil has been estimated at $2.43 per ton of soil. Off-site costs of water quality and quantity impacts from erosion have been estimated at $6.32 per ton of water-eroded soil. This cost estimate includes damage to recreation, water storage, navigation, commercial fishing, flooding, water treatment, municipal and industrial uses, cooling of steam-operated electric power plants, and irrigation. The Natural Resources Conservation Service (NRCS) estimates that average erosion losses in the USA can be reduced from 27 t ha^{-1} y^{-1} with conventional tillage to 7 t ha^{-1} yr^{-1} with conservation tillage, a savings of 20 t ha^{-1} y^{-1} of soil. Extrapolating these estimates indicates the value of conservation tillage associated with erosion reduction alone is worth \$175 ha^{-1} y^{-1}. There is great potential to increase the adoption of conservation tillage in Georgia, with consequent economic benefits. The potential economic benefit from reduced erosion on Georgia's water resources as a result of conservation tillage adoption on all 1.3 M hectares of field crops could be as high as $227 million per year. The economic benefits of conservation tillage in relation to conservation of water resources extends well beyond controlling erosion. Research has demonstrated that conservation tillage increases infiltration, decreases evaporation, and reduces irrigation costs. Conservation tillage warrants recognition as a cost-effective practice to conserve Georgia's water resources.

INTRODUCTION

Drought, rapid population growth, and agricultural and industrial water needs have strained Georgia's water resources in recent years. The recent drought lasting from 1998 to 2002 has been identified as a threat to Georgia's water supply and has given rise to water allocation issues such as the "Tri-State Water Wars" between Georgia, Alabama, and Florida (CSREES, 2004). According to the U.S. Census Bureau, Georgia's population has more than doubled since 1960. There were 8.2 million people living in the state in 2000 and more than half of them made their home in the 20 counties surrounding Atlanta (Fig. 1). For every block of 100,000 new residents, an additional 14 to 15 million gallons per day of water supply is required (Georgia EPD, 2003). Statewide, the average water use per person is 168 gallons per day. The average annual industrial, agricultural, and residential water use in Georgia is 3800 M gallons per day (MGD). In 2001, 42% of this amount was used for agricultural production (Georgia DNR, 2001).

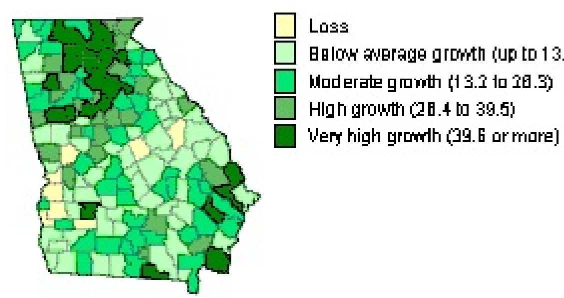

Figure 1. Population change in Georgia, 1990 - 2000 (USDA-ERS, 2004).

In May 2004, the state of Georgia authorized the EPD to prepare a statewide comprehensive water plan by the year 2007 to address water conservation and the long-term water needs. A wide range of water issues were to be addressed, including water allocation to farmers, industry and local government. The state of Georgia also sought to reduce nonpoint source pollution in runoff from the land into streams and lakes. Based on an effort to monitor irrigation water use by Georgia farmers, the state enacted a bill to require all farm uses of water to be metered by the year 2009. However, there is also a potential for farmers to conserve water and reduce on- and off-site impacts from water-eroded soil through conservation tillage.

Discussion and Recommendations

A conservation tillage system is defined as any planting practice or tillage operation, including no tillage, that leaves at least 30% of the soil surface covered with crop residues. The greatest effect of conservation tillage on surface water quality is reduced runoff. Residues protect the soil surface from the impact of raindrops and act like a dam to slow water movement, allowing it to infiltrate into the soil. Typically, a 30% residue cover reduces soil erosion rates by 50 to 60% compared to conventional tillage (Hill and Mannering, 2004) (Table 1). The plant residues that remain on the soil surface in conservation tillage systems also improve soil structure and increase soil water infiltration and soil water storage capacity. This, as well as the shading of the soil surface by the residues, results in less evaporation and more available water for crop production and ground water recharge. Measures to reduce erosion to protect soil productivity would also help to maintain soil properties such as soil biodiversity (Crosson, 2003).

In the U.S., an estimated 4×10^9 tons of soil and 130×10^9 tons of water are lost from the 160×10^6 ha of cropland each year. This translates into an on-site economic loss of more than $27 billion each year, of which $20 billion is for replacement of nutrients and $7 billion for lost water and soil depth (Pimentel et al., 1995). The cost of water loss from water-eroded soil has been estimated at $2.43 per ton of soil. Off-site costs of water quality and quantity impacts from erosion have been estimated at $6.32 per ton of water-eroded soil. The main consequences of erosion on-site are soil degradation, declining soil fertility, limited infiltration capacity and water storage. Off-site impacts include eutrophication of watercourses and lakes, destruction of wildlife habitats, siltation of dams, reservoirs, rivers, and property damage by flooding (COST, 2004; ASAE, 2002; Robertson and Colletti, 1994). The results of several studies indicate that the annual benefits from improving water quality could total tens of billions of dollars (Table 2). Water quality benefits from erosion control on cropland alone could total over $4 billion per year (Hrubovcak, LeBlanc, and Eakin, 1995).

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Table 1. Effects of residue cover on runoff and sediment loss (from Hill and Mannering, 1995).

Residue Cover	Runoff	Runoff Velocity	Sediment in Runoff	Soil Loss
%	% of rain	ft min^{-1}	% of runoff	t ha^{-1}
0	45	26	3.7	30.7
41	40	14	1.1	7.9
71	26	12	0.8	3.5
93	0.5	7	0.6	0.7

The largest agricultural region in Georgia is the Coastal Plains region in the southern half of the state where agriculture accounts for approximately 50% of the land use. Although the Southern Piedmont in the northern half of the state, which includes the Atlanta metro area, is rapidly developing, 20% of the land is still in cropland and pasture (USDA, NRCS, 2004). In a study of runoff versus infiltration in conventional tillage versus no tillage in both a loamy sand soil and a silt loam soil in Alabama with similar sand and clay content of the Georgia Piedmont sandy clay loam soils, Truman et al. (2002) found that no-tillage plots with a winter cover crop had the lowest runoff (highest infiltration) compared to conventional tillage. At rainfall intensities of 25 cm h^{-1}, runoff was reduced by greater than 57% with no tillage compared to conventional tillage in loamy sand soils like those of the Georgia Coastal Plains, and by greater than 31% in soils similar to those of the Georgia Piedmont. In a study of infiltration rates in a Georgia Piedmont soil, Bruce et al. (1992) found that after one hour of simulated rainfall, infiltration rates were 47% greater for sorghum that was no till planted into crimson clover than for conventional till soybean or sorghum planted into fallow. Mean annual rainfall is approximately 1270 mm statewide, but can vary by as much as 40% of the mean due to intense summer rain storms, and tropical disturbances between June and November (New Georgia Encyclopedia, 2005). If no tillage practices were used statewide, runoff could potentially be reduced by 724 mm to 1013 mm (29 to

Table 2. Estimates of benefits from water pollution control (USDA-ERS, 2000)

Water quality benefits of reduced soil erosion from conservation practices	Ribaudo (1986)	Erosion reduction from practices adopted under the 1983 soil conservation programs were estimated to produce $340 million in offsite benefits over the lives of the practices.
Water quality benefits of reduced soil erosion from Conservation Reserve Program	Ribaudo (1989)	Reducing erosion via retirement of 40-45 million acres of highly erodible cropland would generate $3.5-$4.5 billion in surface-water quality benefits over program life.
Recreational fishing benefits from controlling water pollution	Russell and Vaughan (1982)	Total benefits of $300-$966 million, depending on the quality of fishery achieved.
Recreational benefits of surface-water pollution control	Carson and Mitchell (1993)	Annual household willingness to pay for improved recreational uses of $205-$279 per household per year, or about $29 billion.
Recreational benefits of soil erosion reductions	Feather and Hellerstein (1997)	Total of $611 million in benefits from erosion reductions on agricultural lands since 1982, based on recreation survey data.
Drinking water benefits in four regions from reduced nitrates	Crutchfield, Cooper, and Hellerstein (1997)	Monthly household willingness to pay for drinking water meeting EPA nitrate standards of $45 - $60 per month.
Freshwater-based recreation benefits from reduced soil erosion from the CRP	Feather, Hellerstein, and Hansen (1999)	Annual increase in consumer surplus $35.3 million from improved quality of recreation at rivers and lakes.

40 inches) annually.

In 2003, Georgia planted 1.3 M hectares of field crops. The Conservation Technology Information Center (C.T.I.C.) at Purdue University estimated that in 2002, 31% of cotton, 28% of corn, 39% of soybean, 20% of small grains, 21% of sorghum, and 11% of remaining crops (which include peanut) in Georgia were planted with some form of conservation tillage. Extrapolating these estimates indicates the value of conservation tillage associated with erosion reduction alone is worth $175 ha^{-1} y^{-1}. The current benefit to water resources in Georgia from use of conservation tillage to control erosion is thus estimated at $65 million per year. The potential economic benefit from reduced erosion on Georgia's water resources as a result of conservation tillage adoption on all 1.3 M hectares of field crops could be as high as $227 million per year.

There are several programs and policies in effect for Georgia that are addressing the amount and types of irrigation that farmers use in order to conserve water resources (NESPAL, 2004, NRCS, 2004). Federal programs such as EQIP (NRCS, 2004) and state legislation recently enacted to preserve and protect greenspace through public and private land acquisition address the importance of land conservation practices to protect air and water resources (GLCPP, 2004). Georgia farmers that have used a continuous conservation tillage system for several years frequently report that the quality of their soil has improved due to higher soil organic matter, reduced crusting, improved soil tilth, less soil erosion, and decreased runoff, all of which can result in improved production, crop quality, and water quality (Dean et al., 2003). In spite of the available knowledge and the programs to promote conservation tillage in the state, no specific mention has been made of the use of conservation tillage in the development of the current statewide comprehensive water use plan. Based upon the known benefits of conservation tillage to agricultural production, soil and water quality and quantity, and on- and off-site impacts of water loss due to erosion from conventional tillage systems in Georgia and nationwide, conservation tillage needs to be considered in the formulation of the current policy to conserve and protect the state's water supply for the future.

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