Conservation Cropping Systems for Production and Soil Erosion Control in the South[1]

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INTRODUCTION

Soil erosion rates associated with conventional tillage of Ultisols and Alfisols in the Southeast usually exceeds T-values (Larson, 1981). Lowdermilk (1953) suggested circa 30 years ago that tillage procedures that permit crop residues to remain at the ground surface is one of the most significant contributions to American agriculture. Since the intense influx of European settlers during the early 1800's or the beginning of the cotton era, southern farmers and researchers have been struggling sporadically with conservation tillage systems. Ruffin (1832) used a crude mulch tillage in Virginia to control soil erosion. Perhaps, this was the first recorded conservation tillage attempt in the South. In a crop rotation system that included clover and the addition of marl plus dunging, Ruffin described the tillage system as troublesome and imperfect. Hilgard (Jenny, 1961) recognized that improved implements of tillage without sound conservation principles were ruining the once productive land of the Southeast. The next recorded conservation tillage event was cited by Lowdermilk (1953) in north Georgia during the mid 1900's. He describes the conservation principles used by a farmer, "Mr. Gowder," for approximately 20 years on land with slopes up to 17%. His principal tillage implement was a 4-inch wide bull-tongue plow used to chisel his topsoil rather than plowing down crop residues. After 20 years, Mr. Gowder was still growing crop on near original topsoil depths, while his ridiculing neighbors were plowing subsoil.

RECENT RESEARCH

Discussion of conservation tillage research will be limited to studies with erosion measurements. Conservation tillage began on the Experiment Stations using cool season green manuring crops (legumes and small grains) in the 1940's. These tillage practices began with the mulch balk methods and evolved the wheel track planting method (Beale, 1950; McAdams and Beale, 1959; Nutt et al., 1943 Beale et al., 1955; and Larson and Beale, 1961). Often several primary tillage procedures (disk, rip, moldboard plow, etc) were required prior to planting. These conservation tillage procedures reduced soil erosion as much as 80% on runoff plots (Table 1), but little adoption by farmers was experienced. Up to this point conservation tillage was confined primarily to the Southern Piedmont in the Southeast.

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Lister planting equipment, a minimum tillage that required at least one secondary tillage operation, was designed to plow some of the topsoil out of the planting furrow for planting (McAlister, 1962). This tillage pratice experienced some adoption for planting corn in sods and soybeans following small grain harvest in the late 1950's and early 1960's. Unfortunately, this tillage procedure was tested on runoff plots only on silt loam soils of Mississippi (Greer et al., 1976). This tillage approach did not control runoff and soil erosion well in a wheat/soybean cropping system in Mississippi (Table 1). However, this system was given qualitative soil erosion control credit on low silt content Typic Hapludults soils (Hendrickson et al., 1963).

Fluted coulter tillage emerged in the upper South on cool season sods during the late 1960's (Jones et al., 1968; Blevins et al., 1968; Carreker et al., 1972). This breakthrough permitted the first single tillage operation that was capable of reducing soil erosion to rates less than 1.0 ton per acre. Like lister tillage, no runoff studies associated with fluted coulter/cool season sods were conducted. However, one rainulator study (Table 1) was accomplished on live fescue sod that provided some insights with respect to soil erosion control (Barnett et al., 1972). Several runoff studies were published to document the effectiveness of fluted coulter tillage to control soil erosion following grain crop residues on both Alfisols and Ultisols (Table 1 and 2). In all multiple crop modes, soil erosion was reduced below 1.0 ton per acre on rainfed watersheds and runoff plots as well as rainulator plots.

The coulter-inrow chisel practices emerged in the lower South during the late 1970's because of plant root restricting soil layers, especially on coastal plain soils. The inrow chisel practice consistently controls both runoff and soil erosion on the Ultisols (Table 1 and 2). Near 100 year frequency storm energies are required to produce significant runoff with this tillage practice in a double crop mode (Table 1 - Simulated Rainfall). With rainfed conditions, soil erosion on sloping land up to 7.0% is essentially eliminated (Table 2).

Conservation tillage research has evolved slowly during the past 40 years. Most of these conservation cropping systems effectively control soil erosion well below the accepted T-values. However, this research was accomplished on the best land capability classes of Ultisols and Alfisols. Slopes of this landscape were usually less than 8.0%. Uncertainities exist if we stress conservation tillage cropping systems to control soil erosion on marginal farm land with steep slopes during the next few decades.

Table 1. Effect of Tillage/Cropping system on runoff and soil erosion.

Tillage/Cropping Systems	Cover Crop	Soil[†]	Annual Runoff	Annual Erosion	Reference
			%	Tons Acre^{-1}	
		Natural Rainfall			
Mulch-Corn	Vetch/Rye	Typic Hapludults	2.5[‡]	0.43[‡]	(2)
Conventional-Corn	Fallow		16.6[‡]	2.81[‡]	(2)
Conventional-Cotton	Fallow		21.2	20.0	(6)
Lister-Soybeans	Wheat	Typic Fragiudalfs	30.0	4.00	(5)
Conventional-Soybeans	Fallow		32.0	4.70	(5)
Coulter-Soybeans	Wheat	Typic Fragiudalfs	23	0.80	(18)
Conventional-Soybeans	Fallow		29	7.80	(18)
Coulter-Corn	Corn residues	Typic Fragiudalfs	26	4.30	(19)
Conventional-Corn	Fallow		31	9.30	(19)
Coulter-Soybean	Wheat	Typic Paleudalfs	545	0.75[§]	(22)
Conventional-Soybeans	Fallow		27[§]	5.15[§]	(22)
Coulter-Soybeans	Barley	Typic Hapludults	4	0.04	(23)
Coulter-Grain sorghum	Barley		5	0.03	(23)
Conventional-Soybeans	Rye (Green manure)		12	1.53	(23)
In-Row Chisel-Soybeans	Wheat	Typic Hapludults	3	0.03	(10, 1
Conventional-Soybeans	Fallow		18	11.70	(10,11)
		Simulater Rainfall			
Conventional	Bare Fallow	Typic Hapludults	78[¶]	16.74'	(12)
Live Fescue	Fescue		48[¶]	0.16'	(1)
Coulter	Rye Stubble		57[¶]	0.04'	(9)
In-Row Chisel	Rye Stubble		8[¶]	0.08[¶]	(12)

[†]Average slopes range from 3 to 8%. [‡] Corn growing season only (April - September);
[§]Eight selected natural and simulated storms. [¶]Five inches of water applied during 2 hours periods to develop ~ 100 EI units (initial rainulator runs).

Table 2. Effect of Cropping/Tillage Systems* on Grain Yield, Runoff, and Sediment Transport.

Crop	Grain Yield	Rainfall	Runoff	Sediment
	Bu $acre^{-1}$	Inches	%	Tons $acre^{-1}$ $year^{-1}$
		CONVENTIONAL TILLAGE		
Fallow	--	31	9.0	1.4
Soybeans	19	20	33.0	10.3
		COULTER TILLAGE		
Barley	49	35	8.5	0.06
Grain sorghum	81	14	5.7	0.004
		IN-ROW CHISEL TILLAGE		
Wheat	57	28	2.4	0.013
Soybeans	40	19	2.7	0.0
		IN-ROW CHISEL TILLAGE		
Clover	--	24	1.6	0.002
Grain Sorghum	88	13	0.0	0.0

* Twelve years of research on a 6.7 acre watershed at Watkinsville, Georgia (10, 11).

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