Economics of Conservation Tillage in the Southeast

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There has been a dramatic shift in tillage technology used in American agriculture over the past 10-15 years. Conventional practices involving the multiple tillage of the soil by plow, disk, harrow, or cultivator have been eliminated or greatly reduced. In its place is a set of practices generally labeled conservation tillage. Several factors are behind this shift, but it is evident that individual farmers have led rather than followed this trend. One major factor contributing to the shift has been the production cost savings associated with conservation tillage.

This paper analyzes the trends in conservation tillage acreage in the southeastern United States and looks at some of the economic factors influencing this trend. It focuses on the factors influencing both total revenues and total costs the two components of the income equation. The paper closes with a look to the future of conservation tillage.

Conservation Tillage--What Is It?

The meaning of the term "conservation tillage" is continually evolving, depending on both regional usage and by whether the extent of soil stiring or amount of remaining residue cover is the distinguishing factor. When the amount of surface area worked is the dominant criteria, no-till has been defined as having up to 25 percent of the surface worked, while conventional tillage has 100 percent of the surface worked (No-Till Farmer). Current emphasis is on the amount of residue cover left on the soil surface after planting. Accordingly, conservation tillage is commonly used to describe situations where at least 30 percent of the residue cover is left on the soil surface after planting.

A broader definition of conservation tillage is "any tillage system that reduces loss of soil or water relative to conventional tillage; often a form of noninversion tillage that retains protective amounts of residue mulch on the surface"[1] Conventional tillage is "the combined

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1/ Accordingly, the no-till and minimum till definitions used in tables 1 and 2 are each considered conservation tillage techniques. The distinction is maintained because that is how the data have been reported.

primary and secondary tillage operations performed in preparing a seedbed for a given crop grown in a given geographical area" (Mannering, p. 141).

Regardless of the definition adopted, it is important to remember that conservation tillage represents a system of farming rather than a specific technique. Accordingly, practices, and equipment need to be selected based on soil and climatological conditions so as to adequately control soil erosion, conserve moisture and accommodate the crops grown. And most important from the farmer's perspective, tillage systems need to be selected which will contribute to sustained farm profitability.

Conservation Tillage Trends in the Southeastern United States

A review of conservation tillage acreage trends in the southeastern United States show how rapidly some of the tillage changes are occurring. Estimates of cropland acreage in no-till, minimum-till, and conventional-till in the southeastern United States are presented in table 1. The area has been subdivided into three farm production regions: Southeast, Appalachia, and Delta. Between 1973 and 1984, acreage in minimum tillage increased about 275 percent in the three combined regions, with the largest relative increase in the Southeast region. Acreage in no-till increased 290 percent in the three regions, with the greatest increase again in the Southeast region. Comparable increases for the United States were 220 percent and 300 percent. Relative to the United States, no-till is on a greater share of cropland acreage for the three regions, but minimum till is on less. The Southeast and Appalachia regions have larger shares of their cropland in no-till and minimum till than the Delta region (table 2).

While data on the use of no-till and conservation tillage systems shows increases in most states in the southeastern United States, the rate of adoption in the Southeast is considerably less than in the Corn Belt States. A USDA nationwide survey found that about 21 percent of the farmers who planted land to crops used conservation tillage. Thirty-eight percent of the Corn Belt farmers used conservation tillage, but in the Southeast and Delta, only 3-4 percent used it, and 12 percent used it in the Applachian region (Magleby). A major reason for this regional difference is that conservation tillage is used primarily to grow corn, soybeans, and small grains, the predominant crops in the Corn Belt.

A USDA survey of 11.000 farmers nationwide provides several insights into adoption of conservation tillage. Farmers have adopted conservation practices for both cost and time savings and soil and water conservation purposes, although without the cost and time savings many would not have initially tried the practice. Most farmers who adopted conservation tillage in 1983 did so without government cost sharing assistance (Magleby).

Table 1--Trends in acreage in no-till, minimum, and conventional tillage systems in the southeastern United States, with national comparisons

State and tillage system[1]	1973	1977	1981	1982	1983	1984
			1,000 acres			
No-ti11:						
Alabama	17.6	147.8	335.0	430.4	336.7	289.0
Florida	.6	7.0	11.7	25.5	34.9	29.8
Georgia	39.5	113.0	436.4	465.4	445.4	308.8
South Carolina	12.0	21.7	135.4	161.2	153.2	124.3
Southeast region	69.7	289.5	918.5	1,082.5	970.2	751.9
Kentucky	837.6	988.7	1,170.0	1,475.5	1,024.4	1,104.1
North Carolina	160.5	362.0	370.0	467.0	512.0	650.0
Tennessee	44.7	195.7	419.0	449.2	520.0	563.2
Virginia	258.2	343.2	591.0	594.5	527.2	642.6
Appalachia region	1,301.0	1,889.6	2,550.0	2,986.2	2,583.6	2,959.9
Arkansas	.4	0.8	23.2	64.0	66.3	81.2
Louisiana	5.8	3.0	30.0	17.6	29.1	73.0
Mississippi	8.6	95.3	126.5	164.0	142.5	172.2
Delta region	14.8	99.1	179.7	245.6	237.9	326.4
Three region total	1,385.5	2,278.2	3,648.2	4,314.3	3,791.7	4,038.2
U.S. total	4,875.8	7,271.7	9,185.2	11,571.9	11,745.5	14,758.6
Minimum:						
Alabama	16.5	194.6	814.0	1,174.8	545.1	607.0
Florida	34.0	20.0	91.0	217.6	225.7	597.5
Georgia	50.6	1,745.0	3,810.0	3,510.0	1,962.9	2,102.3
South Carolina	783.5	1,455.0	991.0	890.0	171.5	82.1
Southeast region	884.6	3,414.6	5,706.0	5,792.4	2,905.2	3,388.9
Kentucky	1,552.2	1,943.2	1,021.0	1,387.5	1,194.5	1,574.4
North Carolina	578.4	625.9	1,481.0	2,638.0	2,850.0	1,297.6
Tennessee	--	533.0	716.0	741.0	1,057.5	1,020.4
Virginia	370.0	383.8	520.0	642.5	462.8	558.8
Applachia region	2,500.6	3,485.9	3,744.0	5,409.0	5,564.8	4,451.2
Arkansas	.6	234.0	330.0	1,019.8	1,023.0	776.5
Louisiana	65.0	536.0	670.0	690.0	647.1	441.4
Mississippi	40.2	393.0	1,612.5	4,512.0	1,698.0	528.4
Delta region	105.8	1,163.0	2,612.5	6,221.8	3,368.1	1,746.3
Three region total	3,491.0	8,063.5	12,062.5	17,423.2	11,838.1	9,586.4
U.S. total	39,062.8	62,732.2	89,768.0	100,309.9	79,583.2	85,495.2

Continued

Table 1--Trends in acreage in no-till, minimum, and conventional tillage systems in the southeastern United States with national comparisons – Continued

State and tillage system[1/]	1973	1977	1981	1982	1983	1984
			1,000 acres			
Conventional:						
Alabama	2,705.0	3,652.6	3,080.0	2,778.2	2,385.8	3,068.2
Florida	1,078.8	1,186.5	933.5	813.2	1,077.7	3,755.6
Georgia	3,571.5	3,601.0	839.0	1,430.0	3,716.7	3,533.0
South Carolina	1,568.5	1,271.0	1,815.0	2,142.4	2,088.8	2,857.1
Southeast region	8,923.8	9,711.1	6,667.5	7,163.8	9,269.0	13,213.9
Kentucky	539.5	884.8	2,437.0	1,485.0	1,348.3	2,546.0
North Carolina	3,079.3	3,277.2	3,162.0	2,860.0	2,560.0	3,233.7
Tennessee	3,222.5	1,979.0	2,944.0	2,840.0	2,699.8	3,638.4
Virginia	1,518.7	1,077.1	1,001.3	895.0	1,424.6	1,355.3
Appalachia region	8,360.0	7,218.1	9,544.3	8,080.0	8,032.7	10,773.4
Arkansas	6,413.0	7,241.1	7,802.0	3,793.8	3,796.0	7,736.2
Louisiana	3,044.2	3,109.0	3,893.0	4,005.0	4,237.0	4,493.9
Mississippi	4,196.0	5,259.9	2,220.0	1,430.0	4,252.5	5,334.0
Delta region	13,653.2	15,610.0	13.915.0	9,228.8	12,285.5	17,564.1
Three region total	30,937.0	32,539.2	30,126.8	24,472.6	29,587.2	41,551.4
U.S. total	203,991.2	228,631.0	218,326.8	204,175.3	205,049.5	231,302.2

-- = No data

1/ Definitions used are: No-till – where only the intermediate seed zone is prepared. Up to 25 percent of the surface area could be worked. Could be no-till, till-plant, chisel-plant, rotary strip tillage, etc. Includes many forms of conservation tillage and mulch tillage. Minimum tillage – limited tillage, but where the total field surface is still worked by tillage equipment. Conventional tillage – where 100 percent of the topsoil is mixed or inverted, by plowing, power tiller, or multiple diskings.

Source: No-Till Farmer. March 1974, 1978, 1982, 1983, 1984, and 1985.

Table 2--Relative distribution of acreage in no-till, minimum-till, and conventional-till, in the southeastern United States, 1973, 1977, 1981, 1982, 1983, and 1984[1/]

	1973	1977	1981	1982	1983	1984
	Percent of total cropland					
Southeast region						
No-till	0.7	2.2	6.9	7.7	7.4	4.3
Minimum-till	9.0	25.4	42.9	41.3	22.1	19.5
Conventional-till	90.3	72.4	50.2	51.0	70.5	76.2
	100.0	100.0	100.0	100.0	100.0	100.0
Appalachia region						
No-till	10.7	15.0	16.1	18.1	16.0	16.3
Minimum-till	20.6	27.7	23.6	32.8	34.4	24.5
Conventional-till	68.7	57.3	60.3	49.1	49.6	59.2
	100.0	100.0	100.0	100.0	100.0	100.0
Delta region						
No-till	.1	.6	1.1	1.6	1.5	1.7
Minimum-till	.8	6.9	15.6	39.6	21.2	8.9
Conventional-till	99.1	92.5	83.3	58.8	77.3	89.4
	100.0	100.0	100.0	100.0	100.0	100.0
Three region total						
No-till	3.9	5.3	8.0	9.3	8.4	7.3
Minimum-till	9.7	18.8	26.3	37.7	26.2	17.4
Conventional-till	86.4	75.9	65.7	53.0	65.4	75.3
	100.0	100.0	100.0	100.0	100.0	100.0
U.S. Total						
No-till	2.0	2.4	2.9	3.7	3.9	4.4
Minimum-till	15.8	21.0	28.3	31.7	26.9	25.8
Conventional-till	82.2	76.6	68.8	64.6	69.2	69.8
	100.0	100.0	100.0	100.0	100.0	100.0

1 / Source: Data in table 1.

Economics of Conservation Tillage Systems in the Southeast

Profitability is an important factor influencing the adoption of conservation tillage technology. Information is available from research studies and field observation to aid farmers in evaluating changes in yields and changes in various inputs associated with conservation tillage. Several assessments of the impacts on yields and resource use have been completed, and indicate the great variability which exists (Crosson, Christensen).

It is necessary to take both a short- and long-run perspective when assessing the profitability of a conservation tillage system. It is also important to think in terms of impact on net revenues rather than total or gross revenues. Even if yield reductions are associated with a conservation tillage system, profits may remain about the same because of reduced input costs. Thus no system should automatically be ruled inferior just because of lower yields. Yields impact the gross revenue side of the profit equation, but the determinants of net operating profitability are both gross revenues and total variable input costs.

Let's consider for a moment what research results indicate about conservation tillage and yield impacts and major input requirements. Input costs are separated into energy use requirements, labor use requirements, fertilizer and pesticide use and equipment investment costs.

Impacts on Yields of Conservation Tillage Systems. Yield differences associated with tillage methods depend upon the crop and specific location. In general, conservation tillage systems perform better with respect to yields in areas with long growing seasons, which describes most of the Southeast. Nine years of data from a Tennessee experiment shows an average yield of 36 bushels of soybeans per conventionally till acre compared to 32 bushels of a no-till (Hayes, p. 8). Yield studies reported at this conference and in proceedings of previous no-till conference provide information showing how tillage and other factors influence yields in the Southeast (Touchton and Stevenson).

Soil suitability is a critical factor in the success or failure of conservation tillage systems, primarily through the interaction of tillage systems and soils on crop yields. It has been noted that conservation tillage techniques are not adaptable to all soils and that they provide a positive response on some soils but not on others (Cosper). Factors most likely to have adverse yield effects with conservation tillage have been associated with inherent physical limitations of particular soils. These include drainage problems, soil wetness levels, structural stability, water percolation, impervious or restrictive layers in the profile, and surface soil texture.

Labor and Management Requirements. Labor savings associated with conservation tillage are normally due to reductions in preharvest labor requirements. Conservation tillage usually requires less labor, primarily because of fewer operations and trips across the field with equipment complements. There may be an offset to this labor savings of higher labor requirements associated with chemical application, but most experiences seem to indicate that any increases are negligible.

It is well recognized that good management is the key to successful farming. This is particularly true in the use of conservation tillage. Conservation tillage systems are more complex to manage than conventional systems. Good managers will generally be able to successfully handle the additional variables associated with conservation tillage. Managers just getting by with conventional systems may get into real problems using conservation tillage systems.

Equipment Investment Costs. Many factors influence the machinery and equipment investment costs for alternative tillage systems. Variables such as location, farm size, and crop rotations make a comparative analysis of investment costs difficult. Much of the literature shows that conservation tillage requires less investment in equipment than conventional conservation tillage. However, many farm operations require both conventional and conservation equipment, making it difficult to make an either/or comparison. Conventional wisdom states that conventional tillage systems require larger or bigger tractors and more tillage equipment for all the operations than does conservation tillage. With conservation tillage alternatives, the moldboard plow, multiple diskings and multiple chisel plowings are replaced with field cultivators, sweeps, single diskings. and chisel plowings. The machine operations used for this alternative are designed to leave some of the crop residue on the soil surface. No-till options generally exclude any tillage equipment, but conventional grain drills and planters are replaced by specially designed no-tillage equipment which prepares narrow slotted seedbed areas during the planting process. Chemical weed control generally replaces cultivation in conservation and no-till alternatives.

Fuel and Lubrication Requirements. One of the most commonly cited economic savings associated with conservation tillane is reduced fuel consumption. Cost savings from lower energy use with conservation tillage can be significant. Fuel use depends on specific field operations as well as soil draft. Fuel consumption varies greatly between operations depending upon soil types, soil moisture, amount and kind of residue from the previous crop, condition of the implement and tractor and the way the tractor is operated. Under most circumstances, conservation tillage uses less fuel than conventional tillage since there are fewer passes over the field and/or less fuel consumptive machine operations. While it is hard to generalize across all situations, literature reviews have found that reduced tillage systems require on the average 3 to 5 less gallons of fuel per acre than conventional tillage systems (Crosson), and a 70 to 90 percent reduction in diesel fuel per acre between no-till and conventional tillage (Christensen).

Pesticide Costs. Conservation tillage systems generally substitute pesticides for machinery operations to control weed, insect, and disease infestations. An important economic consideration for a farmer is the extent to which additional costs for pest control are offset by savings in equipment investments, energy, or labor. While it is generally assumed that more herbicides will be required with a conservation tillage situation, it is not inevitable that there will be an increased use of pesticides with conservation tillage. Application methods can be develop to reduce the quantities used on specific crops, and circumstances. Many of the problems can be reduced with better equipment, guidelines, scouting and monitoring, rotations, and development of more selective chemicals (Crosson). As mechanical cultivation is reduced, additional use of herbicides, insecticides, and fungicides may be needed to control pests. Estimates of chemical requirements with various tillage systems varies greatly between soils, crops, and total management systems. One survey found increases in pesticide use ranging from 14 to 43 percent for conservation tillage compared to conventional tillage (Christensen).

Looking to the Future

What is the future for conservation tillage? Pierre Crosson has suggested that as much as 50-60 percent of U.S cropland may be in conservation tillage by 2010. Others have projected levels as high as 90 percent. The enthusiasm over conservation tillage will continue only where it is found to be technically, economically, and environmentally acceptable. One way to assess the future for conservation tillage is to examine the factors behind the current trends.

Conservation tillage can result in significant reductions in soil erosion while improving the soil medium for agricultural plant growth. Concurrently, it offers an opportunity for farmers to cut production costs. While farmers may want to reduce soil erosion, they are most likely to adopt conservation practices when they contribute to income and other goals (Magleby). Economic evaluations by farmers typically take both a short and long run view. Many conservation programs in the past have focused on long term investments such as terraces and grass waterways. While these programs are good technical practices, their high costs and long payback period often reduce their economic attractiveness. Given the economic pressures that farmers face, short run economic forces generally have the greatest influence on their decisions. It is in this context that conservation tillage is particularly attractive, since it can produce tangible results in the first year of use. In fact, this short run payoff probably explains much of its attractiveness and rapid adoption, and is likely to continue.

The rate of continued adoption of conservation tillage will depend on the amount of acreage with soils suitable for conservation tillage and the changes in factors influencing its profitability. Soil suitability is a major factor in the success or failure of conservation tillage systems primarily through the interaction of tillage systems and soils on crop yields. Conservation tillage is suitable for many soils, but not all.

Conservation tillage has several attractive features. It reduces soil erosion by maintaining cover and reducing soil loss. It typically reduces the amount of fuel and labor required per acre, and in some instances it requires less investment in agricultural equipment. Yield impacts depend on crop and location factors. In general, conservation tillage will work best in areas with longer growing seasons. In dry years it can cause significant moisture savings.

Some of the areas of concern inlcude the ineffectiveness of chemicals to control weeds and insects and increased chemical costs. Typically, it is presumed that the increased costs of chemicals are offset by savings in labor and fuel. It remains to be seen if conservation tillage creates a new dependency on chemicals for agricultural production. A large increase in the price of chemicals relative to labor or fuel could slow the adoption process, and possibly cause a shift to more conventional systems. Conservation tillage requires more management than conventional tillage, particularly for weed, insect, and disease control. One farmer has noted that conservation tillage is a piece of information or tool to aid the farm business, if used properly (Wetherbee). Good managers have the capacity to adjust their operations to the precise requirements of conservation tillage and to use a total systems approach. Average to poor managers may have difficulty in handling the management requirements, and may not adopt or continue conservation tillage practices.

Summary and Conclusions

Public and individual concerns about the impacts of soil erosion on both soil productivity and the environment, combined with economic forces, have stimulated the development and adoption of conservation tillage technologies in the southeastern United States. Its adoption is increasing throughout the region and it is anticipated that this increase will continue. Acreage in conservation tillage in the southeastern region, increased about 180 percent between 1973 and 1984, somewhat faster than the comparable increase of about 130 percent for the entire United States.

The use of conservation tillage is influenced by physical, technical, and economic factors. Conservation tillage is suitable for many soils. but on some it has adverse yield impacts. The interaction of climatic and soil characteristics precludes conservation tillage on some soils. Yields may be impacted slightly if at all, and savings in energy, labor, and machinery costs often exceed increased chemical costs associated with conservation tillage.

Farmers considering conservation tillage will be closely looking at the returns associated with conservation tillage compared to conventional systems as well as the risks which might be associated with the system. They increasingly recognize that conservation tillage is a systems approach to farming which generally requires more management than conventional tillage, particularly with respect to weed, disease, and insect control.

Pressures to reduce production costs and increase net returns will continue to make conservation tillage attractive for farmers in the Southeast. It will not work on all soils or for all managers, but it is an approach to farming which can improve individual farm income and at the same time contribute to the goals of soil conservation and the improvement of water quality of the region's lakes and streams. Hany of the reasons behind its adoption are expected to continue, but as with all technology, it should be treated as a means to an end, not an end in itself.

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