SURFACE RESIDUE COVER IN NO-TILL COTTON

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Acreage in no-till cotton is expanding rapidly in western Tennessee. No-till is increasingly seen as the most cost-effective way to meet Conservation Compliance requirements for program participation as well as meet farmer goals for erosion reduction.

The soils on uplands in western Tennessee are derived from loess. They are very silty and very susceptible to erosion. Erosion rates in excess of 20 tons per acre per year have often been observed in continuous cotton production with conventional tillage. Almost all upland fields meet the Farm Bill definition of highly erodible land. In addition, most of the upland soils have fragipans which restrict root penetration. Thus loss of soil by erosion leads to a shallower rooting zone and loss of productivity due to more frequent water stress.

The effectiveness of no-till in reducing erosion depends on maintenance of a cover of crop residue over the soil surface. Most western Tennessee cotton fields are in continuous cotton. Cotton is a low residue crop, and may not always provide enough residue to adequately protect the soil by itself. As a practical matter, a cover of at least 30 percent is needed to meet Conservation Compliance requirements. Cover crops can increase the residue cover, but they are costly and difficult to establish early enough in the fall to contribute greatly to winter cover. The purpose of this work is to determine what residue levels are actually being achieved in no-till cotton fields under different soil, landscape and management conditions, with and without cover crops, and to determine the conditions under which the residue cover will fall below 30 percent.

METHODS

Measurements of residue cover soon after planting were made in 23 fields in 6 western Tennessee counties (Crockett, Shelby, Fayette, Lauderdale, Haywood and Tipton) in May, 1993. Within each field, areas of differing slope and/or soil type were chosen for measurement. Within each area, residue cover was determined by the line transect method along three transects of 50 feet. Along each transect, 100 points spaced 6 inches apart were counted. The three transects were then averaged to give one observation. Measurements were made in two to seven areas in each field, for a total of 95 observations and 285 transects. All the fields were in no-till cotton in 1993, except for one field which was in no-till grain sorghum planted in cotton residue from 1992. The length of time in no-till varied from one to six years. In most cases, the fields had been in cotton for two or more years prior to 1993, but one field had been planted in corn in 1992 and another in corn in 1991. Five of the fields had a wheat cover crop established by overseeding in standing stalks in the late fall of 1992. When residue measurements were made, separate counts were made of old crop residue and residue from winter weeds or cover crops. These counts were combined to give total residue cover. If a point overlay both crop residue and winter weed residue, it was counted as crop residue.

For purposes of evaluating the effects of soils and landscapes, observations were divided into three classes: bottoms (0 to 1 percent slope), uplands of 1 to 4 percent slope and uplands of 5 percent slope or more. The steepest slopes ranged up to 9 percent. All the observations on uplands were on highly erodible land as defined by the 1985 farm bill.

Soils in the bottoms were in the Adler (coarse-silty, mixed, nonacid, thermic Aquic Udifluents) or Collins (coarse-silty, mixed, acid, thermic, Aquic Udifluents) series. Most soils on uplands were in the Grenada (fine-silty, mixed, thermic Glossic Fragiudalfs) or Loring (fine-silty, mixed, thermic Typic Fraguidalfs) series. A few observations were on Calloway (fine-silty, mixed, thermic Glossaquic Fragiudalfs), Center (fine-silty, mixed, thermic Aquic Hapludalfs). Henry (coarse-silty, mixed, thermic Typic Fragiudalfs) or Memphis (fine-silty, mixed, thermic Typic Hapludalfs) soils.

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Table. 1 Numbers of Observations Exceeding 30 and 45 Percent Residue Cover

Residue Cover	Observations	
	Number	Percent
%		
0-29	**22**	**22%**
3044	**34**	**34%**
45+	**44**	**44%**

RESULTS

The average surface residue cover across all observations was 44 percent. Most areas measured exceeded the 30 percent residue requirement after planting. Including crop residue, winter weeds, and residue from cover crops, 78 percent of the areas were above the minimum level (Table 1).

Although most areas had more than 30 percent cover overall, residue cover varied considerably by landscape position and slope (Table 2). Bottoms had the highest average percent surface cover, averaging 59 percent without cover crops. All observations on bottoms had more than 30 percent residue cover, with 9 of 11 exceeding 45 percent (Table 3). On the gently sloping uplands of 1 to 4 percent slope, surface residue cover averaged 44 percent without cover crops (Table 2). with 81 percent of all observations exceeding 30 percent cover (Table 3). However, on the most erosive uplands of 5 percent slope or more, residue cover without cover crops averaged only 27 percent (Table 2). and 9 of 14 observations, or 64 percent, did not meet the 30 percent cover criteria (Table 3).

Cover crops increased residue cover by an average of 9 percent on the upland areas of 5 percent slope or more (Table 2). The number of observations was limited, but with cover crops all observation on the 14 percent slope areas and two-thirds of those on the areas of 5 percent slope or more met the 30 percent cover criteria (Table 4).

Within landscape and slope classes, residue cover was affected by the number of years in no-till. the presence of cover crops, and use of corn in the rotation (Table 5).

With continuous cotton without a cover crop, surface residue tended to be higher in fields which had been in no-till for one or more years prior to 1993 (Table 5). However, the effect varied by landscape position. On bottoms, fields previously no-tilled had 66 percent residue cover versus 48 percent on fields in their first year of no-till, a difference of 18 percent. On uplands of 1 to 4 percent slope, the difference was similar at 14 percent. Unfortunately, on the most erosive sites of 5 percent slope or more, there was little difference in residue cover between first year and longer term no-till.

The lower residue cover on the steeper (5% +) slopes and the lack of accumulation through time was very obvious in the field. Where there was no cover crop, rill erosion was quite often visible in these areas, especially if the rows were oriented up and down the slope. The reasons for the low

Table 2. Average Residue Cover by Landscape Position With and Without a Cover Crop

Position	Cover Crop		No Cover **Crop**	
	Observations	Residue Cover	Observations	Residue Cover
	N	%	N	%
Upland				
1 to **4%** slope	12	49	**52**	**44**
≥5% slope	6	**36**	**14**	***27***
Bottoms	**11**	59	**---**	**---**

Table 3. Number of Observations Exceeding 30 and 45 Percent Residue Cover by Landscape Position Without a Cover Crop

	Uplands					
Cover	Number	%	Number	%	Number	%
0-29%	0	0	10	19	9	64
30-44%	2	18	17	33	5	36
45+%	9	82	25	48	0	0

Table 4. Number of Observations Exceeding 30 and 45 Percent Residue Cover By Landscape Position With a Wheat Cover Crop

Cover	Number	%	Number	%

Table 5. Average Residue Cover by Cropping System Within Landscape Positions

Position and Cropping System	Number of Observations	Residue Cover		
		Mean	Std. Dev.	Range
		----------%		----------
Uplands, 1-4% Slopes				
No Cover Crop, 1st Year No-till	22	35	13	20-68
No Cover Crop, 2nd + Year No-till	25	49	13	28-59
No Cover Crop, 1992 or 1991 Corn	5	64	14	48-76
Cover Crop	12	49	17	31-77
Uplands, ≥ 5% Slopes				
No Cover, 1st Year No-till	5	25	9	18-33
No Cover Crop, 2nd + Year No-till	8	28	10	17-43
No Cover Crop, 1991 Corn	1	30	--	--
Cover Crop	6	36	16	21-59
Bottoms				
No Cover Crop, 1st Year No-till	4	48	13	35-62
No Cover Crop, 2nd + Year No-till	7	66	12	50-77

residue level are the lower productivity of cotton on these sites, the lower population of winter annual weeds compared to bottoms and less sloping uplands (Table 6) and possibly downslope washing of residue. There has been considerable discussion about the importance of winter annuals in providing surface cover in low residue crops. In this study, winter annuals contributed considerably to the total residue cover on bottoms and less-sloping uplands, particularly in fields which had been no-tilled in previous years. However, on steeper uplands where extra residue cover was most needed, winter annual weeds contributed very little. This is attributed to lower fertility on these sites, especially lower nitrogen, and greater carryover of herbicides. Both of these effects are due to the lower soil organic matter content on these sites, which are generally severely eroded.

The increase in residue cover on the bottoms and 1 to 4 percent slope uplands in fields in longer term no-till was due to increases in both crop residue and winter annual weeds (Table 6). On the steeper slopes, there was little or no increase in either compared to the first year in no-till.

The effect of cover crops varied considerably by slope. On the uplands of 1 to 4 percent slope, use of a cover crop did not increase the average residue cover after planting when compared to fields in no-till for more than one year. Cover crops did increase residue cover compared to areas without cover crops in the first year of no-till. On the steeper areas, cover crops increased residue cover by about 10 percent on average, and were necessary in most cases to raise residue cover levels above the 30 percent level.

One notable aspect was the wide range in residue cover observed between and within fields with similar soils and cropping systems (Table 5). This was particularly evident with cover crops. In all cases, the cover crop was wheat overseeded in standing stalks. It was evident in the field that this could lead to a significant increase in cover or little or no increase depending on time of seeding, seeding rate, seed quality, care taken to get even distribution, timing relative to defoliation or stalk shredding, and weather conditions. Where proper attention to detail had been given to establishing the cover crop, residue cover was enhanced considerably. Where the cover had been established with minimal input and attention to meet program requirements, the value was much more limited.

It appears that to establish and maintain an acceptable level of residue cover in no-till cotton following conventional cotton, on the less sloping uplands the best way is to seed a cover crop prior to the first year in no-till. After the first year, it appears that adequate residue can be maintained in most cases without a cover crop. On the areas of 5 percent or greater slope in western Tennessee,

Table 6. Residue Cover From Cotton and Winter Weeds by Landscape Position and Years in No-till [No Cover Crop)

Position and Years In No-Till	Observations	Residue Cover		
		Total	Cotton	Winter Weeds
		----------%----------		
Uplands, 1-4% Slopes				
1st Year No-till	22	35	29	6
2nd + Year No-till	25	49	39	10
Uplands, ≥ 5% Slopes				
1st Year No-till	5	25	21	4
2nd + Year No-till	8	28	26	2
Bottoms				
1st Year No-till	4	48	38	10
2nd + Year No-till	7	66	49	17

well-managed cover crops appear to be necessary to maintain residue levels of 30 percent or more at planting, even in continuous no-till. Even with cover crops, residue levels are sometimes inadequate for good erosion control in these areas.

As noted earlier, most fields in this study were in continuous cotton. However, in two fields corn had been grown either the season before or two seasons before. Based on these limited observations, it appeared that having corn in the rotation increased the surface residue as effectively as cover crops, if not more so (Table 5). Based on the two fields examined, the effect of corn declined considerably in the second year of cotton, but more fields need to be examined for a more definitive answer.

In summary, in most situations in no-till cotton in west Tennessee, surface residue levels of 30 percent or more at planting are being maintained. The residue is a combination of old crop residue, cover crops and winter weeds. Unfortunately, the residue levels drop as slope increases, productivity declines and erosion potential increases. On slopes of 5 percent or more, it appears that either well-managed cover crops or rotation with higher residue crops will be needed to maintain adequate cover for erosion control.

Observations on the steeper slopes and in fields rotated with higher residue crops were limited in number. More information is needed for these situations. This study is continuing in 1994.