EROSION MEASURED FROM A LISTER-TILL SYSTEM[1/]

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INTRODUCTION

Farming the highly erodible sloping soils in North Mississippi by conventional methods has produced a severe erosion problem, which has pointed out the need for new soil conservation practices. To meet this need, experiments were conducted at North Mississippi Branch Experiment Station, Holly Springs, beginning in 1969 to evaluate the effectiveness of no-till and minimum-till systems. The results from the no-till system have already been reported (1)[3/]. In this paper we present the results of the minimum-till (lister-till) system.

In a lister-till system, only one operation is needed to plant the crop, combining middle buster and planting units. Seeds are planted in the furrow made by the middle buster. Crop residues are generally covered but sometimes protrude through the turned soil. Until they are destroyed by cultivation, contoured ridged middles channel overland flow during most rainstorms. Some storms are sufficiently large and intense so as to cause overtopping.

Although lister-till is usually practiced in drier areas, research in Mississippi has shown that lister-till minimized weed problems and produced high yields as compared with other minimum-till practices (2). Other advantages of lister-till include reductions in erosion and in the number of tillage trips over the field (3, 4). A major disadvantage reported for a lister-till system is that highly erosive rainstorms, after cultivation has destroyed ridges between the rows, may cause greater soil loss than from conventional-till farming methods. Other disadvantages include managing crop residues, controlling planting depth, and excessive silting over seeds during heavy rains (3).

Our major objective of this study was to evaluate runoff and soil loss from soybeans double-cropped with wheat and continuous soybeans grown in a lister-till system.

Study Area and Instrumentation

Duplicate 0.25-acre plots and a 1.45-acre watershed were used in this study. The plots were 150 feet wide and 72.6 feet long on 2.5-, 5-, and 10-percent slopes. Rows graded to 0.2- to 0.4-percent slope

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3/ Numbers in parentheses refer to references cited.

across the plots drained into a grassed waterway at the side of the plots. Runoff was measured with a 1-foot H-flume and FW-1 water stage recorder and sampled for soil loss estimates with an N-2 Coshocton-type wheel sampler. The Providence, Loring, and Memphis silt loam soils in the experimental areas were moderately to relatively high in fertility.

The average slope of the watershed was 7-percent. Contoured rows drained into a grassed waterway in the center of the watershed. Runoff was measured with a modified Parshall flume and FW-1 water stage recorder. Sediment was collected in a concrete silt box located immediately below the flume. An Iowa slot-type sampler was used to sample runoff for sediment concentration analysis of overflow from the silt box.

Crop Management

Soybeans followed wheat (double-cropping system) on the watershed and on 2.5-, 5-, and 10-percent sloping plots. We used single-cropped soybeans on 5-percent sloping plots for comparing differences in soil loss from single-cropping vs. double-cropping. Conventional-till single-cropped soybeans were grown on all plots and on the watershed during the year immediately before this study.

Wheat was planted in 20-inch rows with a sod-seeder in late October or early November at a rate of 1 bushel/acre. Fertilizer (10-20-20) was drill applied about 2 inches below the seed at 200 pounds/acre. An additional 70 pounds/acre of nitrogen (as ammonium nitrate) was top dressed in early March. Wheat was harvested about mid-June.

Immediately after wheat harvest, Dare variety soybeans were planted with a lister planter in furrows 40-inches apart at a rate of 1 bushel/acre. The test areas were fertilized with an additional 300 pounds/acre of 0-20-20 at planting. Fertilizer was drill applied about 3 inches to the side and about 2 inches below the seed. A preemerge application of alachlor herbicide was broadcast at a rate of 2 pounds/acre active ingredient.

As compared with conventional-till, soybean minimum-tillage operations were considerably decreased both before and after planting. The only tillage at planting was with the middle-buster units. About 4 weeks after planting, soybeans were cultivated with small sweeps near the row. About 8 weeks after planting, the ridged middles were also cultivated. To minimize soil erosion, tillage was decreased at planting and cultivation of the ridged middles was delayed until some cover was provided by the crop canopy.

RESULTS AND DISCUSSION

Since we evaluated only 2 years of data in this study, we compared measured vs. expected values of rainfall erosion index (a measure of the erosivity of rainfall defined as the product of storm kinetic energy in hundreds of foot-tons/acre times the maximum 30-minute intensity in inches/hour) (5). A storm was defined as 0.01 inch or more of precipitation without a 1-hour break.

The 2-year average annual rainfall at Holly Springs (Table 1) for the 1970-1971 water years (October 1 through September 30) was only slightly higher than the 50-year average (53 inches). But the average annual erosion index was much higher than the expected annual average of 320 units (5). Rainfall was fairly evenly distributed throughout the year, but was slightly lower during July-September than that of other 3-month periods. Even with less rainfall, about 43 percent of the 2-year average annual erosion index was measured during July-September. During this period, runoff from each of the plots was less than half the amounts during any of the other 3-month periods. Soil loss from the plots during this period was lower than that during January-March and April-June but slightly higher than that during October-December. Evidently, the combination of crop canopy and decreased runoff offset the high erosion potential of rainfall during July-September.

Soil loss increased as percent slope increased with the following relationship between soil loss and percent slope for the double-cropped lister-tilled plots:

$$SL = 1.42 + 0.52 X$$

where SL is annual soil loss (in tons/acre) and X is percent slope. Figure 1 shows the relationship of slope gradient and soil loss ratios (the ratio of soil loss from the field gradient to that from a 9-percent slope) derived from the 1970 to 1971 lister-till study as compared with a relationship derived from previous data at Holly Springs in 1963 to 1968. The earlier data were collected from the same plots as in the lister-till study but with a different cropping system--clean tilled contoured corn. Soil loss ratios for both periods of record were quite similar.

As the soil loss increased with percent slope runoff similarly increased. There was a small increase from 2.5- to 5-percent slope and a considerable increase from 5-to 10-percent slope. Single-cropped soybeans were grown only on 5-percent sloping plots. Both runoff and soil loss from these plots were slightly higher than that from the 5-percent sloping, double-cropped plots. Runoff from the 7-percent sloping, double-cropped watershed was slightly higher than that from from the 10-percent sloping double-cropped plots, while soil loss was slightly lower. Possibly the decrease in soil loss on the watershed, even with higher runoff, was because deposition was greater on the watershed than on the runoff plot. Sediment delivery ratios usually decrease as land area increases significantly.

A major advantage of lister-till, as compared with conventional-till, is that soybeans can be planted quickly after wheat harvest. Also, the seeds are placed about 7 inches below the ground surface, where moisture is usually sufficient for germination, while that near the soil surface has been depleted by the wheat crop. Another advantage of lister-till vs. conventional-till is the decreased labor and fuel requirements because of decreased tillage trips through the field. Since the crop residues in the row ridges also decreased soil surface sealing, normally caused by high intensity rainfall, infiltration was increased.

We observed some major disadvantages of lister-till in this study. Exceptionally large rainstorms soon after planting decreased crop stands by covering the seeds too deeply with soil eroded from the furrow side-slopes. These storms also caused concentration of chemicals near the plants that caused some crop damage. Other problems associated with lister-till were cultivation of the ridged middles and inability to place seeds and fertilizer at uniform depths. Cultivation problems involved controlling the tractor travel direction, particularly on steeper slopes with curving contours, and the buildup of crop residues around cultivator sweeps.

Crop Yields

Table 2 presents the crop yields for all treatments. Also, included in this table is the crop yield of conventional-till soybeans (single-cropped) on 5-percent sloping duplicate plots with rows up-and-down hill. Although these plots were not part of the lister-till study, we presented the crop yields to indirectly compare conventional-till vs. lister-till. The lister-till, single-cropped soybean yields were slightly higher than the conventional-till soybean yields and considerably higher than the double-cropped, lister-till soybean yields. The decrease in soybean yields should be weighed against returns gained by double-cropping with wheat.

Conclusions

Two-year average annual soil losses from lister-till, double-cropping system of soybeans and wheat were 3, 4, and 7 tons/acre on 2.5-5-, and 10-percent sloping plots, respectively. The average annual soil loss from the same system on a watershed with an average slope of 7-percent was 6 tons/acre. The average annual soil loss from lister-till, single-cropped soybeans on 5-percent sloping plots was 5 tons/acre. These soil loss rates indicated that we could not recommend contoured lister-till, even in a double-cropping system, in North Mississippi for slopes steeper than 5-percent.

REFERENCES

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Table 1.--Two-year average (10/1/69--10/1/71) rainfall, erosion index, runoff, and soil loss from single and double-cropped soybeans.

	Oct.-Dec.	Jan.-Mar.	Apr.-June	July-Sept.	Totals
RAINFALL (INCHES):	15	13	14	13	55
EROSION INDEX (UNITS):	71	81	129	211	492
RUNOFF (INCHES):					
2.5% Double-cropped	4.9	4.7	4.2	1.9	15.7
5% Double-cropped	4.4	6.0	4.6	1.8	16.8
5% Single-cropped	5.3	5.8	4.9	1.8	17.8
10% Double-cropped	7.2	7.3	5.5	2.5	22.5
7% Average, Double-cropped watershed	7.6	8.1	5.8	2.2	23.7
SOIL LOSS (TONS/ACRE):					
2.5% Double-cropped	.5	.8	.8	.6	2.7
5% Double-cropped	.5	1.2	1.4	.9	4.0
5% Single-cropped	.6	1.6	1.9	.6	4.7
10% Double-cropped	1.0	2.3	2.1	1.2	6.6
7% Average, Double-cropped Watershed	1.2*	3.4*	1.0*	.5*	6.1*

* Includes soil deposited up to 60 feet above flume

Table 2.--Soybean and wheat yields from conventional and lister-till systems.

		CROP YIELDS (BUSHELS/ACRE)					
	Percent	1970		1971		2-Year Average	
System	Slope	Soybeans	Wheat	Soybeans	Wheat	Soybeans	Wheat
Soybeans, double-cropped (lister-till)	2.5	22	37	20	31	21	34
Soybeans, double-cropped (lister-till)	5	26	29	22	31	24	30
Soybeans, double-cropped (lister-till)	10	19	32	21	26	20	29
Soybeans, single-cropped (lister-till)	5	31	--	36	--	34	--
Soybeans, double-cropped (Watershed) (lister-till)	7 (Avg.)	25	30	24	23	24	26
Conventional-till soybeans, single-cropped, rows up-and-down slope	5	25	--	31	--	28	--

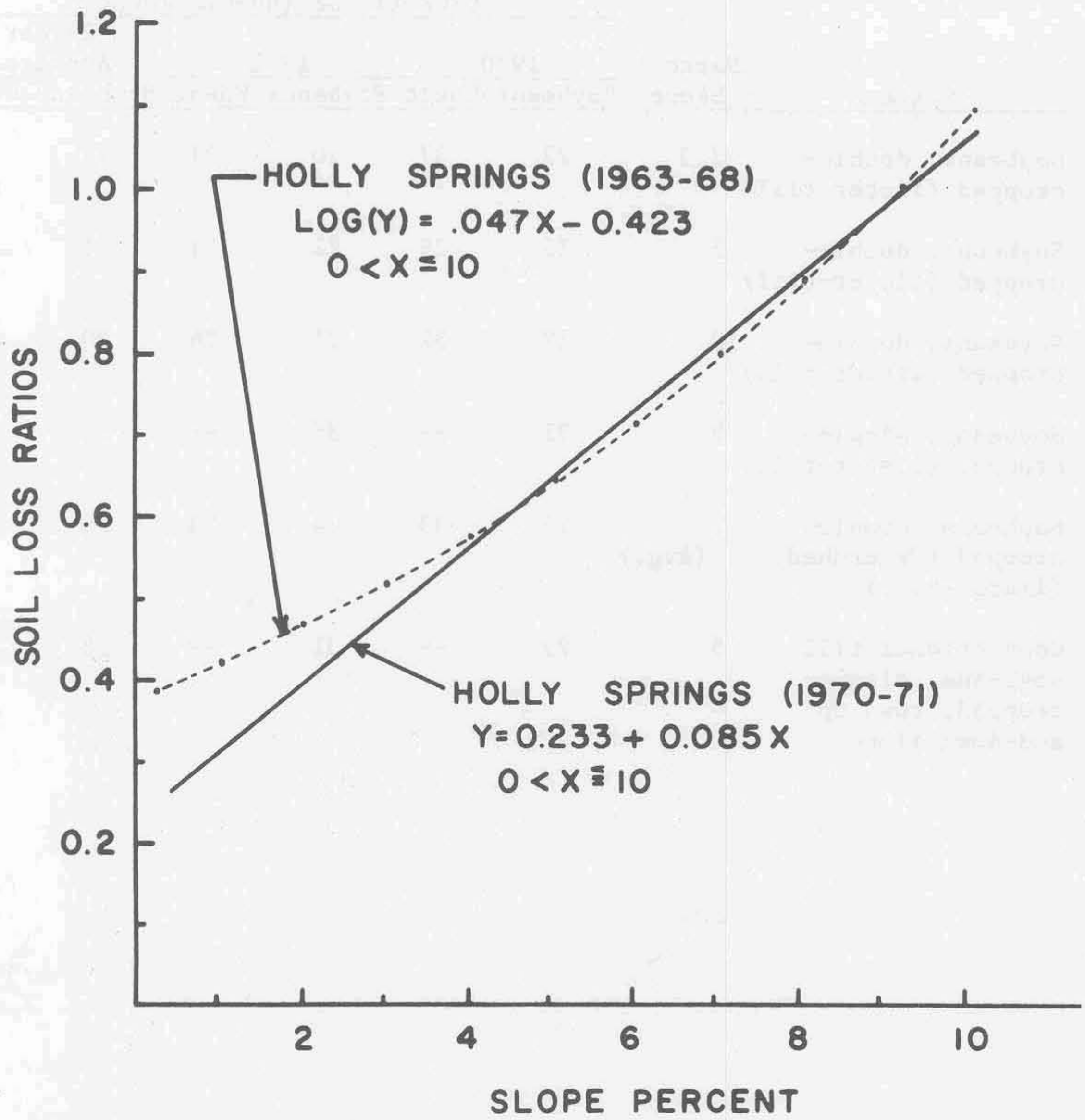

Figure 1. Relationships of slope and soil loss ratios derived from a lister-till double-cropping system (soybeans-wheat) and from a conventional-till system (corn with residues left on ground after harvest).