The Erodibility of Some Indiana Soils[1]

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Knowledge of the relative erodibility of soils is essential to sound planning of conservation and management programs. A new procedure for predicting soil losses from cropped land is now being introduced into the Cornbelt (7). This procedure utilizes an absolute soil erodibility factor with continuous cultivated fallow as base. Measurements of soil losses from fallow are necessary to obtain an accurate value of the erodibility factor of the various soils. Soil losses were measured with the ARS-Purdue rainulator. This paper presents the methods and results of such measurements on 15 locations within the State of Indiana.

Several laboratory procedures for measuring soil characteristics considered indicative of the soil's erodibility have been proposed in the literature (1, 2). Many of these characteristics are being measured as a part of this study in conjunction with the actual soil loss measurements. When a large volume of the information has been gathered, quantitative prediction of erodibility based on these concomitant measurements may be possible.

Procedure

Fifteen pairs of plots were located on various soil types with the help of Soil Conservation Service personnel in the spring of 1961. Plots were selected to obtain a range of soils differing in texture and parent material combined with a narrow range of slope.

Whenever possible, sites were selected which had been in row crops during the two years preceding the test to reduce variability due to past cropping history. These plots were plowed in the spring and kept fallow by disking until July or August.

Prior to plowing, all existing vegetation and residues were removed and the plots were disked twice to smooth the surface. Plowing was up and down slope to a depth of about seven inches. All locations were disked five times after plowing and prior to making the tests with the rainulator—once shortly after plowing, twice approximately one month after plowing and two more times just prior to the rainulator runs. The final disking in all cases was up and down slope. A small farm tractor with three-point hitch equipment was used for tillage operations.

Locations, soil type, percent slope, cropping history, date of plowing and dates of rainulator runs are presented in table 1. Cropping history is given for the years 1959, 1960 and 1961. Since all locations were plowed in the spring, little effect on soil erodibility would be expected from the 1961 crop. The Fox and Parr silt loams located in Fountain County

1. Contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., in cooperation with the Purdue Agricultural Experiment Station. Purdue Journal Series Paper No. 1995.

TABLE 1. Locations and descriptions of plots from which soil loss and runoff measurements were taken.

Location	Soil Type	% Slope	Crop Hist.[1]	Date Plow[2]	Date Run[3]
Fountain Co., Sec. 14, T21N, R7W	Fox silt loam	8.63	CBW_m	5-17	8-7
Fountain Co., Sec. 9, T20N, R6W	Manlove silt loam	7.23	BW_mM	5-16	8-15
Fountain Co., Sec. 1, T21N, R6W	Manlove silt loam	4.60	MFF	5-5	10-7
Fountain Co., Sec. 28, T21N, R6W	Parr loam	7.20	CBW_m	5-16	8-10
Kosciusko Co., Sec. 21, T32N, R7E	Miami sandy loam	7.84	CCC	5-23	7-19
Kosciusko Co., Sec. 11, T30N, R6E	Morley loam	10.52	CCC	5-22	7-19
Kosciusko Co., Sec. 34, T31N, R5E	Celina loam	8.24	CCC	5-22	7-26
Kosciusko Co., Sec. 34, T31N, R5E	Celina sandy loam	8.50	CCC	5-22	7-26
Orange Co., Sec. 6, T2N, R2E	Bedford silt loam	6.72	CCC	5-25	9-6
Orange Co., Sec. 10, T1S, R1E	Elkinsville silt loam	7.82	CC_gC	5-24	8-31
Orange Co., Sec. 2, T1S, R1E	Zanesville silt loam	8.38	MCO_m	5-25	8-31
Tippecanoe Co., Sec. 30, T24N, R4W	Miami loam	9.48	CCC	5-18	8-22
Tippecanoe Co., Sec. 20, T24N, R4W	Celina loam	9.09	BW_mM	5-19	8-22
Tippecanoe Co., Purdue Throckmorton Farm	Wea silt loam	5.58	CCO_m	5-18	8-2
Washington Co., Sec. 27, T2N, R4E	Bewleyville silt loam	14.54	CO_mM	5-24	9-6

[1] Denotes cropping history—1959, 1960 and 1961. C—corn, B—soybeans, W_m—wheat with meadow intercrop, M—meadow, O_m—oats with meadow intercrop, F—fallow, Cg—corn with winter cover of rye grass that was heavily pastured in 1960. Essentially no cover remained in the spring of 1961.

[2] Dates given are month and day plots were plowed

[3] Dates given are month and day rainulator runs were conducted.

which were in winter wheat were the only ones that had a significant amount of growth at time of plowing.

Each set of plots was treated and measured as follows. Each plot was covered with black plastic between the time of the last disking and the time of the run. This was to insure that a freshly tilled surface was exposed to the initial rainulator run and that the soils tested were at a moisture content at or below field capacity. Gravimetric moisture determinations were made from the upper 12 inches to further investigate moisture as a variable between locations. The rainulator was assembled over the adjacent plots, each 12 feet by 35 feet, as shown in figure 1.

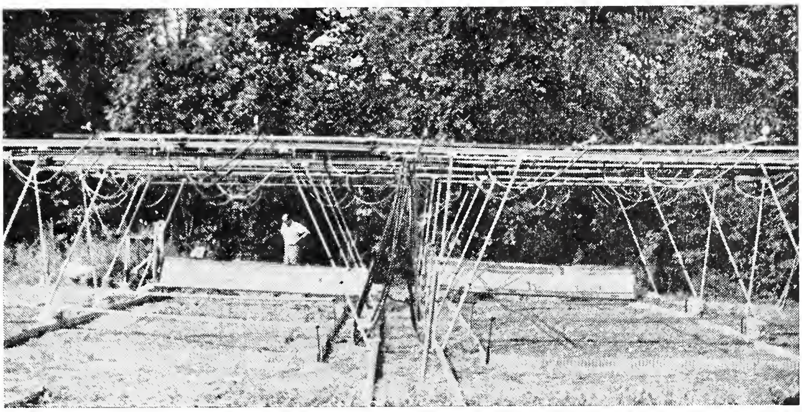

Figure 1. Rainulator assembled over two plots.

The plots were subjected to a total of 5 inches of artificial rainfall at an approximate intensity of 2.5 inches per hour applied in three separate storms. The three storms consisted of an initial run of 60 minutes' duration, a wet run of 30 minutes' duration approximately 24 hours later, and a very wet run of 30 minutes' duration starting 15 minutes after the cessation of the wet run.

The rate of runoff was measured continuously with a calibrated flume and an FW-1 waterstage recorder. Aliquot samples of the runoff were taken throughout the run, and the amount of soil in the runoff water was determined. The soil loss for the time of sampling was then taken as the product of the percent soil in the sample and the total runoff for the sampling period.

Complete profile descriptions of the soil at each location were made by Soil Conservation Service soil scientists. These descriptions, along with the test results, may provide another means for evaluation of test results with variations in soils.

Soil samples to a depth of 6 inches were taken just prior to the run. These samples were used to determine such things as the particle size distribution, organic matter content and aggregate stability of the soil. At 10-minute intervals during the run, small portions of the plots were covered, and the top centimeter of soil under these covers was used to determine the suspension percentage and dispersion ratio of the soils. The latter offers indirect measurement of soil structure.

Results

A summation of the rainfall application, infiltration, runoff, percent soil in runoff and soil loss for the three runs by location is given in

TABLE 2. Summary of results by soil type. Data presented are results from a total of 5 inches of rainfall applied at an intensity of 2.5 inches/hour.

Soil Type	Infiltration	Runoff	Soil Content of Runoff	Soil Loss
	in.	*in.*	*percent*	*tons/acre*
Fox si. l.	2.56	2.44	6.44	17.80
Manlove si. l.	2.73	2.27	6.29	16.17
Manlove si. l.	1.79	3.21	3.31	12.03
Parr l.	2.38	2.62	4.07	12.07
Miami s. l.	2.17	2.83	3.45	11.07
Morley l.	2.17	2.83	5.08	16.22
Celina s. l.	2.24	2.76	4.71	14.73
Celina l.	1.84	3.16	5.36	19.21
Bedford si. l.	2.14	2.86	7.56	24.49
Elkinsville si. l.	1.85	3.15	5.94	21.20
Zanesville si. l.	2.35	2.65	4.59	13.77
Miami l.	2.34	2.66	5.28	15.98
Celina l.	1.98	3.02	5.76	19.69
Wea si. l.	2.80	2.20	3.64	9.07
Bewleyville si. l.	1.71	3.29	7.62	28.41

table 2. The soil-loss data in this table have not been adjusted for differences in slope and cropping history. The apparent lack of correlation between runoff and soil loss is accounted for by differences in the amount of soil carried by the runoff water as indicated by percent soil in runoff. The differences among soils are reflected by both amount of runoff and amount of soil suspended in the runoff.

The total soil loss from the various soil types adjusted to account for differences in slope and cropping history is given in table 3. The adjusted soil losses were obtained by using adjustment factors previously published (5, 6). The adjusted soil losses are what would be expected from each soil if it were in continuous fallow on a 9 percent slope, 72.6 feet long. This is the base plot used in the soil loss prediction equation now being adopted for use in the Cornbelt (7). Two separate adjustment factors were therefore involved in these adjustments—one for length and degree of slope and one for prior cropping practices.

In the soil-loss prediction equation, the rainfall factor is given as an index determined from the characteristics of the rainfall. The erosion index (4) for the 5 inches of rainfall applied equals 100. The erodibility factor, i.e. the amount of soil loss per unit of the erosion index from a base plot, can be obtained by dividing each adjusted soil loss by 100. These values are shown in the last column of table 3 and

TABLE 3. Actual and adjusted soil loss and estimated "K" factors obtained from rainulator runs.

Soil Type	Soil Loss			"K" factor
	Actual	Adjusted for Slope	Adjusted for Slope & Crop	
	tons/acre	*tons/acre*	*tons/acre*	
Fox si. l.	17.80	27.81	32.72	.33
Manlove si. l.	16.17	32.34	46.20	.46
Manlove si. l.	12.03	44.56	44.56	.45
Parr l.	12.07	24.14	28.40	.28
Miami s. l.	11.07	19.72	23.20	.23
Morley l.	16.22	19.08	22.45	.22
Celina s. l.	14.73	24.14	28.40	.28
Celina l.	19.21	31.49	37.05	.37
Bedford si. l.	24.49	56.95	67.00	.67
Elkinsville si. l.	21.20	40.77	47.96	.48
Zanesville si. l.	13.77	22.57	30.09	.30
Miami l.	15.98	22.81	26.84	.27
Celina l.	19.69	28.54	40.77	.41
Wea si. l.	9.07	26.58	31.27	.31
Bewleyville si. l.	28.41	19.60	28.00	.28

indicate the relative erodibilities of the various soils tested. These relationships are subject to change as the adjustment factors become more refined.

The success in predicting relative soil loss from other than direct measurements has not yet been established. One of the most promising of the laboratory measurements mentioned in the procedure has been the suspension percentage. This is a measure of the amount of soil existing in particles of <20 microns in size after being subjected to agitation in water. This procedure is a modification of the one given by Middleton et al. (1). The coefficient of determination (R^2) between the soil loss as the dependent variable and slope and suspension percent as the independent variables was .68. This was highly significant. More data are needed to test this and the other laboratory measurements procedure more fully.

Discussion

The results reported here are the first year results of a study in progress. These results, although preliminary, show that Indiana soils do vary with respect to inherent erodibilities. Through the direct approach of evaluating the various soils under similar rainfall patterns, it is hoped that "K" values for use in the soil loss prediction equation can be obtained which will better characterize these soils. The direct results given in table 3 correspond in magnitude with similar results obtained from runoff plots under natural rainfall and reported elsewhere

(3). The data are still too limited to fully explore the possibility of using laboratory measurements to predict soil loss from fallow.

The laboratory measurements conducted in this study should, however, be an aid in determining the erodibility factors of Indiana soils. It is essential that quantitative evaluations of soil erodibility be made, if the methods of predicting erosion losses are to be refined. The direct method employed in this study is too time consuming and costly to be used to evaluate each soil type and variation in soil type. A faster, less expensive method must be found.

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