SOIL QUALITY-AGRONOMY
Technical Note No.7

Effects of Soil Erosion on Soil Productivity and Soil Quality

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Soil erosion has long been considered detrimental soil productivity. It is the basis for soil loss tolerance values. Considerable loss in productivity is likely to occur on most soils if they erode for several centuries at present soil loss tolerance levels (2). Erosion-caused losses of productivity on cropland and pastureland in the United States approach $27 billion with an additional $17 billion for off-site environmental costs (1). Worldwide costs for erosion-caused losses and environmental off-site damages are estimated at $400 billion per year (1).

Soil formation is a very slow process. As a result, most soils cannot renew their eroded surface while erosion continues to degrade the soil. The development of a favorable rooting zone by the weathering of parent rock is much slower than development of the surface horizon. One estimate of this renewal rate is 0.5 ton per acre per year for unconsolidated parent materials and much less for consolidated materials (3). These very slow renewal rates support the philosophy that any soil erosion is too much.

Several studies illustrate the negative impact of soil erosion on cropland productivity. In Indiana three studies compared crop growth on slightly eroded and severely eroded phases of three soils. Corn yields on severely eroded soils were 9% to 34% lower than those on slightly eroded soils. Soybean yields were 14% to 29% lower (Table 1).

Table 1. Corn and soybean yield loss in severely eroded soils compared to slightly eroded soils in three studies in Indiana.

	Three-year study (4)	Six-year study (5)	Ten-year study (6)
Corn	- 16% to - 34%	- 15%	- 9% to - 18%
Soybeans	- 14% to - 29%	- 24%	- 17% to 24%

What are some of the possible reasons that soil erosion degrades soil and results in lower crop yields? Loss of organic matter, resulting from erosion and tillage, is one of the primary causes for reduction in crop yields. As organic matter decreases, soil aggregate stability, the soil's ability to hold moisture, and the cation exchange capacity decline.

In the Indiana study (4), levels of organic matter and phosphorus were lower and clay content was generally higher in the upper six inches (15 cm) of the severely eroded compared to the slightly eroded soil (Table 2). In addition, measurements made in 1982

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showed that the potential plant-available water declined as much as 50 to 75 percent in the severely eroded phase compared to the slightly eroded phase (Table 3).

Table 2. Average values for content of clay, organic matter, and P in the upper six inches of three erosion phases of Corwin, Miami, and Morley soils in Indiana in 1981.

Soil and erosion phase	Clay	Organic Matter	Phosphorus
	----------% ----------		lbs/acre
Corwin			
Slight	20.8[ab]	3.03[a]	61.6[a]
Moderate	19.6[a]	2.51[b]	60.8[a]
Severe	23.0[b]	1.86	40.7[a]
Miami			
Slight	15.4[a]	1.89[a]	95.0[a]
Moderate	18.1[b]	1.64[ab]	86.2[a]
Severe	22.1[c]	1.51[b]	68.2[a]
Morley			
Slight	18.6[a]	1.91[a]	81.2[a]
Moderate	23.0[b]	1.76[ab]	66.3[ab]
Severe	28.4[c]	1.60[b]	50.4[b]

Table 3. Total potential plant-available water in the soil profile for Corwin, Miami, and Morley soils for selected sites in Indiana in 1982 .

	Plant-Available Water (%)		
Erosion Phase	Corwin	Miami	Morley
Slight	12.92	16.10	7.38
Moderate	9.77	11.47	6.21
Severe	6.63	4.76	3.62

These results are not unique to Indiana. Studies from across the Midwest have measured significantly lower yields on eroded soils (Table 4). Changes in available water holding capacity, topsoil depth, percent clay, and percent organic matter were common explanations for the reduced yield.

Precipitation is also a significant factor in determining the effect of erosion on productivity. With adequate moisture, some researchers saw no yield difference between severely and slightly eroded soils (See IL results in Table 4). The impact of erosion on productivity also depends on the soil type and the shape, aspect, and position of the slope.

Table 4. Results of erosion/productivity studies across the Midwest.

			Limitation on Crop Production					
State	Erosion Class	% Yield Change from Baseline Condition	Decreased AWHC	Lower pH	Increased Bulk Density	Increased % Clay	Decreased Organic Matter	Decreased Rooting Volume
IL	SEVERE	0						
IN	MOD	-5	X			X		
	SEVERE	-15	X			X	X	X
IA	MOD	-7					X	X
	SEVERE	-16	X				X	
MI	MOD	-11		X				
MN	MOD	-3	X				X	
MO	SEVERE [1]	-22						
NE	MOD	-7	X		X	X		
	SEVERE	-9	X		X	X		
ND	SEVERE	-20		X	X	X	X	
SD	MOD	-4		X		X		X
	SEVERE	-16	X	X	X			X
WI	MOD	-8	X					
	SEVERE	-6	X					

[1]Constructed soils were used

In summary, soil erosion can have a significant, negative impact on crop yields, especially in years when weather conditions are unfavorable. As soil erosion continues, the soil is further degraded. Poor soil quality is reflected in decreases in organic matter, aggregate stability, phosphorus levels, and potential plant-available water. The net result is a decrease in soil productivity. Although these studies considered only erosion by water, similar soil degradation and productivity losses can occur as a result of wind erosion.

References

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