Impact of soil erosion on soil productivity

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Impact of soil erosion on soil productivity

Abstract
To understand the effect that soil characteristics have on soil productivity (and the impact of erosion on soil productivity), producers need a working knowledge of soil properties. Iowa's soils range in thickness from a few inches to several feet. Each soil has a unique combination of properties; however, some properties are common to all soils. All soils consist of solid materials and pores. Soil solids consist of mineral particles and organic matter. The pores are filled with air, water, or both. The ratio of soil solids to pores in a defined volume is a measure of soil density.

Keywords
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Soils are formed from "parent material." One of three parent materials contributes to nearly all Iowa soils: glacial drift (37 percent), loess (37 percent), and alluvium (21 percent). A soil's parent material influences the soil texture, or the ratio of sand, silt, and clay-sized particles occurring in the soil layers. The percentage of each size fraction in a soil layer can be interpreted by textural classes. Soil properties that directly affect productivity include topsoil thickness, texture distribution, rooting depth, density, soil fertility, and slope.

Topsoil thickness

Preserving topsoil is important because deep surface layers generally translate into higher crop yields. Topsoil material is enriched with organic matter. Organic matter provides soil with large pores, thus reducing soil density and enhancing water infiltration. The vertical cross section of soil is divided into three parts: topsoil (A horizon), subsoil (B horizon), and parent material (C horizon). The soil profile is the name for this combination of vertical layers in the soil. As the slope gradient increases, topsoil thickness usually decreases, especially where cultivation has occurred. Thin topsoils usually mean lower organic matter content and less rooting depth and plant-available water capacity. When topsoil is eroded, yield usually suffers.

Texture distribution

The textural distribution within the soil profile determines how much plant-available water will be present. Soils with coarse textures throughout the profile tend to dry out fast because water drains away easily. Conversely, soils with fine textures tend to puddle or have standing water on or near the surface with frequent rain. Therefore, in areas where rainfall is moderate (26 to 35 inches in Iowa) soils with medium textures are preferred because they have a high percentage of silt and an adequate amount of sand and clay. This textural profile moderates dry and wet tendencies and provides optimum water holding capacity. Soils with loam, silt loam, silty clay loam, and clay loam textures hold 10 to 11 inches of plant-available water in the first 60 inches of the soil profile. Most Iowa soils consist of medium-textured material.
within the soil profile.

**Rooting depth**

As crops approach maturity, roots extend through the topsoil layer into the subsoil to find available water. Subsoil properties, such as coarse sand and gravel, shallow depth to bedrock, high soil densities, and clay content in excess of 42 percent can limit root elongation and development. Therefore, total rooting depth has a direct impact on yield. Most of Iowa’s medium-textured soils have 72 or more inches of rooting depth.

**Soil density**

The ideal soil density for topsoil material is 1.25 grams per cubic centimeter or less. Erosion and reduced organic matter content increase topsoil density. Ideal soil density for subsoil material is 1.40 grams per cubic centimeter or less. Corn and soybean roots have difficulty penetrating densities in excess of 1.65 grams per cubic centimeter.

**Soil fertility**

Soil fertility is vital to a productive soil, but a fertile soil is not necessarily a productive soil. Steep slopes, poor drainage, and other factors can limit productivity.

**Slope and erosion**

Erosion is directly affected by the steepness and length of the slope. Greater slopes increase the runoff velocity and the movement of sediment carried in runoff. Severe or prolonged erosion can cause changes in yield potential and soil productivity, depending on topsoil thickness and subsoil properties. In addition, nearly all organic matter is located in the topsoil, along with approximately 50 percent of plant-available phosphorus (P). A similar relationship exists for potassium (K). Losing topsoil to erosion, therefore, contributes to a loss of nitrogen, P, and K, and a decline in potential crop yield.

The addition of animal manure and fertilizers can supply needed crop nutrients and help offset losses in soil fertility caused by erosion. But the productivity of eroded soils can only be restored by added inputs if favorable subsoil material is present (Figure 1). Productivity lost by excessive soil erosion cannot be restored through additional nutrient inputs for soils with subsoil material that has unfavorable properties for plant root growth (Figure 2). And in soils with fragile subsoils, limited rooting depth, coarse sand and gravel, or high densities, there is little or no ability to recover yield losses with increased inputs—the loss of potential yield can be devastating (Figure 3).

**Summary**

Understanding the impact of erosion on soil productivity means knowing the characteristics of your soils and their profiles. Information about soil profile characteristics is available in each county soil survey report. Moreover, preserving topsoil means preserving inherent fertility, and lowers the need for purchased fertilizer inputs, which means a better bottom line.
Figure 1. Impact of erosion on soils with favorable subsoils.

Figure 2. Impact of erosion on soils with unfavorable subsoils.

Left: Figure 3. Impact of erosion on soils with fragile subsoils.

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