SOIL MANAGEMENT PRACTICES FOR REDUCING RISK

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Farmers are faced with uncertainty and risk every growing season. Changes and differences in weather patterns are typically the main driver for this risk, but other factors such as commodity prices and pest pressure can also be contributing factors. Although every farm activity will have a certain inherent level of risk associated with it, some of this risk can be reduced and its impact lessened with certain management practices. This presentation will provide some recommendations to help lower risk for a crop production operation by looking at soil management, but these recommendations are not comprehensive by any means. It is advised to also pay close attention to agronomic, weed, insect, and other pest management guidelines to further improve risk management of a farming operation using an integrated approach.

The first step for managing soil to reduce production risks is to understand the soils you are working with. However, this can be a difficult task since soil can vary from one field to the next and even within a field. Homogenous soil and field conditions are simpler to manage than heterogeneous conditions. One of the largest factors affecting soil variability is slope. Position on a landscape can determine and affect to some degree the characteristics of a given soil profile. Exploring soil profiles in different positions on a slope typically reveals that there are zones of soil loss and accumulation (Fig. 1). Soil at a higher elevation has greater energy potential and thus is more prone to erosion, while areas with lower elevation are often areas where eroded soil accumulates. As soil erodes from higher elevation areas, subsoil layers are brought closer to the surface and often can be exposed.

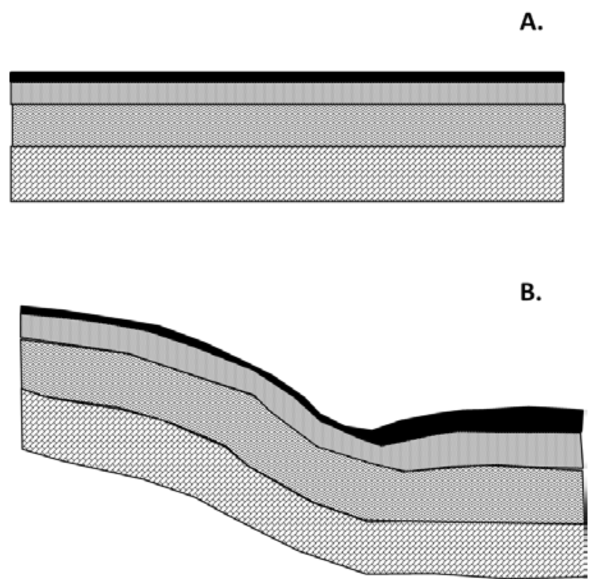

Figure 1. The soil profile of a field with relatively flat slope (A) typically is more uniform than the soil profile of a sloping landscape (B). Note that erosional processes can later the relative soil horizon thickness and depth to underlying soil layers, creating variability within a field.

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Overall, this process creates shallower soil conditions in upslope positions in the landscape and thicker soil layers downslope, but often eroded soil is transported into streams where they can cause siltation and contamination issues. An example of this problem is the hypoxic zone in the Gulf of Mexico due to nitrogen delivery from the Mississippi River Basin and sediment dredging required to keep this stream open to commercial navigation (Fig. 2).

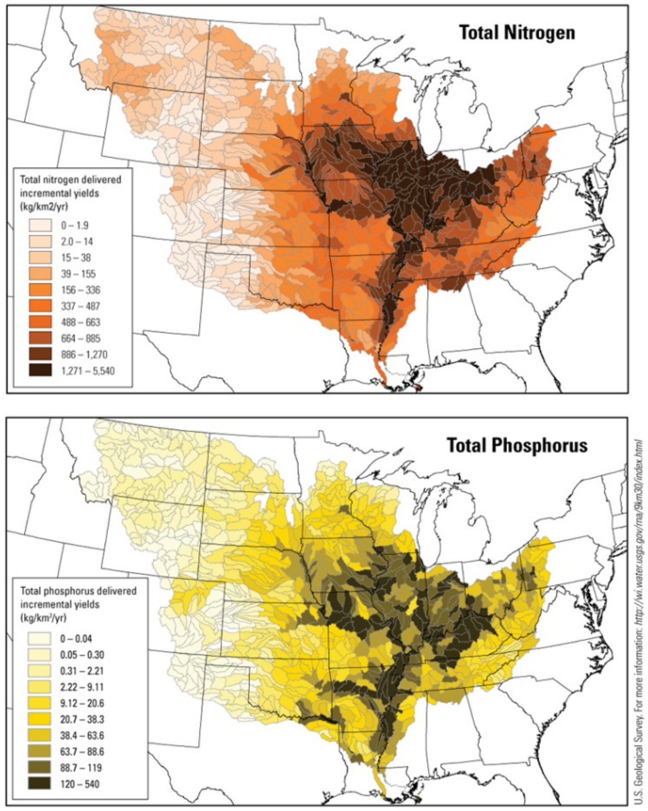

Figure 2. Nitrogen and phosphorus contribution from states within the Mississippi River Basin (Source: USGS; http://wi.water.usgs.gov/rna/9km30/). Nutrients lost from fields need to be replaced with fertilizer addition to maintain fertility levels.

As mentioned above, the erosional process can create areas with shallower soils with exposed subsoil layers and areas where this soil is deposited within a field. This process creates short- and long-term issues that increase the risk of a crop production operation. Changes in soil fertility and soil pH that can affect productivity are common in recently eroded areas. In this scenario, fertilizer and lime might be needed to replace lost nutrients and correct pH issues. Recent estimates for 2013 of the fertilizer replacement value for an average ton of soil lost due to erosion in Wisconsin are $8.80 per acre to replace nitrogen, phosphorus, and potassium.

Long-term problems are more difficult to correct, such as a decrease in the available rooting depth in the soil profile. Research conducted in South Dakota aimed to reduce the spatial variability caused by erosion on a landscape by moving topsoil from areas of accumulation to eroded areas (upper slope) as a remediation technique (Papiernik et al., 2013). Results from this 6-year study showed that replacing topsoil to eroded areas of a field improved overall soil chemical, physical, and microbiological properties with subsequent corn yield increases of between 20 to 60%. However, yields from areas within the field (i.e., toeslope) from which topsoil was removed decreased by 20 to 40%. These results highlight the importance of minimizing the degradation of soil given that remediation efforts can be tradeoff and costly.

The capacity of an eroded soil to store plant available water is diminished due to a reduction in rooting depth, loss of organic matter, and an exposure of subsoil soil layers that commonly have a larger clay content (Fig. 3; Arriaga and Lowery, 2003a). Results from a long-term study conducted in southwestern Wisconsin demonstrated that soil water storage increased as erosion severity increased but corn grain yields generally decreased, highlighting a reduction in plant available water (Fig. 4). An increase of 2.5 to 5% in rainfall amount during the growing season was needed to offset the reduction in plant available water storage capacity of the soil profile with increasing erosion level and maintain optimal corn grain yield. This work also concluded that corn grain production was more sensitive to changes in soil water storage with increasing erosion. Other research conducted at this same site measured a reduction of greater than 50% in organic matter storage within the soil profile to a 2-foot depth with increasing erosion level (Arriaga and Lowery, 2005). Although the use of amendments and manures can help increase the organic matter content in a soil and partially restore productivity, some of the negative impacts of erosion on soil properties are difficult to revert (Arriaga and Lowery, 2003b).

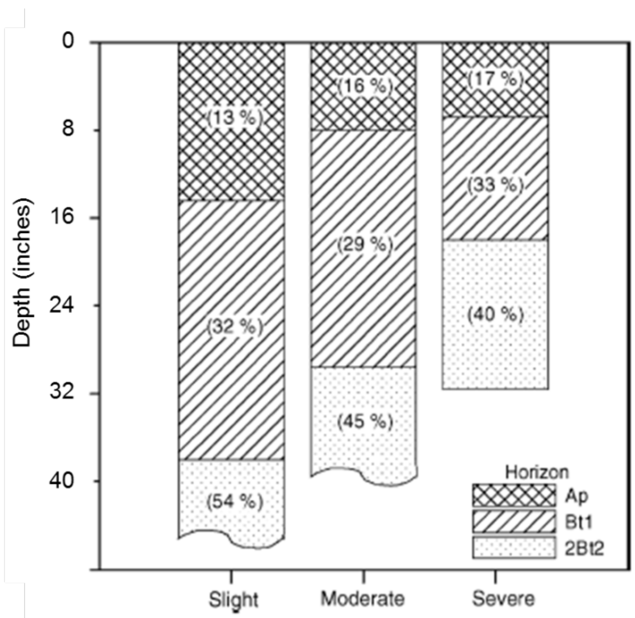

Figure 3. Thickness of different soil horizons for three levels of erosion (slight, moderate and severe). Note that the depth to undelaying subsoil horizons is reduced with increasing erosion level, and thus, clay content (shown in parenthesis) is increased near the surface. (Source: Arriaga and Lowery, 2005).

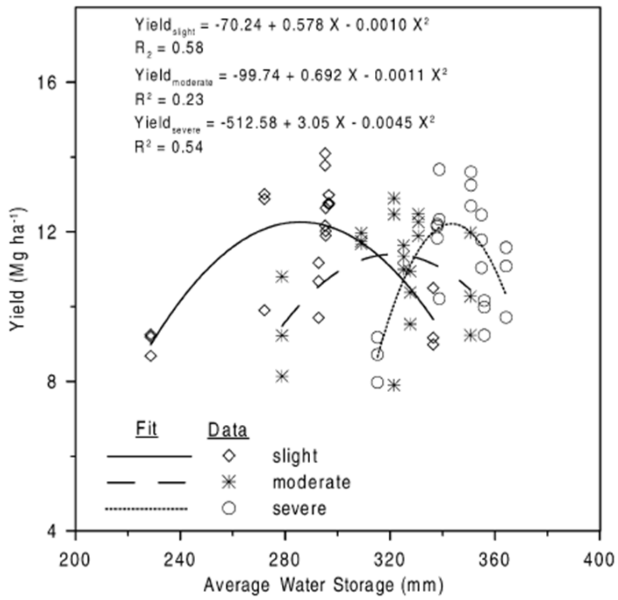

Figure 4. Impact of three soil erosion levels on average water storage in the soil profile and corn grain productivity. Note that the range of water storage is reduced and yield variability is increased with increasing erosion severity. The Pr>F for the slight, moderate and severe erosion level equations is <0.01, <0.01 and 0.10, respectively. (Source: Arriaga and Lowery, 2003a).

Soil erosion control is a top concern for reducing risk within a crop production operation from a soil management standpoint. Good soil management is at the center of an economically and environmentally sustainable operation. Soil management plans should consider soil type, topography, crops, tillage practices, and other crop production factors. The overall goal is to maximize economic crop production levels, maintain or increase land values, and minimize pollution. A management plan can be a useful tool to help achieve these goals.

References

Arriaga, F.J., and B. Lowery. 2003a. Corn production on an eroded soil: effects of total rainfall and soil water storage. Soil & Tillage Research 71:87-93.

Arriaga, F.J., and B. Lowery. 2003b. Soil physical properties and crop productivity of an eroded soil amended with cattle manure. Soil Science 168(12):888-899.

Arriaga, F.J., and B. Lowery. 2005. Spatial distribution of carbon over an eroded landscape in southwest Wisconsin. Soil & Tillage Research 81:155-162.

Papiernik, S.K., T.E. Schumacher, and D.A. Lobb. 2013. Pulling back the soil spatial variability caused by long-term cultivation. Abstracts of the ASA- CSSA-SSSA International Annual Meetings, Nov. 3-6, Tampa, FL.