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A National Menace Reconsidered, Part 3: Conservation Buffers

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The month of March closes out and completes the transition from winter to spring. This year's transition is from the warmest winter on record and the hottest February—the ninth consecutive warmest month—into a spring under the lingering effects of one of the strongest El Nino events on record and the rapidly intensifying consequences from climate change (Sengupta and Erdenesanaa, March 6, 2024; NOAA, March 8, 2024; Henson, March 8, 2024; Copernicus, March 8, 2024; Sommer, March 11, 2024; Becker, March 14, 2024; NOAA, March 21, 2024; NOAA, 2024). What this portends for the crop year ahead rests heavy on the mind preparing for planting season. Spring rains also impact soil erosion and this article continues the series exploring that topic (*farmdoc daily*, March 14, 2024; March 21, 2024). Today's discussion focuses on conservation buffers, or portions of land dedicated to vegetation, such as grassed waterways, filter strips, and similar practices, designed to reduce erosion and other environmental or natural resource concerns.

Background

Fifty years ago, the Senate Committee on Agriculture and Forestry requested a systematic study of natural resources and the conservation or protection of them. On March 25, 1975, the Committee released a report by 12 scientists with the Council for Agricultural Science and Technology (CAST) that, among other things, raised renewed concerns about soil erosion. Farmers were being pushed to increase productivity, which was bringing millions of acres back into intensive farming. For example, the reported noted that 8.9 million acres that had been idled under federal farm policy in 1973 were converted to cropland in 1974 with too little soil erosion controls in place and that only 2 million acres in total remained diverted (U.S. Senate, March 25, 1975; Coppess, 2024). Farmers were in the early stages of a massive increase in cropland acres being used to produce crops, as has been noted previously (see e.g., *farmdoc daily*, June 26, 2020; February 27, 2020). Figure 1 illustrates the total acres planted each year from 1945 to 2023 of the major field crops as reported by NASS (Quickstats). The years 1972 through 1981 are highlighted in Figure 1 as the years in which acres planted to these crops increased by more than 67 million acres (238.5 million in 1972 to 305.8 million acres in 1981).

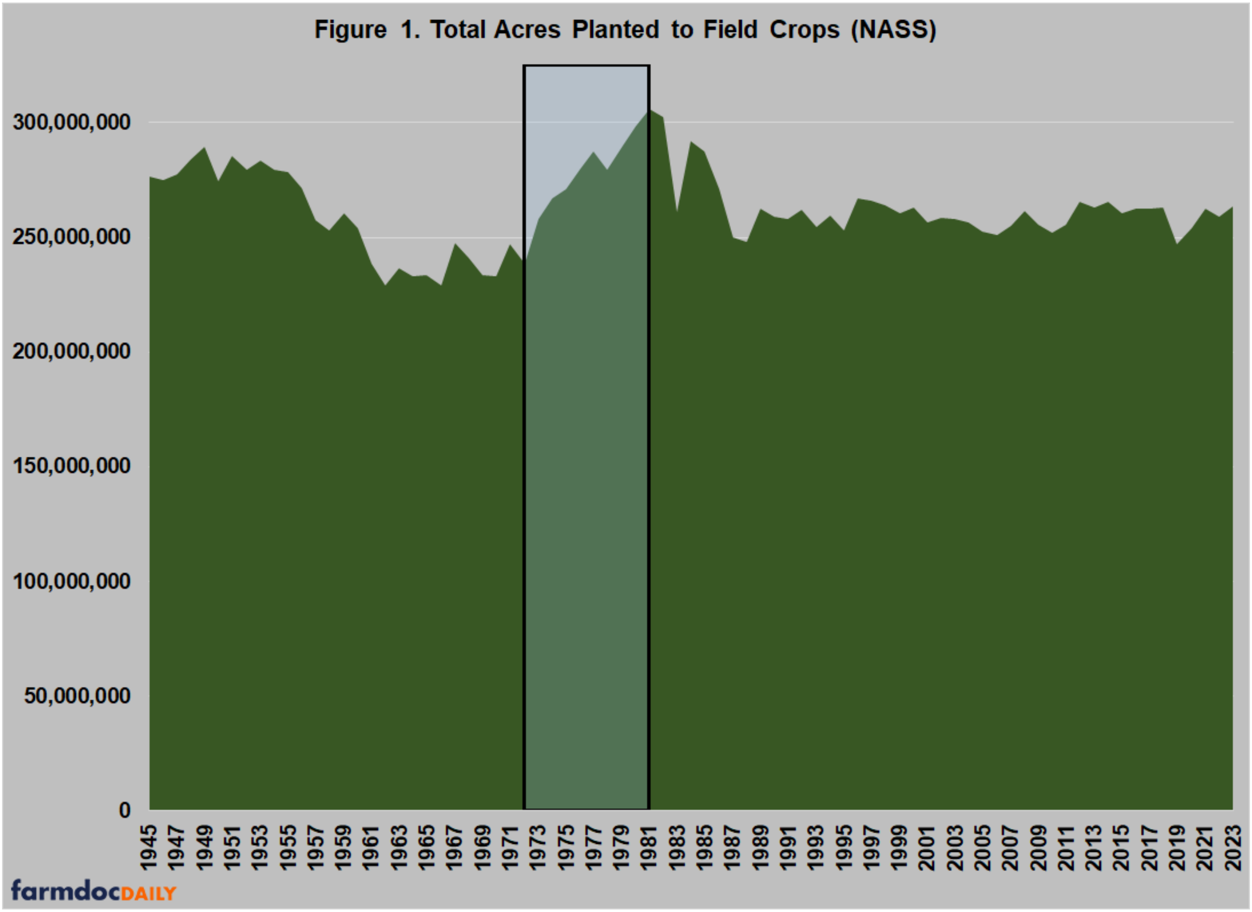


Figure 1. Total Acres Planted to Field Crops (NASS)

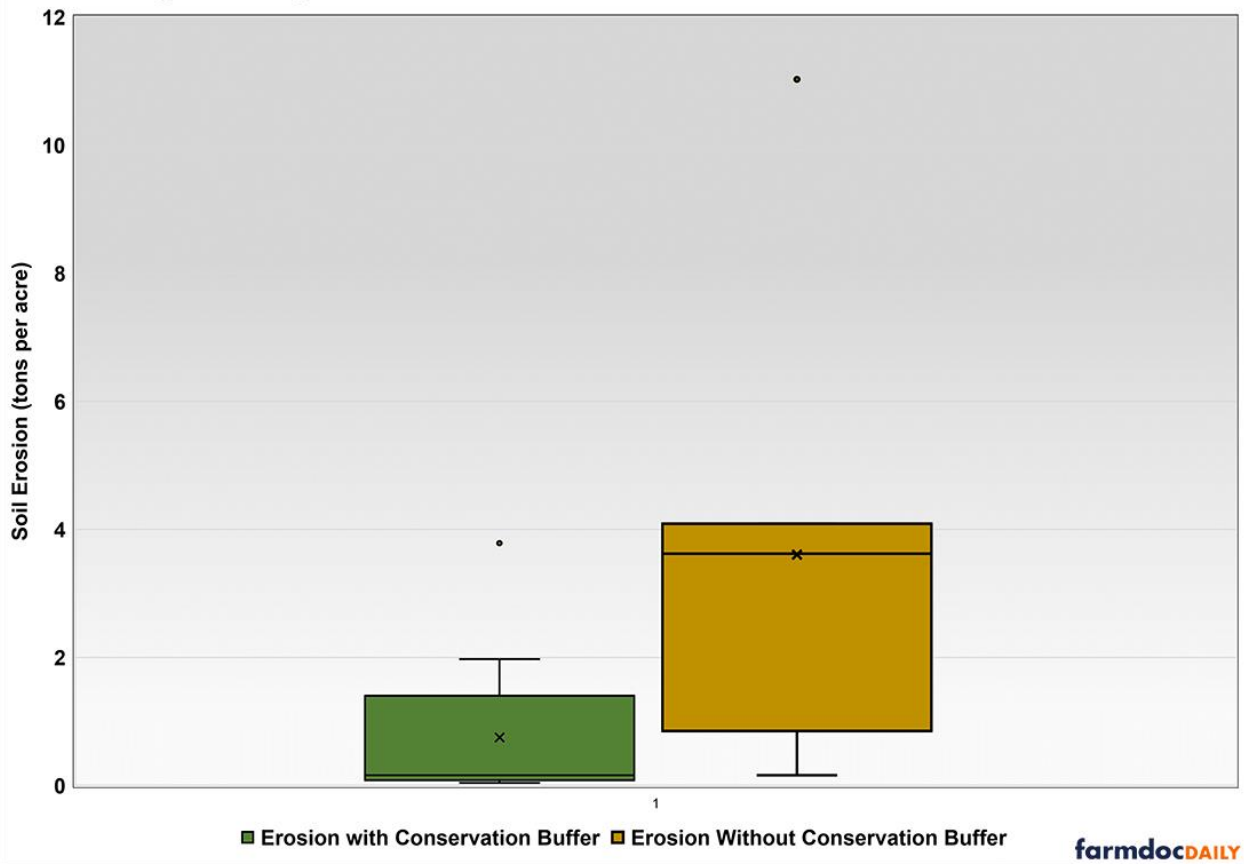
The historic acreage data is critical to the discussion below because of the significant change wrought in the 1970s on American farm fields and farmers. While that change and its consequences extended well beyond buffers and other practices, acreage expansion from the early 1970s to the early 1980s would have had very direct impacts on such practices because many of the acres brought back into farming had been purposely removed from production in the 1950s and 1960s. It had long been common for agricultural landscapes to contain uncultivated areas within fields and between them, although many began to be removed with the introduction of clay drainage tiles in the mid-1800s. Purposeful reintroduction of conservation buffer practices to address soil erosion followed the Dust Bowl catastrophe of the 1930s and were readopted significantly after World War II. The term "conservation buffer" was not widely used, however, until the 1970s and that era also marked a significant uptick in research on the practices for water quality and other natural resource benefits. The return of millions of acres to tillage, fertilizers, and pesticides also catalyzed a second drive for federal conservation policy, leading directly to the landmark 1985 Farm Bill (Lovell and Sullivan, 2006; see also, Rissing, 2019; Brown and Schulte, 2011; Manning, 2004;Vought et al., 1995; Malone, 1985; Ervin and Ervin, 1982).

Discussion

Decades of research has consistently found that conservation buffers reduce soil erosion and nutrient losses. Conservation buffers are strips of vegetation placed in the landscape to influence ecological processes, and specifically work to reduce soil and nutrient loss, as well as improve water quality. The term includes many practices, including grassed waterways and vegetative filter strips (see e.g., Borin et al, 2010; USDA-NRCS, September 2000; USDA-FS, 2008). For this discussion, we reviewed five studies of conservation buffer practices in the United States. Nearly all used rainfall simulations on multiple plots with varying buffer specifications to generate runoff events and evaluate the impacts on sediment loss, as well as nutrient and chemical loss, due to interception by the buffer practice. The studies differed on a few key specifications, such as the length of the buffer strip, type of vegetation in the buffer, and slope of the buffer; simulations also differed in terms of saturated versus unsaturated soil, and the variety of fertilizer applied (Dillaha, et al., 1989; Magette, et al, 1989; Asmussen, 1977; Abu-Zreig, et al., 2004; Blanco-Canqui, et al., 2004).

Specification differences aside, all found conservation buffers to be an effective method in reducing sediment loss, regardless of variability in buffer attributes such as length, slope, vegetation, and soil saturation level. Across studies, buffers diminished sediment loss by 53 to 98 percent. Those farming systems without a buffer in place resulted in an erosion range of 0.85 to 11.03 tons per acre per year. Those systems with conservation buffer practices experienced an erosion range of 0.06 to 3.87 tons per acre per year. Actual tons of soil erosion varied across studies based on soil type, farming practices applied, climate, and rainfall, among other incremental characteristics. It is important to note that although this range does consider fields with differing climate and soil characteristics from across the U.S., the ranges do not represent a binding estimate for soil erosion in any field or region. The calculated ranges demonstrate that conservation buffer practices decrease the risk of soil erosion. Figure 2 illustrates the calculated ranges of soil erosion from the research reviewed.

Figure 2. Range of Soil Erosion from Research on Conservation Buffer Practices



Given the fact that many plant nutrients bind to sediment, decreasing soil erosion will also reduce nutrient losses. This result is particularly the case with phosphorus, due to adsorption, or the binding of phosphorous on clay surfaces or the iron and aluminum and hydroxides present in the soil (see e.g., Prasad and Chakraborty, 2019). The effectiveness of conservation buffers in removing suspended solids from runoff arises through the practice's ability to trap the nutrient in the suspended soil solid. In fact, research has found a reduction of phosphorus losses between 69% and 82% from buffer strips measuring 4.6 to 9.1 meters. Because nitrogen moves in a more soluble form, losses experienced an average reduction in runoff of between 63% and 76%, slightly less than phosphorus loss reductions (Dillaha, et al., 1989; Magette, et al, 1989).

The effectiveness of buffer practices is determined by attributes such as length, slope, and vegetation. It can also be impacted by soil saturation levels and precipitation. For example, total sediment losses have been found to decrease as filter strip length (or more intuitively, width) increases; in other words, longer (or larger/wider) filters are more effective in ‘trapping’’ suspended material (Magette, et al., 1989). Native grasses that are hardy, deep rooting and can withstand wet conditions, have also been found to be more effective for water retention and trapping sediment and nutrients (Abu-Zreig, et al., 2004). Research has also found that trapping efficiency decreases as sediment has more time to accumulate in the buffer strip, such as through a sequence of events that include increased rainfall. The higher levels of soil saturation that resulted translated into 23% less water infiltration and 28% more runoff. Thus, under wet conditions, 94% of sediment was captured by the buffer, as opposed to 98% for dry buffers (Asmussen, 1977). Another study found that a 4.6m filter’s effectiveness dropped from 90 to 5 percent between different simulated rainfall events up to 2 inches of rain in an hour (Dillaha, et al., 1989). As to be expected, conservation buffers have limits under extreme precipitation events and cannot stop channelized rushing water. It is a difficult, important reality for all conservation practices facing increasing stress from extreme weather events that are becoming more prevalent (see e.g., *farmdoc daily*, December 7, 2023; January 4, 2024; January 15, 2024). Under such realities, integrating multiple conservation practices into a single farming system, such as no tillage or cover crops, to complement a buffer, can help mitigate this risk. Conservation buffers can be an important component of Best Management Practices, especially for tile-drained watersheds (see e.g., Lemke et al., 2011).

Returning to the effort to calculate the costs of soil erosion and the value of conservation practices, we previously calculated an initial updated estimate of the cost of soil erosion for the farmer at $85.44 per acre (*farmdoc daily*, March 21, 2024). The ability of conservation buffers to decrease soil erosion between 53% and 98% on average from the studies reviewed translates into a potential value of the practices of between $45.28 and $83.73 per acre. In total, the initial updated cost of soil erosion was $113.92 per acre with 75% borne by the farmer and 25% by society. With that, the reduction in soil erosion from adopting conservation buffers could provide an approximate savings to society between $15.09 to $27.91 per acre and a total savings between farmers and society that could range between $60.38 to $111.64 per acre.

Concluding Thoughts

The discussion herein continues the exploration of existing research on soil erosion and conservation practices that can address the challenge. Conservation buffers—portions of a field with permanent vegetation to influence ecological processes and reduce soil and nutrient losses—are an important conservation practice. Applying previous research arrives at an initial rough estimate of savings for adopting conservation buffer practices that ranges from $60.28 per acre to $111.64 per acre, 75% of the benefit accruing to the farmer ($45.28 to $83.73 per are) and 25% of the benefit accruing to society ($15.09 to $27.91 per acre). As before, much of the benefit depends on the cost of soil erosion, including yield and nutrient losses, which will differ from field-to-field each year, and from year-to-year in the same field. Much depends on field conditions and weather; more and more, the weather is being influenced by climate change producing more extreme events and increasingly extreme events, which could have substantial consequences for the costs of soil erosion and the benefits of conservation. Future articles will continue exploring the costs of soil erosion and the benefits of conservation.

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