Abstract

The benefits of healthy soils in sustaining crop production are most evident when growing conditions are less than ideal. Healthy soils increase the capacity of crops to withstand weather variability and short-term extreme precipitation events and intra-seasonal drought. A systems approach to conservation management of row cropping system is important to enhance soil health and improve environmental quality. The objective of this poster is to highlight the importance of building soil health for sustainable agricultural systems.

Introduction

The benefits of healthy soils in sustaining crop production are evident when growing conditions are less than ideal. Increasingly highly variable weather conditions present increased risks to crops and require a more careful attention to conservation planning to mitigate impacts on soil health and crop productivity. Healthy soils increase the capacity of crops to withstand weather variability including short term extreme precipitation events and intra-seasonal drought (Al-Kaisi et al., 2013). Soil health is defined by the level to which it is able to continually provide a complex and multiple functions as a living ecosystem with the capacity to sustain plants, animals, and humans (Doran et al., 1996). Furthermore, healthy soils maintain or enhance water and air quality through the improvement of soil C storage and water infiltration, and support human health and wildlife habitat. The objective of this poster is to highlight the importance of building soil health for sustainable agricultural systems.

Challenges of Managing Soil Health

With current and future economic, social and climatic issues, conservation planning is increasingly becoming necessary (Figure 1) in order to mitigate the impact on soil health and subsequent effects on crop production, food security, environmental quality and human health.

- There is a need for paradigm shift from the soil management approach that depends on intensive soil tillage towards one of a systems approach whereby soil management is viewed from the standpoint of the soil as a living ecosystem that produces essential ecological services (Figure 2) for healthy communities, food security, environmental (air and water) quality. This shift in soil management paradigm means adopting more soil conservation practices and cropping systems that enhance soil health and environmental quality for sustainable agriculture (Figure 3).

- Soils under modern production agriculture have degraded significantly through massive soil carbon losses from faster rates of crop residue decomposition, nutrient leaching and soil erosion resulting from yearly intensive soil tillage without much attention to its impact on soil health and sustainable agriculture.

- In the Midwest, cropping lands are estimated to have lost approximately 50% of the Soil organic carbon (SOC) from their initial levels from which lands were converted to agricultural lands from their natural state, reaching a new quasi-equilibrium (Fenton et al., 2005; Iowa Association of Naturalists, 2001).

- Robinson et al (1996) estimated that the conversion of row-crop systems to 4-year rotations had the potential to replenish as much as 30% of the total SOM lost since cropping began in Iowa.

Why implement Conservation Agriculture Systems?

Current soil erosion level stands at approximately 5 tons/acre (Al-Kaisi, 2015) and in some areas this figure can be exceeded 10-fold or more. This presents a continued challenge to sustain any effort to implement and target conservation practices.

- Across the U.S and elsewhere, many producers have voluntarily adopted conservation agriculture management practices, that have lead to documented benefits in higher crop yields, more efficient usage of time and equipment, and also reductions in soil erosion (Zhou et al., 2009).

- The adoption of conservation system should be practical, site specific and an integral component of the overall agricultural production system, in order to achieve its intended objectives.

Crop Residues and the Cover Crops Benefits for Soil Health

- Crop residue and cover crops play significant roles in improving soil health and sustainability. Improve soil organic carbon and the moisture holding capacity of soils (Figure 4).

- Climate variability has magnified the challenges presented by weather, especially, where soils are exposed to conditions without physical protection, coupled with the intensity of tillage, which accelerates soil carbon loss, erosion, evapotranspiration, and soil crusting.

- One of the functions of cover crops and crop residue is the physical protection of the soil from potential erosion during heavy rain events by reducing the impact and kinetic energy of rain drops effect on the soil surface to facilitate a gentle infiltration and slow movement of water in the soil profile (Jensen et al., 2012).

An Integrated Approach to Soil Health

Integration of different components of conservation agriculture systems are essential for optimizing soil biological, chemical, and physical functions to build and sustain soil health.

Some areas for consideration include the:

1. Careful planning for implementing the intended conservation agriculture system (CA) and the consideration of site and regional specific constraints (soil type, drainage class, topography of landscape, Climate etc.) to achieve goals of the CA system.

2. Selection of suitable tillage systems such as no-tillage or strip-till, that are suitable for site or region specific conditions, as essential parts of the CA system, to minimize the productivity and environmental constraints to the system. (Licht and Al-Kaisi, 2005).

3. Proper implement attachments such as residue cleaners and combine calibration during harvest to ensure uniform residue distribution for optimum management of the selected tillage system (Kasper et al., 1990; Licht and Al-Kaisi, 2005).

4. Selection of cropping systems (i.e., crop rotations) that sustain soil and improve soil functions (physical, biological, and chemical properties), sustain productivity, and enhance environmental quality. (Al-Kaisi et al., 2015)

5. Sustainability of nutrient management programs through careful seasonal assessment that ensure adequate nutrient supply to the plants for optimum grain yield and biomass production for replenishing soil organic matter and enhancing microbial biodiversity (Mikha et al., 2012; Al-Kaisi et al., 2015).

6. Well planned management operations that will minimize soil compaction by rethinking implement design and timing of operations to help reduce the random travel on field for traffic control to improve soil structure (Hanna and Al-Kaisi, 2009).

References


