Soil Carbon Response to Projected Climate Change in the U.S. Western Corn Belt

Brian Wienhold, USDA-Agricultural Research Service, Lincoln, NE
Virginia Jin, USDA-Agricultural Research Service, Lincoln, NE
Marty Schmer, USDA-Agricultural Research Service, Lincoln, NE
Gary Varvel, Retired, USDA-Agricultural Research Service, Lincoln, NE

Background

Carbon stored as soil organic carbon (SOC) is a large terrestrial pool in the earth's C budget and is strongly influenced by management. Over the next 50 to 100 years the U.S. Corn Belt is projected to experience an increase in annual temperature, a longer growing season, and a slight increase in precipitation that will be more variable. The objectives of this study are to: (1) use SOC data from a long-term (initiated in 1986) tillage and cropping rotation study under current weather conditions to validate CQESTR; then (2) use the validated model to simulate SOC dynamics for four tillage practices, two crop rotations, and two yield trend scenarios using weather data that reflects projected climate change effects for 2065.

Methods & Materials

Management practices and baseline crop yields and SOC (0 to 7.5, 7.5 to 15, and 15 to 30 cm) were collected from a long-term tillage study near Lincoln, NE (Fig. 1). Average yields for continuous corn and corn – soybean rotation and SOC measured in 1999 for chisel, disk, ridge, and no-tillage under current weather conditions were used as initial conditions for CQESTR. The model was validated by comparing SOC estimated after 12 years under current conditions with SOC measured in 2011. The validated model was used to estimate changes in SOC for a 17 year period under the same four tillage practices and two rotations under weather conditions projected for 2065. Two yield trend scenarios were used: one assuming continuation of increasing yields observed from 1971 to 2016, the second assuming negative temperature effects on future yields.

Results

- **CQESTR estimated SOC and measured SOC agreed well after 12 years across all management systems and soil depths (Fig. 2).**
- **After 17 years CQESTR estimated SOC exhibited a 4-way year x tillage x rotation x yield trend interaction in the 0 to 7.5 cm increment; a year main effect in the 7.5 to 15 cm increment; and a year and tillage main effect in the 15 to 30 cm increment (Fig. 3).**
- **Summed over the 0 to 30 cm depth CQESTR estimated SOC exhibited year x rotation x yield trend and year x tillage x yield trend interactions (Fig. 4).**

Fig. 1. Areal photo of three replications of the tillage study near Lincoln, NE.

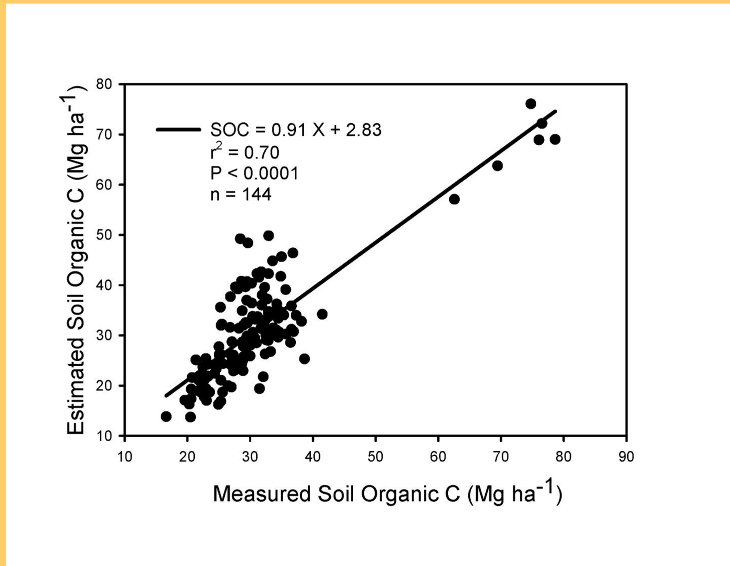

Fig. 2. Relationship between CQESTR estimated soil organic carbon and measured soil organic carbon.

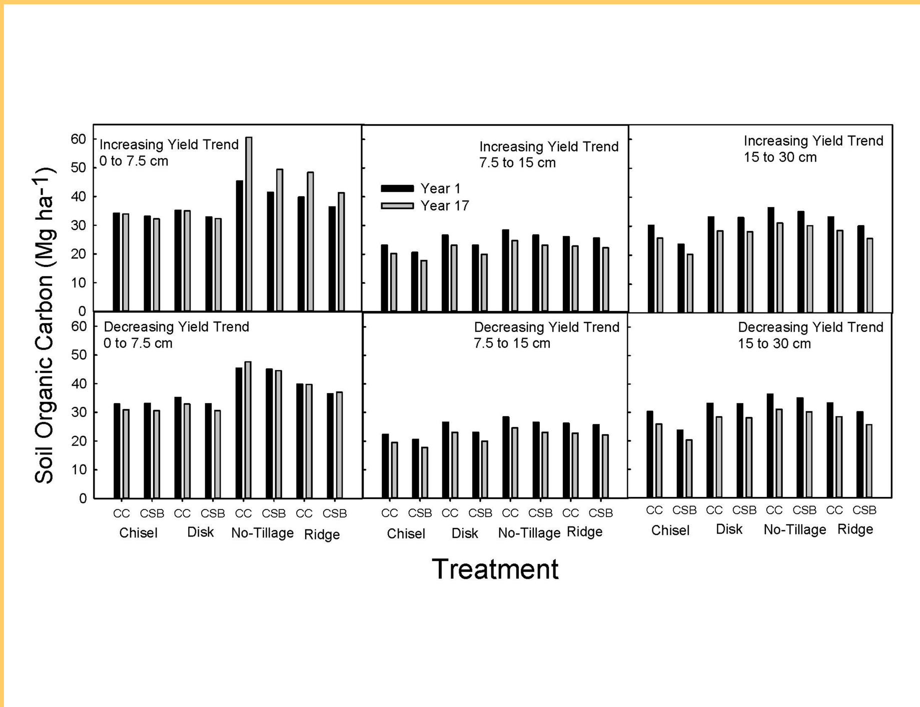

Fig. 3. Change in soil organic carbon over 17 years under climatic conditions projected for 2065 under two yield trend scenarios.

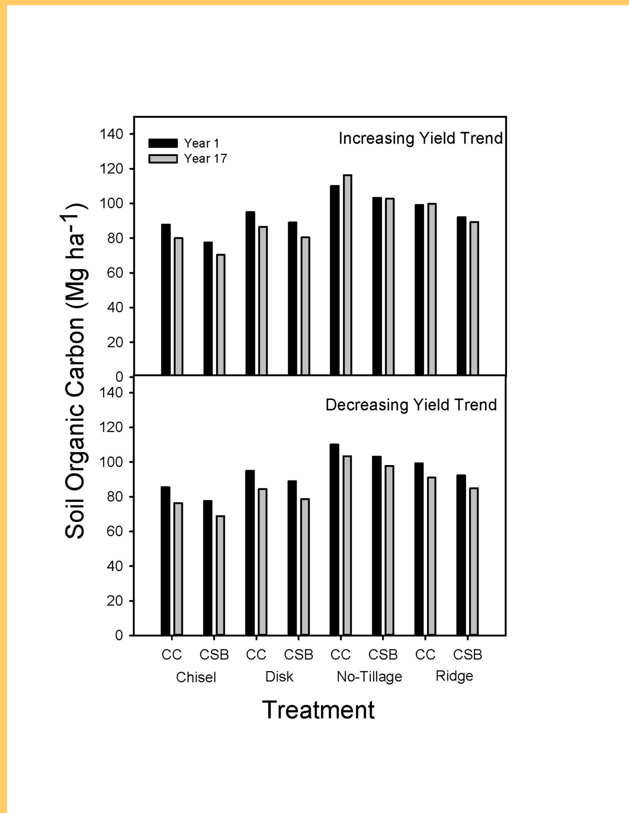

Fig. 4. Cumulative changes in soil organic carbon over 17 years under projected climatic conditions for 2065 under two yield trend scenarios.

Conclusion

Reduced tillage intensity and sustaining yield increases will be essential for sustain or increasing SOC. If increasing temperatures reduce yields additional C inputs such as cover crops or manure will be needed to sustain SOC and prevent declines in soil quality.