



Estimation of soil organic carbon losses and counter approaches from organic materials in black soils of northeastern China

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Abstract

Purpose The northeast plain of China is one of three extensive regions with black soil rich in organic matter in the northern hemisphere. The replacement of natural grassland with cropland has resulted in massive loss of soil organic carbon (SOC), causing serious degradation in this region. Therefore, long-term field experiments combined with modelling approaches were used to examine and project effects of different soil management practices on SOC sequestration.

Materials and methods The RothC model was used to simulate SOC stocks, and the straw retention factor was adjusted in our study. Strategies for improving carbon sequestration were evaluated over 30 years under four carbon input scenarios: straw return at the current rate (with a straw retention factor of 40%), complete straw retention (with a straw retention factor of 100%), manuring at the current rate (0.43 Mg C ha⁻¹ yr⁻¹), and manuring at double the current rate (0.86 Mg C ha⁻¹ yr⁻¹).

Results and discussion Simulations with the RothC model indicated that the SOC stock in the 0–20-cm soil profile at the experimental sites has decreased by 64.1% since the 1980s. Moreover, SOC levels appear to have declined rapidly during the first 10 years after site reclamation, with losses ranging from 3.51 to 5.89 Mg ha⁻¹ yr⁻¹. Straw return at the current rate was predicted to reduce the SOC sequestration rate by 0.07 Mg ha⁻¹ yr⁻¹ in the northern black soils over the 30-year simulation period but cause SOC levels to slowly increase toward equilibrium in the southern black soil region. In simulations with the higher rate of straw retention, SOC stocks rapidly increased (by 0.36–0.53 Mg ha⁻¹ yr⁻¹) across the black soil region over the 30-year period. SOC stocks also increased under the higher rate of manuring, by 0.01–0.19 Mg ha⁻¹ per year.

Conclusions The results suggest that increasing inputs of carbon sources such as straw and manure, together with appropriate tillage, could substantially improve SOC sequestration in the black soil region of northeastern China.

Keywords Black soils · Long-term experiments · RothC model · Scenario analysis of future SOC stocks · SOC degradation · Straw return

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