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Dryland Soil Carbon and Nitrogen after Thirty Years of Tillage and Cropping Sequence

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Introduction

- Increased conservation of soil C and N through improved management practices are needed to enhance C sequestration for C trading, reduce the rate of N fertilization and N losses through leaching, denitrification, and volatilization, and mitigate the emissions of greenhouse gases (CO₂, N₂O, and CH₄) from agroecosystems.

Objectives

- Evaluate the 30-yr influence of tillage and cropping sequence combination on crop biomass (stems + leaves) returned to the soil and soil organic C (SOC), inorganic C (SIC), total N (STN), NH₄-N, and NO₃-N contents at the 0-120 cm depth under dryland cropping systems in the northern Great Plains.
- Quantify C and N sequestration rates, and
- Examine if soil total C (STC) can be used to estimate SOC in dryland cropping systems where STC contents are higher than in irrigated cropping systems.

Results

- Mean annualized crop biomass yield was lower in STW-F than the other treatments (Fig. 1).
- The SOC and STC at 0-7.5 cm was greater in STCW than the other treatments, except NTCW (Fig. 2). The SIC at 90-120 cm was also greater in NTCW and STCW than the other treatments.
- The SOC at 0-7.5 cm decreased linearly with year from 1984 to 2003 (Fig. 3). The rate of decrease was 99 to 130 kg C ha⁻¹ yr⁻¹ lower in STCW and NTCW than STW-F (Table 1).
- The SOC and STC at 0-120 cm were linearly related (Fig. 4).
- The STN at 0-7.5 and 15-30 cm was also greater in STCW and NTCW than the other treatments (Fig. 5A).
- As with SOC, STN also declined with year (Fig. 5B). The rate of decline was 8 to 19 kg N ha⁻¹ yr⁻¹ lower with NTCW and STCW than the other treatments (Table 1).
- Soil NH₄-N content at 0-7.5 cm was greater in STCW and FSTCW than the other treatments (Fig. 6).
- Soil NO₃-N content at 0-7.5, 7.5-15, and 90-120 cm was usually greater in FSTCW than the other treatments (Fig. 6).

Discussion & Conclusions

- Reduced soil disturbance and greater amount of crop residue returned to the soil increased C and N storage and lowered their rate of decline in NTCW and STCW than STW-F at the surface layer.
- Soil total C can be used to predict SOC in dryland cropping systems which can reduce the time and cost of soil analysis.
- Increased tillage intensity increased soil available N (NH₄-N and NO₃-N contents).
- Improved management practices, such as reduced tillage with continuous nonlegume cropping, can sequester C at 99 to 130 kg C ha⁻¹ yr⁻¹ and N at 8 to 19 kg N ha⁻¹ yr⁻¹ in the surface layer compared with the traditional conventional tillage with crop fallow in dryland cropping systems in the northern Great Plains.

Figure 1. Effect of tillage and cropping sequence combination on mean annualized crop biomass yield (stems + leaves) residue returned to the soil from 1984 to 2013.

Figure 2. Soil organic C (SOC) and inorganic C (SIC) contents at the 0-120 cm depth as influenced by 30 yr of tillage and cropping sequence combination.

Figure 3. Regression coefficients for SOC and STC at the 0-120 cm depth as influenced by year as affected by tillage and cropping sequence combination (Figs. 3 and 5A).

Figure 4. Relationship between soil total C (STC) and organic C (SOC) at the 0-120 cm depth.

Figure 5. Soil total N (STN) content at the 0-120 cm depth as influenced by 30 yr of tillage and cropping sequence combination (B) Relationship between STN at the 0-7.5 cm depth and year as influenced by tillage and cropping sequence combination.