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RESEARCH ARTICLE

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Responses of soil organic and inorganic carbon vary at different soil depths after long-term agricultural cultivation in Northwest China

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Abstract

Whether the dryland to cropland conversation in arid regions could lead to a decrease in soil carbon (C) and land degradation remains unclear. In this study, we investigated the vertical patterns of soil C change with different lengths of land use history in the arid regions of China and explored the controls and mechanisms of these changes. One native desert grassland and six croplands with similar management but different cultivation times (i.e., 1, 3, 5, 15, 30, and 50 years) and were selected in Xinjiang, Northwest China. We measured both soil organic and inorganic C concentrations and soil properties (e.g., total nitrogen [N], NO_3^--N, NH_4^+-N, pH, and electrical conductivity) with a 20-cm depth interval down to 2 m in all croplands. The results showed that soil organic carbon (SOC) stocks increased with cultivation year for the topsoils (0–120 cm), which could be a result of higher plant C inputs and decreased soil pH in cropland than in the native desert. Soil pH explained the largest variation (45%) of SOC concentration. Soil inorganic C (SIC) stocks decreased with cultivation year in topsoils layers (0–40 cm) but increased in deep soil layers (120–200 cm), resulting in the net increment of SIC to the depth of 200 cm. This pattern might be caused by changes in soil pH in the cropland. Overall, this study demonstrated that, instead of reducing soil C, proper management of the desert ecosystem can enhance soil C sequestration in the arid regions.

KEYWORDS

arid, chronosequence, grassland conversion, land use change, pH, saline soil

1 | INTRODUCTION

Drylands are characterized by low vegetation coverage, low precipitation, and high evaporation and salinity. They occupy ca. 41% of the global land area and supports about 2.5 billion people worldwide (Lal, 2009; Middleton & Thomas, 1997). Drylands are experiencing severe global changes and are threatened by anthropogenic activities such as land use change (LUC). Among the disturbances, the conversion of native vegetation to cropland and cropland management (e.g., irrigation and fertilization) reduces soil carbon (C) stocks, soil moisture, and nutrient availability (Jiao, Zhu, Zhao, & Yang, 2012; Plaza-Bonilla et al., 2015; Yu et al., 2014). Eventually, it makes the dryland soils fail to sustain plant growth and ultimately leading to land degradation in the arid and semiarid regions. Thus, how soil C changes with LUC deserves intensive investigations.

Soil C includes soil organic C (SOC) and soil inorganic C (SIC). SOC has drawn considerable attention, because it is linked to multiple soil functions (e.g., soil fertility and water retention), turns over fast, and responds quickly to LUC. In contrast, SIC is relatively inert with a mean residence time of 1,000–10,000 years (Sanderman, 2012), but it is also

