Research progress on soil carbon storage in farmland

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Abstract: Soil organic matter plays a significant role in fertilizing soil, nourishing crops, regulating soil properties, and improving tillage properties. Therefore, research on the cycling, transformation, and balance mechanisms of carbon in soil has become a hot topic both domestically and internationally. Practice has shown that in order to fully utilize these effects, it is necessary to coordinate the accumulation and decomposition of soil organic matter, in order to not only increase the content of soil organic matter, ensure basic soil fertility, but also provide necessary nutrients to crops at an appropriate decomposition rate. Meanwhile, the impact of carbon cycling in soil on the atmospheric environment has received attention. How to increase soil carbon storage becomes the fundamental guarantee for unleashing the enormous role of soil organic matter and protecting the environment.

Keywords: farmland; Soil; Carbon storage

Introduction

In global terrestrial ecosystems, organic carbon storage reaches 1500Pg (Batjes, 1996; Lal , 1999；Amundson , 2001）, The carbon content of soil is much higher than that of living organisms, and the dynamic study of soil carbon plays an important role in carbon balance and global carbon cycling in terrestrial ecosystems. Meanwhile, it is crucial to maintain the stability of the soil carbon pool while reducing CO2 emissions into the atmosphere (Kirschbaum, 2000; Amundson ,2001； Rustad et al ·,2001）。 The transition of land use from natural vegetation to farmland leads to soil organic carbon loss (Jenny, 1941; Mann, 1986). The significant loss of soil organic carbon can be attributed to reduced organic matter input, accelerated decomposition of crop residues, and weakened physical protection of soil organic matter by tillage methods. The situation of agricultural soil carbon emissions has been extensively discussed in the study of global climate change. Promoting soil carbon sequestration through good soil management is considered a good strategy to slow down the increase in atmospheric CO2 concentration. There have been some reports on the changes in CO2 storage in agricultural soils (Eve et al ·, 2002a）, Especially the impact of cultivation, ranch management, secretions, irrigation, and fertilization on soil organic carbon storage.

1.Soil Carbon Status in China

China is a country with a long history of agricultural development and multiple soil types. The estimated total storage of soil organic carbon pool ranges from 50 Pg to 200 Pg (Pan Genxing, 2003). With the increase of industrial carbon emissions, global soil carbon loss has received widespread attention due to intensive agricultural land use (LaI, 2002b;). Field research results from various regions indicate that a significant amount of carbon has been fixed in the soil over the past 10 years. However, the level of soil organic carbon balance is determined by the biological, chemical, and physical properties of the soil that control microbial activity. Under stable conditions, the annual accumulation and decomposition of soil organic carbon are equal, while the organic carbon content remains unchanged and in a dynamic equilibrium state. In addition, different farming systems, crop residue management and rotation systems, as well as agricultural measures such as fertilization, have a significant impact on the level of organic carbon balance.

The organic carbon content of farmland soil is largely influenced by human activities. The increase in organic carbon content improves soil fertility and productivity, while also increasing the fixation of atmospheric CO2. Therefore, studying the carbon sequestration potential of agricultural soil organic carbon and the ways and means to achieve its carbon sequestration potential are of great significance for the sustainability of soil productivity and global carbon cycling, and the operability of realizing soil carbon sequestration potential is strong.

Under traditional farming methods, soil organic carbon content sharply decreases, but humans can also take effective measures to restore increasingly degraded soil or adopt agricultural compensation measures to offset carbon emissions in the industrial sector. Moreover, increasing soil carbon storage on arable land is a win-win policy that can increase agricultural productivity and mitigate greenhouse effects, which is of great significance for countries to fulfill their commitments under the Kyoto Protocol and reduce greenhouse gas emissions globally.

At present, it is widely believed internationally that China has suffered sustained and serious soil carbon losses due to forest destruction and soil erosion. Therefore, whether there has always been carbon loss in agricultural soils in China, or whether all agricultural practices in China are carbon loss behaviors, is an important scientific issue related to the sustainable development of agriculture in China. Although Chinese scholars have made many effective research works in the above areas, there are still shortcomings in the current research on organic carbon composition, dynamic changes, organic carbon balance, and carbon sequestration potential of farmland soil.