# Soil organic carbon sequestration on a long-term rice cropping system

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## Abstract

Long-term single rice cropping system has long managed in Korea. Soil management practices, that may alter the SOC (soil organic carbon) content, expected to cause changes in soil quality. Managing SOC is becoming a crucial issue not only for improving soil quality and productivity but also for mitigating global warming through carbon sequestration. The objective of this research was to evaluate soil organic carbon dynamics on a long-term single rice cropping system in Korea. Research was conducted in the research farm at NIAST-RDA, Suwon. We found that SOC contents increased continually at the long-term compost plots and enhanced in carbon storage rate. In conclusion, continuous returning of plant residues (i.e., compost) recommend to sequester soil carbon for long-term single rice paddy soils effectively. This results imply that continuous application of compost in a single rice cropping paddy field may contribute not only for increasing SOC content in the soils but also for mitigating global warming through reducing carbon dioxide emission into atmosphere.

## Media summary

Long-term rice cropping with appropriate soil management, such as continuous compost application and return of plant residue into the soil, could contribute to mitigate greenhouse gases emission from the soils.

## Key Words

Soil organic carbon, global warming, sequestration, rice cropping system, long-term experiment.

## Introduction

Changes in agricultural management either increase or decrease SOC in soils. SOC storing into the soils through agricultural management can result in the sequestration of atmospheric $CO_2$, thereby mitigating the current increase in atmospheric $CO_2$ at least partially (Sampson and Scholes, 2000). Korean paddy field has long managed with implementation of intensive soil management practices including plowing prior to transplanting for improving rice production. Since chemical fertilizer became the most crucial factor and mechanization replaced the animal power, intensive soil management has leaded rice production in Korea. Soil organic carbon content in rice paddy soil has rapidly decreased mainly because of intensive plowing and inappropriate fertilization. Jung (2007) summarized that national average of soil organic carbon content has decreased continually since 1940's. It is also true that rice productivity has increased for the same period. Jung (2007) also pointed that rice productivity hit the peak in 1990's and has slightly decreased thereafter. Korean paddy areas showed exactly same trend with rice production. In 1990's, the concept of environment-friendly agriculture has introduced for Korean farmers who were interested in producing high quality agricultural products without negative impacts on environment such as water, air and soil. Because of quality-oriented farming, people realized the importance of appropriate soil management to protect the foundation of production.

On the other hand, global warming became an issue for all nations. IPCC (2007) reported that concentration of green house gases (GHG) has seriously increased in atmosphere. Mainly increasing of fossil fuel might be the major factor to increase GHG in atmosphere. Since IPCC announced that agricultural practices may contribute to mitigate global warming through carbon sequestration, which is the processes of storing carbon from atmosphere into the soil. Numerous researches have been

doing to find out the best agricultural practices to improve storage rate carbon into the soil. Previous researches documented that agricultural management practices, such as residue application and reduced tillage intensity, are being promoted to increase biomass incorporation into SOC pools, enhance soil quality, and sequester atmospheric $CO_2$ (Lal, 1997; Paustian et al., 2000; Uri, 2001). While it has been well established the tillage and residue management practices influence on SOC in cropland, continuous long-term rice cropping experiment is rare. Therefore, such experiments are essential for evaluating potential of SOC pool for continuous rice cropping system in Korea. The objective of this research was to evaluate the effects of long-term single rice cropping practices on SOC dynamics in the paddy field.

## Methods and Materials

### Site description

A long-term rice cropping experiment plots were established in 1954 and are located at the research farm in National Institute of Agricultural Science and Technology, Suwon, Korea (37°16′27″ N, E126°59′36″ E). Field consists of approximately 0.17 ha and is located near research farms, adjacent to a plain paddy field near to reservoir. The soil in the research field is described as a Gangseo soil by the National Institute of Agricultural Science and Technology (NIAST, 2000). The Gangseo soil is a moderately well-drained and moderately rapid permeability (coarse-loamy, mixed, nonacid, mesic family of Fluvaquentic Eutrudepts). These soils have grayish brown fine sandy loamy Ap horizon and mottled brown to dark brown, yellowish brown or grayish brown fine sandy loam cambic B horizon. C horizons are brown to dark brown with grayish brown mottles and have stratified loamy fine sand to loam textures. They developed in coarse loamy alluvial materials on broad continental alluvial plains.

The plots designed as a completely randomized. Each plot is approximately 6.3m by 8.3 m. Soil samples were collected in early April prior to plowing for each year. Samples took from the 0- to 15-cm depth in each plot. SOC determined by wet combustion method.

## Results and Discussion

### Soil organic carbon dynamics on a long-term rice cropping field

Long-term compost plot had significantly affected on SOC contents in a single rice cropping field since 1969. SOC content in none compost treatment plots hit the peak (12.8 g $kg^{-1}$) for 1980's and tended to decreased thereafter while SOC content of continuous compost treatment plots had rapidly increased until 1980's and had slightly increased thereafter. This result showed that continuous composting may contribute accumulation of soil carbon into the soils. Storing carbon into the soils through appropriate soil management may contribute mitigate carbon dioxide concentration into atmosphere. In this research, we found that long-term continuous composting resulted in greater SOC storage in a single rice cropping field. This result imply that continuous composting in a paddy field may contribute not only for increasing SOC in the soils but also for mitigating global warming through reducing carbon dioxide emission into atmosphere.

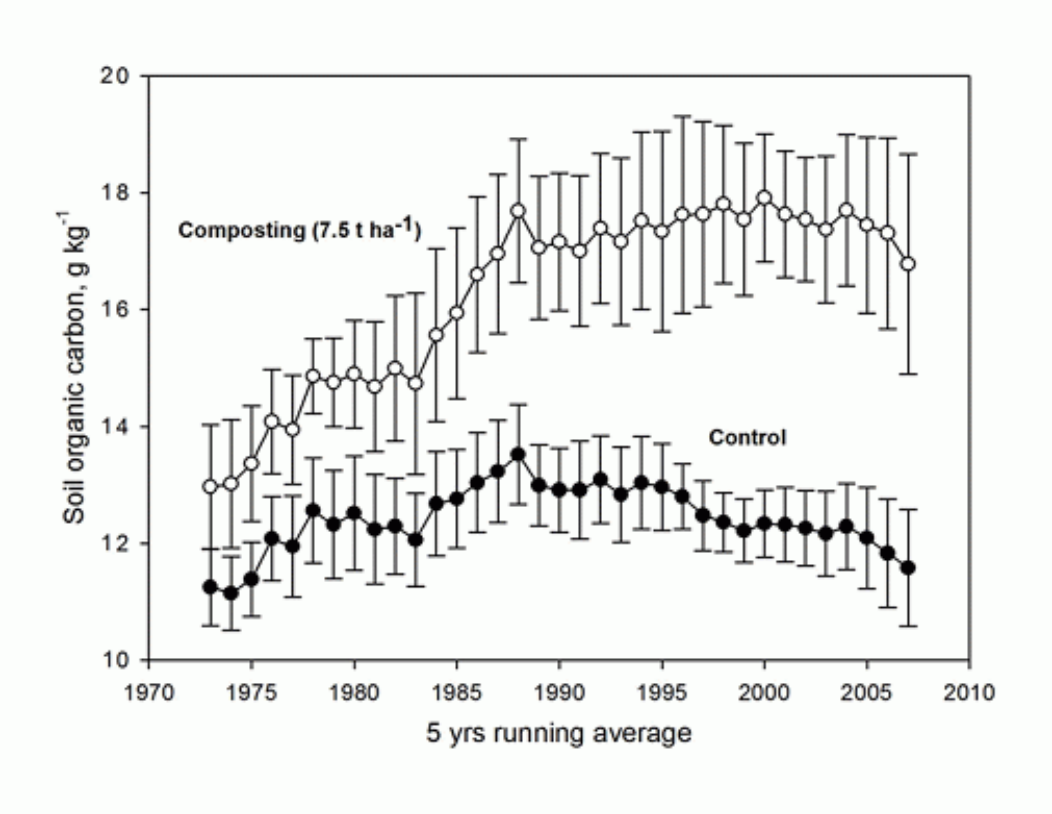


Fig. 1. Long-term compost effects on SOC dynamics in a long-term single rice-cropping system

**Conclusion**

Continuous application of compost contributed to increase of SOC content in a long-term single rice cropping system in Korea. We conclude that this result showed an excellent example of sequestering SOC into the soils by application of appropriate soil management practice, such as continuous compost application in the single rice paddy field. It may imply that appropriate soil management practice has great potential to mitigate global warming through enhancing the function of sink source of atmospheric carbon.

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