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Editorial

Soil Carbon and Microbial Processes in Agriculture Ecosystem

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As global warming progresses, concerns also arise regarding the decline in agricultural productivity and soil degradation. On the other hand, the demand for food is increasing as the population grows, and the maintenance and enhancement of soil productivity to support this demand are becoming important global issues.

Soil carbon (C), in particular, plays a crucial role not only in maintaining soil fertility but also as a global C sink. Soil C is a complex product resulting from various biological, physical, and chemical processes, and it is a fragile entity that is vulnerable to inappropriate human activity and global climate change. Soil microbes with efficient C use help reduce C losses and increase C storage. In this context, it is essential to understand the dynamic nature of soil C and microbial processes in agricultural ecosystems.

To facilitate a deeper understanding of the dynamics of soil C and the microbial processes that affect it, this Special Issue focuses on various aspects of C cycling and its related microbial processes in agricultural ecosystems—from the molecular level to regional or global scales. Topics of interest in this Special Issue include the spatiotemporal dynamics of soil C, C balance, characteristics of soil organic C, C dynamics in plant–soil systems, and various approaches to managing soil C maintenance and C sequestration.

Andosol, derived from volcanic ash, is one of the soils with the highest C content in the world. Elucidating the factors that contribute to this C accumulation in soils will provide the basis for the development of soil C sequestration technologies. Howlett et al. [1] investigated the characteristics of soil C accumulation in Japanese Miscanthus grasslands in terms of microtopography and estimated the accumulation rate of C based on $\delta^{13}C$ and ^{14}C dating. They found that the C accumulation in C4 grassland was lower than previously thought. On the other hand, Komal et al. [2] investigated the soil C accumulation potential of agroforestry in the eastern region of Pakistan, which is exposed to the major impacts of climate change due to global warming. They found that C storage potential differed among tree species and observed that woody vegetation C stock was comparable to soil C stock. These results highlight the significance of tree-planting agendas on cultivated lands in terms of climate-smart agriculture in Pakistan.

Agricultural activities, especially fertilization, have a significant impact on the balance of elements in the soil, which in turn affects soil C cycling and accumulation. Liu et al. [3] used a geographic information system to determine spatiotemporal changes in C, N, and P in agricultural land around Taihu Lake in China. Due to years of fertilization, N and P accumulated in areas with high agricultural activity. The results suggested that the imbalanced C:N:P stoichiometry, characteristics of agricultural soil, may lead to decoupled C, N, and P biogeochemical cycles, thereby having an adverse impact on soil C sequestration. Matsuoka-Uno et al. [4] showed that the mineralization of organic matter in humus-rich Andosol is greatly enhanced by liming and phosphorus fertilization, shedding light on the importance of fertilizer management for C accumulation in agricultural land, similar to the study by Liu et al. [3].

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Various soil amendments have been developed and used to promote soil C accumulation and proper C cycling. Biofertilizers containing *Trichoderma*, known as plant growth-promoting fungi (PGPF), are widely used to maintain crop growth and health. Zhu et al. [5] studied the effect of *Trichoderma*-containing biofertilizer on the mineralization characteristics of soil aggregates. They found that this material not only improves the soil microenvironment but also maintains soil organic matter by retarding mineralization in fine fractions of soil aggregates. Novotny et al. [6] investigated the effect of biochar addition in vermicompost preparation and found that the simultaneous addition of biochar and superphosphate enhanced the humification of compost and resulted in compost of good quality. In the C cycle in agroecosystems, we cannot forget about methane, which is produced by the anaerobic decomposition of C. Wang et al. [7] examined changes in methane emissions from agricultural land in China from 2000 to 2019 based on land-use maps and other data. They found that emissions have not changed significantly since 2006, and the primary source of methane emissions is paddy fields.

Soil management in agricultural lands has a significant impact not only on sustainable crop production but also on C accumulation in the soil by influencing the soil C cycle. The relationship between soil management, soil microorganisms, and soil organic matter has been studied from various angles. Wei et al. [8] focused on the effects of cover crops in mango orchards and how they affect the soil microflora.

Liu et al. [9] focused on an autotrophic microbe that is usually overlooked in research. Their studies indicate that the bacterial community structure, composition, and CO_2-fixing capability are highly regulated by soil management practices and that minimal disturbance to the soil's microenvironment, coupled with the retention of crop residues in the soil, will improve bacteria-involved biological activities and increase nutrient cycling and soil productivity.

Li et al. [10] compared Integrated Soil-crop System Management (ISSM) based on crop models and nutrient management with conventional farming methods. They found that ISSM not only increased yields but also made soil organic C more persistent and complex within microbial networks.

Conflicts of Interest: The authors declare no conflict of interest.

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