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EDITORIAL

Highlights of the special issue on "Healthy Soil for Healthy Food"

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Soil is essential to human life and society, as soil is crucial to agricultural production, climate mitigation, water purification and many other functions. Soil is also connected with human health and nutritional security. It is projected that by 2050 global population will be 50% greater than at present and the global demand for food will have doubled. With the current challenges of combating soil degradation and decreasing land area for food production, securing global food production and producing healthy food is of paramount importance. Strategic soil management in agricultural systems is necessary to promote soil health to achieve a proper balance between food production and environment. Soil health goes far beyond soil science itself, and it requires multidisciplinary and cutting-edge knowledge in biology, physics, chemistry and many other areas. This special issue focuses on the advances in our understanding of soil health, particularly from the perspective of soil microbiome. A holistic view on soil health assessment and proper management sustainable soil management is also included. The issue consists of 7 reviews and 4 research articles covering a wide range of topics on the novel indicators, approaches for soil health assessment, mitigation of soil pollutants, soil microbiome and plant health, strategies to improve soil health for sustainable soil management.

It has recently been acknowledged that soil health needs to be evaluated using a holistic framework, e.g., simultaneously evaluating physical, chemical and biological properties. However, soil quality assessments are focused on mainly chemical and physical soil properties. Although soil biota are important for delivering multiple ecosystem functions, biological indicators are underrepresented, despite being the most relevant to soil health. Bongiorno (https://doi.org/10.15302/J-FASE-2020323) summarized and discussed the potential of different soil properties, i.e., labile organic carbon, soil disease suppressiveness, free-living nematode community characteristics and microbial catabolic profiles, as novel soil quality indicators in agricultural systems. She found that POXC was the indicator that discriminated best between soil management practices, followed by nematode indices based on functional characteristics. Lu et al. (https://doi.org/10.15302/J-FASE-2020327) summarized the application of soil nematodes communities as useful biological indicators of soil health, with community characteristics such as abundance, diversity, community structure and metabolic footprint being closely correlated with the soil environment. Both free-living and plant-parasitic nematodes are effective ecological indicators, contributing to nutrient cycling and having important roles as primary, secondary and tertiary consumers in food webs.

In terms of the assessment of soil health, Kuzyakov et al. (https://doi.org/10.15302/J-FASE-2020338) suggested to use an SQI-area approach on a radar diagram combining physical, chemical and biological properties. The advantage of the area-based approach is that it is independent of the SQI principle and allows rapid and simple comparison of parameter groups and soils. They also proposed to determine the resistance and sensitivity of soil properties through comparison with the decrease of soil organic carbon. They found that the most physical soil parameters are usually more resistant, and most biological parameters are more sensitive to degradation of organic carbon. Similarly, Wang et al. (https://doi.org/10.15302/J-FASE-2020337) discuss the difficulties in establishing a consensus on the key indicators to define and quantify soil quality (or soil health). They propose that a system

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modeling approach captures the interactions of climate, soil, crops and management, and their impact on system performance would help to quantify the value and quality of soil. They used three examples to demonstrate this. Soil management is an integral part of systems management that includes managing the crops and cropping systems under specific climatic conditions, within a context of future climate change.

The plant and soil microbiota are essential role for plant health and exert influence on resilience toward biotic as well as abiotic factors. Beneficial soil microbes, such as arbuscular mycorrhizal fungi (AMF) and rhizobia, are important for plant health and growth. Xue and Wang (https://doi.org/10.15302/J-FASE-2020347) discussed the recent progresses on the regulators of AMF symbiosis from plants, AMF and surrounding environments. Understanding the interaction between host plants and AMF is important for manipulating the AMF symbiosis. The impact of AMF on the root fungal community and other soil microbial community needs to be examined to fully understand the beneficial impacts and the operation of the AMF in field soil. Harnessing disease-suppressive microbiomes constitutes a promising strategy for optimizing plant growth. The research of Fu et al. (https://doi.org/10.15302/J-FASE-2020328) investigated the impact of the assembly of banana bulk soil and rhizosphere microbiomes in a monoculture system consisting of bio-organic and organic management practices in relation to the suppression of Fusarium wilt of banana. They found that changes in bulk soil bacterial community determined its induced rhizosphere bacterial community. Both biocontrol agents and responsive bacterial genera act as direct disease suppression indicators. Their results indicate that the beneficial effects of taxa-specific suppression should be considered in the design of bio-organic fertilizers for suppression of plant diseases. With the similar idea for manipulation of soil microbiome, Wei et al. (https://doi.org/10.15302/J-FASE-2020346) propose a new concept of rhizosphere immunity. Plant immunity has been mostly seen as a plant-centered process. In their review, they propose that there is imperative to shift our vision away from the compartmentalization of plant health-related research, to fully embracing the role of plant-associated microorganisms and environmental conditions as integral components of plant immunity, for example, approaching immunity from a meta-organism perspective. This provides a new perspective of rhizosphere and plants as a whole for multidisciplinary management strategies, bundling the latest discoveries in phytopathology, microbiome research, soil science and agronomy, into novel management strategies for sustainable agriculture.

In terms of mitigation of key pollutants in the agricultural ecosystems, He et al. (https://doi.org/10.15302/J-FASE-2020333) provides an overview of the transmission of antibiotic resistance genes in agroecosystems resulting from the application of animal manures and other organic amendments. They suggest that future studies are needed to achieve control and mitigate the spread of antibiotic resistance in agricultural ecosystems. In particular, a holistic perspective and multisector efforts should be undertaken to translate fundamental knowledge into effective strategies. Zhao (https://doi.org/10.15302/J-FASE-2020335) provides an overview of strategies to manage the risk of potentially toxic metal(loid) contamination in agricultural soils. The risk of Cd and As accumulation in food crops can be mitigated through agronomic practices (e.g., liming and paddy water management) and crop breeding. The author also proposes that long-term monitoring of anthropogenic additions and accumulation of metal(loid)s in agricultural soils should be undertaken. Mass-balance models should be constructed to evaluate future trends of metal(loid)s in agricultural soils at a regional scale.

Informed soil management is important for improving soil health. Schneider et al. (https://doi.org/10.15302/J-FASE-2020348) provides an excellent example showing that woodchip incorporation is successful at capturing moisture from small rainfall events and maintaining higher soil moisture until the next event, both Ningxia, China and North Dakota, USA. With addition of fertilizer, woodchip incorporation further improved growth of wheat and alfalfa. The authors suggest this strategy may be a key part of responding to a changing climate. The review of Liang et al. (https://doi.org/10.15302/J-FASE-2020339) summarizes the research advances from an Australia-China Joint Research Centre Program, “Healthy Soils for Sustainable Food Production and Environmental Quality”. The project had five deliverables underpinned by a core objective of delivering new research and innovative products that address the current and future challenges of food security and sustainable soil management. The project adopted a multidisciplinary approach to address the challenges in soil degradation and pollution assessments. Based on the experience of the project, there is the call for a partnership combining excellence in research, industry and policymakers as this will ensure not only the right direction of the scientific research is taken but also high-quality outputs are transferred to industry and end-users.

As the guest editors, we thank many soil scientists for their passion and devotion to soil, and we are grateful to all the authors for their contributions to this special issue on “Healthy Soil for Healthy Food”, as well as the *FASE* editorial team for their invaluable support.

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Dr. Fusuo Zhang, Professor of Plant Nutrition at the China Agricultural University, Academician of the Chinese Academy of Engineering, and Dean of the School of Agriculture Green Development. His group has developed a series of integrated crop and nutrient management technologies to increase crop yield and improve nutrient use efficiency, while reduce environmental pollution. Through the vast network and governmental action the great changes have been made for transformation of agriculture in China. He has published over 400 peer-reviewed papers, including the prestige *Science*, *Nature* and *PNAS*, and received many national awards and international prized. In 2018, he received honorary doctorate from Wageningen University and Lancaster University.