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Editorial: The restoration of degraded soils: amendments and remediation

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Editorial on the Research Topic
The restoration of degraded soils: amendments and remediation

This Research Topic (RT) sheds light on the use of eco-friendly amendments, and sustainable management practices to improve soil physical and chemical properties and avoid soil degradation. According to FAO (2024), soil degradation is defined as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services. Soil degradation includes acidification, organic carbon decline, nutrient loss, salinization, and pollution. In light of the climate changes, environmental pollution, and the rapid growth of the population, it is urgent to increase agricultural production to warrant food security. However, the agricultural production level is still far below the consumer demand (FAO, 2017). Thus, the agricultural yield levels should be increased to face upcoming global food demands.

The demanding challenges to provide food for the rapid increasing population may intensify agricultural practices, leading to soil degradation. Moreover, industry and mining activities have exacerbated soil degradation, leading to negative impacts through various mechanisms, including the release of toxic chemicals and elements, air pollution that settles into soil, and physical disturbance of soil. These activities, therefore, reduced soil quality, leading to a reduction in the quantity and quality of food production and a reduced capacity for soil carbon storage. Deforestation and logging also contribute enormously to unprotecting the soil, making it more vulnerable to erosion and accentuating its degradation (Soil biodiversity and soil erosion, 2018). As a result, approximately 33% of the globally cultivated area is degraded (FAO, 2015). Thus, innovative management strategies should be adopted to ensure food security and sustainable exploitation of resources for obtaining ecosystem services while protecting the environment.

FAO proposed integrated and interconnected actions to achieve more sustainable agriculture, especially to "enhance soil health and restore land" and "mainstream biodiversity conservation and protect ecosystem functions," which are aligned with the target of this RT. All those challenges are needed to improve agricultural production systems and their management, protect natural resources, and avoid land degradation. To this end, it is essential to preserve and protect the soil from potential threats affecting its quality and productivity, such as over-fertilization or loss of biodiversity (FAO, 2021), which are now expensive and highly irreversible. In this context, if mitigation solutions are not taken in time, continued soil degradation will cause irreparable losses. Therefore, introducing practicable mitigation solutions, such as new amendments, better land use management, and appropriate remediation technologies, is crucial to stopping soil degradation as a key challenge to maintaining soil health.

Green and sustainable management practices, including organic and inorganic soil conditioners, have been introduced to improve soil's physicochemical and biological properties. The cultivation of trap crops may also result in sustainable agricultural practices to reduce soil degradation. However, limited literature is available; therefore, more research is still needed. Thus, the effects of conventional agricultural practices and the mechanisms of how these practices contribute to deteriorating soil health and living organisms have been considered.

In this regard, the contributions to this RT deal with different technologies to be applied to soil for reducing soil pollution, such as the literature reviewed by Reza Boorboori and Lackóová who summarized a wide variety of solutions to improve soil properties after its pollution, focusing on biochar as the most promising technique for accelerating the efficiency of phytoremediation process. They also reviewed different biochar types, their properties, and their effect on pollutant immobilization, highlighting the need to acquire information from field experiments to gain more practical insights. Another studied technology was adopted by Liu et al., who assessed the addition of different soil conditioners to enhance the soil aggregate stability and, consequently, to improve soil structure and fertility after its abandonment. Their addition to the soil significantly increased the soil organic matter, specific surface area, surface charge, cation exchange capacity, and aggregate mean weight diameter, among other parameters related to soil stability. Therefore, the soil amendments addition may positively affect not only chemically but also the physical soil properties contributing to soil restoration after abandonment.

The use of trap crops to reduce the incidence of pests is of high relevance in sustainable agricultural practices. Xu et al. studied the capacity of some plants to hyperaccumulate cadmium (Cd) and their effect on the reduction of black bean aphids. They not only found a reduction in the plant infestation due to the high concentration of Cd in the plant tissue but also the growth of a plant able to reduce Cd concentration from the soil. This shows a double-positive effect as a sustainable agricultural practice to reduce pest incidence and subsequent pesticide application.

As a consequence of unsustainable practices, Li et al. revealed the effects on soil microorganisms of a continuous cropping system of tobacco where a significant enrichment of soil available nitrogen, available phosphorus, available potassium, and organic matter was found, but also a decrease of bacterial diversity together with changes in the structure of bacterial and fungal communities, indicating the need to pursue sustainable agricultural practices, especially regarding fertilization of tobacco crop to improve and increase agricultural soil biodiversity. In this sense, Liu et al. analyzed pesticide residues in typical fruits of China, finding 25 pesticides. Despite the chronic and acute intake risks of a single pesticide and the hazard index of the mixture of pesticides for adults and children in all fruit types were found to be safe for human consumption and below the maximum residue limit in China, the fruit quality was strongly affected. Therefore, effective tactics must be implemented to correct the use of plant protection products, including management technology, to protect consumer health and the environment.

In conclusion, organic and inorganic soil amendments improve the soil's physiochemical and biological properties. However, overuse of soil conditioners, over-fertilization, and unreasonable pesticide application cause significant soil degradation and ecological risks. Therefore, suitable agricultural management approaches are urgently needed. Otherwise, cultivated soils will face severe degradation, threatening food production and security. Thus, it is necessary to improve soil quality in agricultural systems with the use of appropriate soil control and management, with emphasis on the responses of agricultural systems to soil variations. Hence, the future of soil health relies on sustainable management practices to maintain soil quality or restore degraded areas.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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