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Integrated soil-water-crop management in salt-affected areas

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Salt-affected soils, which include both saline and sodic soils, are indeed found in various regions around the world. They can be found on all continents and are present under a wide range of climatic conditions. However, their distribution is more prevalent in arid and semi-arid regions compared to humid regions. Soil salinization and sodification are significant processes of degradation that pose a serious threat to soils and their ecosystem services. Salinization refers to the accumulation of salts in the soil, often due to factors like high evaporation rates and insufficient drainage. Sodification, on the other hand, occurs when the soil becomes sodic, meaning it contains high levels of exchangeable sodium.

These processes of soil degradation have global implications, particularly in arid and semi-arid regions. They are considered major challenges for agricultural production, food security, and sustainability in these areas. High salinity and sodicity negatively impact plant growth and limit crop productivity. They can also lead to soil erosion, waterlogging, and a decrease in biodiversity. Efforts are being made worldwide to address the issues related to salt-affected soils. Strategies include implementing improved irrigation practices, such as irrigation schedule adjustment, to minimize salt accumulation. Additionally, the use of salt-tolerant crop varieties, land reclamation techniques, and proper soil management practices can help mitigate the effects of salinization and sodification. Overall, the management of salt-affected soils is crucial for ensuring the long-term sustainability of agricultural systems and the protection of ecosystems in arid and semi-arid regions.

Bringing together science, practice, and policy, this special issue provides a platform for knowledge exchange and collaboration among researchers, practitioners, and policymakers in the field of saline soil management. The goal is to collect and systematize the knowledge acquired so the data on the management options and initiatives that would contribute to sustainable agricultural practices promote soil health and improve the resilience of agricultural systems in the face of salinity and sodicity challenges.

The nexus between science and policy goals on which to direct future efforts on salinity-affected soils emerges in Batlle-Sales' contribution, as part of Global Soil Partnership (GSP) work, who states that salinization and sodification of soils and waters is expanding in extent and intensity worldwide, and climate change is likely to increase its environmental impact. This process of degradation must be stopped, and salt-affected soil ecosystems and agricultural lands must be sustainably managed and restored. To make this possible, there is an impressive body of scientific and technical knowledge and modern technologies that can be used for appropriate agricultural production, saving water, energy, and other resources while respecting the environment. The GSP and its International Network of Salt-Affected Soils (FAO-INSAS) play an active role in the coordinated joint work of scientists, stakeholders, farmers, decision-makers, knowledge concentration and transmission, capacity building, education, and recommendation of guidelines and other aspects related to saline and sodic soils.

Marta Paz *et al.* (2023) conducted a study highlighting the increasing prevalence of salinity-affected soils globally and in Europe. The main contributing factors are improper land use and poor management practices, but also climate change that exacerbates the risk of saline soils due to increased aridity and rising sea water levels in coastal areas. The study identified several effective measures to address salt accumulation in soils. Case studies have demonstrated the effectiveness of these techniques in combating salt accumulation. Phytoremediation has been identified as an effective practice to mitigate soil sodicity, in which plants and microorganisms are used to restore affected soils. Leaching and drainage have been identified as effective measures to mitigate soil salinity by removing excess salts from the soil profile. Crop rotation and soil organic matter management have been recognized as adaptive measures that improve plant tolerance to salt-affected soils. These practices improve soil structure and fertility, enabling crops to better withstand salt stress.

As reported by Tedeschi *et al.* (2023) beneficial soil microorganisms, such as arbuscular mycorrhizal fungi and plant growth-promoting bacteria, when present in saline environments, can alle-

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viate plant salinity stress through multiple mechanisms. Furthermore, it has been shown that biostimulants can alleviate the detrimental effect of salinity on plant growth and production. Treatments with increasing levels of salt concentration in irrigation water combined with foliar biostimulant treatments on wild arugula investigated by Sifola *et al.* (2023) showed how plant response appears to depend on biostimulant application, growth conditions, and genetic traits in secondary salinity contexts.

Extensive studies as explained by Salvucci *et al.* (2023) have made it possible to assess the effects of cultivation on saline soils to develop appropriate soil management techniques to ensure their fertility. The morphological and physicochemical properties of the soils studied indicated that cultivation, through irrigation and the presence of soil cover, reduced salt accumulation in the upper soil horizons. Salt leaching to deeper horizons and reduced evaporation, which reduced capillary rise, kept electrical conductivity within tolerable values for most crops. In contrast, abandonment of previously cultivated fields has compromised soil fertility, threatening soil conservation and stabilization of agricultural production in the medium to long term. In fact, an accurate tillage management of salt-affected soils as reported by Baliuk *et al.* (2023) can improve integrated management of salt-affected soils to ensure sustainable agricultural development. Deep plowing with additional fertilization can be used for long-term improvement of salt-influenced soil quality.

As reported by Sherafati *et al.* (2023) on decade-long study on the effect of furrow and subsurface drip irrigation using unconventional water on soil salinity and the growth of pistachio trees that due to severe climate change and excessive salinity increase in soil and water resources, a well-managed subsurface drip irrigation can provide a more sustainable production method for salt-affected soils for pistachio orchards by reducing water consumption and salt entry into the soil.

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