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Editorial

Chemical and Ecotoxicological Assessment of Elements of Toxicological Concern in Agriculture

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Soil is one of the most important resources on land and plays a central role in sustainable development; as such, it is important for us to maintain its pristine quality and safeguard its multifaceted capabilities. Healthy soil can filter and absorb rainwater, enriching and replenishing underground water reservoirs and enabling the slow natural refilling of aquifers. Furthermore, the soil hosts a multitude of microorganisms and minuscule biota in dynamic and diverse biocommunities. These communities enable residue decomposition and nutrient recycling so that energy and raw materials can be recuperated and extensively utilized within an ecosystem. Agricultural soil, in particular, is also the precious substrate for crop production that bears a substantial yield and enough foodstuffs for both animal species and human beings all around the world. It is, therefore, imperative to foster soil's productive capabilities through the promotion and application of modern, sustainable, and environmentally friendly agriculture practices.

Adopting sustainable agriculture practices is nowadays even more difficult since we globally experience harsher climatic conditions, water scarcity, and extreme weather phenomena. Furthermore, diminished raw resources, as well as new industrial concepts, such as waste minimization and circular economy, demand the reuse of everything that can be reused. Organic debris, for example, in the form of biosolids, should be returned to the ecosystem as a fertilizer, ideally closing the loop between agricultural production and consumption. This material recirculation, however, may jeopardize human and environmental safety due to the recirculation of pollutants within an ecosystem. There are "classic" omnipresent pollutants such as metals of toxicological concern, that we should worry about, together with new and emerging ones, such as endocrine disruptors or microplastics. We should, therefore, take all the precautions necessary to circumvent their presence in agricultural soil through improved methods of detection and quantification, isolation and abatement, and decontamination and depuration. Only then may we achieve sustainable, safe, socially just, and acceptable development for all.

In this context, this Special Issue focuses on the "Chemical and Ecotoxicological Assessment of Elements of Toxicological Concern in Agriculture". Here, we have included original research as well as review papers that cover these aspects. In more detail, in the work of Vázquez-Blanco et al. [1], vineyard soils in Galicia, Spain, were fully assessed for their edaphic characteristics, the Cu and Zn content, and the phytosanitary treatments they received for three consecutive years. The results showed several factors that might have hindered vineyard production in Galician plots. The authors made a detailed indicator grouping and rated the performance of the vineyards across these indicators. Some of the most significant parameters were linked to the compactness and stoniness of the soil, while others were pH- and nutrient-related. It is worth mentioning that the continuous application of phytosanitary treatments created an evident imbalance in Cu and Zn concentrations. Cu was highly elevated in the cultivated vineyards to concentrations deemed phytotoxic, while there was also a steady increase in Zn to phytotoxic levels in the last year only. The extensive analyses in this study eloquently showed the multidimensional parameters that dictate a "success" or "failure" in demanding cultivation such as wine grapes. Furthermore,

Citation: Emmanouil, C. Chemical and Ecotoxicological Assessment of Elements of Toxicological Concern in Agriculture. *Agronomy* **2023**, *13*, 796. https://doi.org/10.3390/agronomy13030796

Received: 14 February 2023
Accepted: 7 March 2023
Published: 9 March 2023

the connections between phytosanitation, soil metal accumulation, and soil metal mobility are clearly depicted in realistic field conditions.

Similar research was performed in another part of the world- Punjab, Pakistan by Javaid et al. [2]. This time the crop under investigation was fragrant rice, and the elements of toxicological concern included Pb, Cu, As, Cr, Cd, Hg, and Al. A thorough analytical investigation into soil, water, and rice kernels for these elements showed a diverse spatial distribution. Irrigation water contained concentrations higher than the permissible WHO limits in some instances, and the same was true for soil concentrations in some of the examined areas. In any case, when considering the rice kernel concentrations, the risk to humans from rice ingestion was generally low. However, the risk from Hg ingestion was the most notable exception, with values well above the threshold point of one. It is evident, therefore, that unhygienic practices such as irrigation with polluted water and adjacent industrialized activities wreak havoc on traditional agriculture. As such, the pollution status in the examined rice fields (soil, water, and crops) should be regularly assessed.

Contaminated irrigation water was also the focus of research by Álvarez-Esmorís et al. [3], who studied three common antibiotics: doxycycline (DC), enrofloxacin (ENR), and sulfamethoxypyridazine (SMP) under different environmental fate scenarios. These conditions entail different water pH values and the addition of specific salts or humic acids, under the presence or absence of simulated sunlight. The results showed a significant degree of photodegradation in the antibiotics, while degradation kinetics were also affected by water pH and by complexation with the additives. Differences between the antibiotics were evident since the dissipation of DC and ENR was enhanced by some salts and humic acids while SMP was not affected. As previously mentioned, circular economy practices actively promote wastewater reuse in agriculture; at least in the EU, this necessity is depicted in the new regulation for wastewater reuse (Regulation (EU) 2020/741), where the minimum requirements for this action are set. In this context, it is now imperative for the scientific community to investigate the under-studied environmental fate and behavior of many common pollutants found in municipal wastewater, such as antibiotics.

The next participation in this Special Issue, the review of Perković et al. [4], consists of a comprehensive analysis of the current and emerging pollutant threats in agricultural soils. The authors initially summarized the state-of-the-art knowledge on heavy metal pollution in agricultural soils and afterward expanded their research to microplastics and ANB (antibiotic-resistant bacteria). Their research verified that heavy metals continue to be a global threat to humans, flora, and fauna; however, much less information is available for the two latter categories: microplastics and ANB. For microplastics, for example, sources can include agricultural practices such as the use of plastic mulching, but they may also derive from biosolids or wastewater use. Microplastics can accumulate in crops, fruit, and vegetables and enter the food chain, while their effect on human health is still mostly unknown. For the ANB, the knowledge situation is quite similar; possible sources of exposure include the use of manure, biosolids, or wastewater, which can initially be contaminated with ANB, while these microorganisms may diffuse through many different routes when found in soil, including sorption, plant uptake, removal with runoff, or transport into groundwater. From the assessment of our state of knowledge on microplastics and ANB, as performed by the authors, it was evident that we must deal with serious data gaps. Novel research is required on matters such as the interactions between ARB and the contaminants present in agricultural soils or on the behavior and mobility of microplastics in the soil under different edaphic and climatic conditions.

In our final participation, the review work of Rahim et al. [5] also echoes concerns on pollutants (inter)actions in agricultural soils, focusing on the quite ubiquitous and highly toxic Cd metal. Here, the authors summarize much of our knowledge on Cd sources, including the chemical speciation of Cd in the soil and acceptable daily intakes, while also critically assessing some of the available options for soil decontamination based on biochar substrates. A variety of biochar substrates, whether pristine or with modifications, are nowadays available for decontamination purposes, and the authors herein present how well each variant can minimize Cd mobility, bioavailability, and potential accumulation in crops. Finally, the researchers dwell on what advances can still be made in biochar adsorption in the future.

As such, the above-mentioned participations materialize the appropriate *modus operandi* of environmental engineering, which includes problem shaping, monitoring, analysis, synthesis, risk characterization, and finally, the proposition of realistic and sustainable solutions that respect the natural environment.

Acknowledgments: The editor of this Special Issue thanks all reviewers and authors of the publications for their cooperation and valuable experimental and theoretical research and analysis.

Conflicts of Interest: The author declares no conflict of interest.

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