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EDITORIAL

HIGHLIGHTS OF THE SPECIAL ISSUE "PROGRESS ON NITROGEN RESEARCH FROM SOIL TO PLANT AND TO THE ENVIRONMENT"

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Nitrogen (N) is an essential nutrient for plants, animals and humans, being a key element in proteins. Rapid increases of global population thus require more N inputs to soil to improve food production. However, N losses induced environmental problems, due to inefficient N use by crops and animals, are threatening our environment via soil acidification, eutrophication and water pollution, air pollution and biodiversity loss/health impacts and by greenhouse gas emissions and climate change. Therefore, humans are facing a huge challenge on how to balance the N requirement (to meet the food demand) and the N restriction (to avoid environmental damage). This includes the need for improving the N use efficiency (NUE), as one pillar to realize green development. This special issue summarizes recent progress on N research at different scales: from soil to plant and to the environment, and includes 15 review and research articles, distinguishing four topics, related to (1) N use and turnover (3 articles), (2) N management (4 articles), (3) N impacts on environment and climate (5 articles), and (4) mitigation approaches to improve NUE and reduce N losses (3 articles).

Considering the efficient N use by crops and microorganisms, Liu et al. (https://doi.org/10.15302/J-FASE-2022441) focus on the current understanding of metabolic adaptations to N availability, by reviewing the potential approaches to improve NUE in high-yielding cereal crops. They argue that the use of precision gene modification will promote a sustainable second Green Revolution. Peng et al. (https://doi.org/10.15302/J-FASE-2022450) summarize the potential role of soil microbial N cycle processes and plant–microbe interactions for improvements of NUE and soil health in intensive cropping systems. Through a case study, Zhong et al. (https://doi.org/10.15302/J-FASE-2022451) evaluate the impacts of different intercropping systems on soil bacterial community composition, diversity, and function in tea gardens, showing that intercropping with soybean and rapeseed enhances biological N fixation and tea's N nutrition through shifts in soil microbial communities.

In terms of N management in agroecosystems, Zhang et al. (https://doi.org/10.15302/J-FASE-2022458) propose a composite N management index (SNMI) combining the performance in N crop yield and NUE, thereby accounting for the need for both food production and environmental protection. They find large and increasing differences in SNMI values between countries since the 1970s, reflecting different levels of N management practice at a global scale. Liang et al. (https://doi.org/10.15302/J-FASE-2022447) review the major challenges and future opportunities to make Australian agrifood systems more sustainable, with less pollution and higher profits by a combination of agronomic, ecological and socioeconomic approaches and efforts. Zhang et al. (https://doi.org/10.15302/J-FASE-2022455) review the progress on N management in vegetable production in China, distinguishing improvements related to the optimization of

(1) N fertilizer rate, (2) N fertilizer type/forms, such as slow release fertilizers, urease and nitrification inhibitors strategy, and (3) improved crop and soil management, including high yielding cultivars. Then Zhu et al. (https://doi.org/10.15302/J-FASE-2022443) summarize the current status and challenges of N management in both vegetable and orchard systems, and provide solutions for more sustainable future cash crop production including rational N fertilization, substituting mineral N fertilizers with organic fertilizers, fertigation, and adding mineral N fertilizers with urease and nitrification inhibitors.

Focusing on N cycling and its environmental and climatic impacts, Zhu et al. (https://doi.org/10.15302/J-FASE-2022456) evaluate the effects of substitution of mineral N fertilizer by organic manure on N losses from soil-crop systems in hilly purple soil regions and confirm the advantage of partial substitution of organic manure instead of full substitution. Shen et al. (https://doi.org/10.15302/J-FASE-2022448) summarize N cycling and the related losses of N (NH_3, N_2O, NO_x and NO_3) to air and water in subtropical hilly regions, based on monitoring and modelling results. Stevens et al. (https://doi.org/10.15302/J-FASE-2022457) review the progress in research on the effects of N deposition on global grasslands, distinguishing Europe, North and South America, Asia, Africa and Australasia, in terms of declines in species richness and increases in biomass production due to soil eutrophication and acidification. Du et al. (https://doi.org/10.15302/J-FASE-2021429) review the literature on N deposition effects on urban forests, with a special focus on N cycling, soil acidification, nutrient imbalances, greenhouse gas emissions, tree growth, and plant and soil microbial diversity. They argue that urban forest ecosystems, being N deposition hotspots, should receive more attention. Using a simple model, Vitousek et al. (https://doi.org/10.15302/J-FASE-2022452) analyze how increasing temporal variation of precipitation reduces crop yields and increases N losses from intensive cropping systems, being a threat in view of expected climate change.

Addressing mitigation approaches to improve NUE and reduce N losses, Ti et al. (https://doi.org/10.15302/J-FASE-2022454) report the historical trends of N flows, threats of N losses, successful stories of N management, and barriers in N pollution control in China. They conclude that Integrated measures and policies are crucial for the abatement of adverse impacts of N. Misselbrook et al. (https://doi.org/10.15302/J-FASE-2022459) review the contribution of two Sino-UK Virtual Joint Centres for Nitrogen Agronomy (CINAg and N-CYCLE) in improving the agricultural NUE of fertilizers utilizing livestock manures, and soil health in China. Finally, Liu et al. (https://doi.org/10.15302/J-FASE-2022453) systematically summarize the latest progress of N research in China, covering reactive N induced environmental problems, various N management technologies and successful practices. They propose a new framework of food-chain-nitrogen-management to meet the future N challenges including the recycling of organic manures, optimized crop and animal production and improved human diets.

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