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Editorial: Nitrogen use to improve sustainable yields in agricultural systems

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Editorial on the Research Topic
Nitrogen use to improve sustainable yields in agricultural systems

Nitrogen (N) plays a vital role in plant nutrition. It is required in larger amounts than other essential nutrients as N is an integral part of a plethora of plant metabolites such as amino acids, chlorophyll, nucleic acids, ATP and phytohormones. Thus, N acts as the backbone of optimum plant growth and development (Anas et al., 2020). The food demands of growing population in twentieth century could be met with prolific crop production; thanks to the discovery of urea, a nitrogenous fertilizer. The sufficient food availability in turn allowed population to further increase exponentially. The increasing trend of population and diminishing land resources over the years have compelled crop production systems to become more intensive and to use high unwarranted amounts of nitrogenous fertilizers for vigorous growth and yields. In the USA, N fertilizer use increased from 0.22 gN m^{-2} y^{-1} to 9.04 gN m^{-2} y^{-1} between 1940 to 2015; an about 40-fold increase (Cao et al., 2018). An increase of about 4-fold in cereal production has been monitored since 1960s to present times but it occurred with a 9-fold increase in the N fertilizer application (Ladha et al., 2022). However, a substantial amount of the N fertilizer applied, is lost through leaching, ammonia volatilization and denitrification. Málinaş et al. (2022) highlighted the severity of N losses from agricultural fields by ascertaining that nearly 50% of N applied globally is lost, contributing to groundwater pollution, eutrophication, soil acidification and global warming. For sustainable crop production, agricultural practices must intensify productivity while maintaining environment quality simultaneously (Govindasamy et al., 2023). To this end, augmenting biological N fixation and reuse of organic wastes can play significant role in reducing N fertilizer applications, and in sustaining soil and environmental health.

This Research Topic presents original research and review articles on recent scientific advances in N use efficiency, N balance assessment, biological N fixation and integrated nutrient management. In all, ten papers are presented. Four articles by Castillo, Kirk, Rivero, Fabini et al., Chivenge et al., Winnie et al., and Ntinyari et al. explored the options for optimizing N use efficiency by moderating N losses. Chivenge et al. demonstrate that the combined use of site-specific nutrient management (SSNM) and digital decision support tools such as Rice Crop Manager, Nutrient Expert, and RiceAdvice improved rice yields, profit, and N use efficiency, and reduced N losses. They advocated

that the use of SSNM would improve farmers' profits too. Winnie et al., showed that the Abjua declaration of increasing fertilizer consumption in West Africa to 50 kg nutrients (i.e., N + P + K)/ha was too low to improve food security and optimize NUE. Castillo, Kirk, Rivero, Fabini et al. used N balance, N use efficiency, and N surplus (NSURP) to suggest that crop-livestock systems could be efficiently propagated and promoted to greater crop yields and higher livestock productivity without increasing N fertilizer user. Castillo, Kirk, Rivero, Haefele et al. demonstrated the application of a model, DNDC in optimizing N management in rice, rice-soybean and rice-pasture crop systems. Kebede presented a state-of-the-art review of legumes-driven biological nitrogen fixation. The author suggested that selection of appropriate legumes and their use at the maximum genetic potential, inoculation of legumes with compatible effective rhizobia, and the use of appropriate agronomic practices can sustainably utilize biological N fixation and increase crop yields. Paramesh et al. presented an excellent review of integrated nutrient management (INM) practices and opined that INM is vital for the revival of soil health along with achieving higher crop yields and decreasing environmental pollution and greenhouse gas emissions. INM approaches should indeed be practiced widely to sustainable utilize soil resources of the earth.

Ferdous et al. assessed the feasibility of reducing ammonia volatilization from irrigated rice system by applying lower rates of N fertilizers. They could achieve both aims by utilizing biochar and compost, either alone or in combination, as nutrient providers. The article by Thakur et al. investigated the effect of multitrait *Pseudomonas* sp as a growth-promoting bioinoculant on a medicinal plant, *Andrographis paniculata* (Kalmegh). The authors found the bioinoculant to be a potent plant growth-promoting agent and an environmentally friendly approach for improving crop performance. Lastly, Betts et al. explored the relationships among nitrogen balance, fertilizer application advice, and farm financial performance and found N balance to be a responsive indicator of farm financial performance.

Overall, these ten articles published in this Research Topic have clearly identified the "problems and issues" associated with N use in crop production in diverse agricultural systems. The articles also showcased feasible sustainable strategies for improving N use efficiency, tracking N flows, reducing N losses while increasing crop yields and reducing environmental pollution. The nutrient management strategies opined in the presented articles shall pave way for improved N management in crop production while attaining the goals of food security.

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