Nitrogen in Indian Agriculture

Poor fertility of the Indian soils found its echo in the Report of Royal Commission on Agriculture in India submitted in 1928 to Parliament. The report clearly recognized the existence of deficiencies of nitrogen (N), phosphorus (P_2O_5) and potash (K_2O). Today situation is same as was in the first half of the 20th century, whether judged by the extent of deficiencies or even the ideal nutrient consumption ratio of 4:2:1. Nitrogen is universally deficient in Indian soils with 99% of soils responding to N application. Being a constituent of proteins, N holds a key to the life on Earth. It follows a Liebig's law of minimum and unless its deficiencies are corrected first, addition of other nutrients becomes a wasteful exercise.

Conscious of this, Government of India undertook number of steps for improving the fertility of the Indian soils as a key to the sustainable agricultural development. Production of ammonium sulphate as a by-product of steel industry in 1933 by Tata Iron and Steel Company Limited, Jamshedpur marked the beginning of manufacture of nitrogenous fertilisers in the country. Production of urea, first commenced in 1959 by FCI, Sindri, revolutionized the fertiliser-N production with number of urea manufacturing units currently being 30. Diammonium phosphate (DAP) production started in 1967 by Gujarat State Fertilizers and Chemicals Limited was a landmark in itself as N and P carrier. Calcium ammonium nitrate (CAN), nitrophosphate and subsequently NPK complex fertilisers offer an array of N carriers available to the farmers. Over the years, urea became the workhouse for N application.

These developments paid dividends. From 1950-51, fertiliser N use grew from a measly amount of about 0.45 kg ha^{-1} to nearly 87 kg ha^{-1} in 2014-15. Country became self-sufficient in food grains in 1990-91 and has marched on to have over-flowing granaries. We are inching towards becoming both food- and nutrition-secured nation. Of course, entire credit of this momentous achievement is not due to fertiliser nitrogen alone. Application of N, P & K and other nutrients resulted in Green Revolution. Even globally, general perception is that nearly half of the world's cereal production is due to the use of mineral fertilisers.

In spite of the best research and development efforts, use efficiency of N fertilisers continues to be abysmally low, seldom exceeding 35% in lowland rice and 50% in the upland crops. Low use efficiency of N may be due to escape of N in the atmosphere in the form of NH_3 or nitrous oxide and leaching of nitrates. Agricultural scientists played a stellar role in developing management practices like split application of N, use of slow release nitrogenous fertilisers, nitrification inhibitors, urease inhibitors, site-specific nitrogen management, fertigation, etc., for enhancing the use efficiencies of the applied N. A step forward in this direction is 'Nutrient Stewardship' approach ('4Rs' of fertiliser management) which emphasizes on : (i) right source that supplies fertiliser nitrogen (more appropriately in balance with other nutrients) matching with the crop needs, (ii) right rate that neutralizes crop removals, (iii) right time that makes N available fulfilling variable crop demands and (iv) right place as per distribution of deficiency where loss is minimum and crops can absorb easily.

Healthy productive soils sustain life on Earth. Use of mineral fertilisers is vital to support healthy soil and global food production. International Fertilizer Industry Association (IFA) emphasized 'Nutrient Stewardship' approach in 2013 on efficient nutrient management to produce competitively nutritious food with zero or minimum harm to soil health, environmental integrity and well-being of other natural resources. It essentially welds together precise agronomic methods, integrated nutrient supply and management, balanced fertiliser application, site-specific nutrient treatment utilizing green sensors or leaf colour chart, etc. Citing experience of FAO and IFDC, IFA has reported 10 to 30% improvement in existing fertiliser nitrogen use efficiency. There is essentially a need to train the trainers in the transfer of this approach with the emphasis that it will save on fertilisers, improve income, rescue farm resources from degradation and sustain productivity growth.

Application of nitrogen alone is not a prescription to obtain higher yields. Data from the long-term experiments on acid Alfisols of Palampur, Ranchi and Bangalore showed that continuous application

of nitrogenous fertiliser alone after sometime either produced crop yields comparable to those obtained in the control or at times were lower than the control. It occurred because of accentuation of P deficiencies induced by N-fertiliser-induced soil acidification. For achieving sustainable productivity of the cropping systems, integrated and balanced use of fertilisers, manures and amendments is the answer.

Green Revolution era witnessed dynamic changes in terms of accelerated use of machinery edging out the use of animals in cultivation practices, land becoming scarce for soil fertility-restoring/rejuvenating practices, increasing menace of residues burning, etc. Availability of organics for use as a nutrient source or as an amendment or as optimizer of soil physical and biological health decreased. Wherever these were available, prices were sky-rocketing. It is established that use efficiency of N and other nutrients in low organic carbon soils will continue to be low unless steps are taken to improve carbon or in other words carbon-sequestering practices are followed. Conservation agriculture, relying on the principles of use of resource conservation technologies like residue retention and following legume-component crop rotations, holds a promise in improving the N use efficiencies. Nitrogen is a classical element which becomes central in developing the conjoint mix of mineral, organic and biological sources.

Realising the importance of fertiliser as a key production input government enacted regulations and policies to ensure availability and quality of fertilisers. Fertilisers were declared Essential Commodity in 1957 under ECA 1955 and Fertiliser (Control) Order to regulate quality, trade, price and movement. Various pricing polices ensured the affordability of fertilisers by the farmers. The policies also encouraged production of fertilisers in the country. These policy initiatives included Retention Price Scheme (RPS), New Pricing Scheme (NPS), Nutrient Based Subsidy Scheme (NBS) and New Urea Policy (NUP).

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A milestone development in the policy front was introduction of Nutrient Based Subsidy (NBS) Scheme in April 2010. It was aimed at balanced fertilisation by change from product based subsidy to nutrient based subsidy. However, it covered only P&K fertilisers and urea was left out. Price of urea continued to remain controlled at almost same level as was in 2010. Simultaneously, the fixed subsidy on P&K fertilisers under NBS was reduced substantially resulting in high retail price of these fertilisers. This distortion in price of urea-vis-à-vis other fertilisers has affected the use ratio of N, P & K very adversely because farmers buy more low price urea than other high price fertilisers. Coating of urea with neem oil may help to improve nitrogen use efficiency marginally, but fertiliser use efficiency can only be optimised by balanced use of all nutrients. This needs correction in pricing policies for fertilisers.

At the initiative of Honourable Prime Minister, the programme for providing soil health cards to all farmers was launched last year. Awareness among the 138 million farming families powered with the soil health cards by 2017 will hopefully generate demands for right products and formulations. All stakeholders have to be ready with answers and services. But it will remain only a cherished dream if the price parity, both inter- and intra-nutrients, is not restored. Free water and power (in some states) coupled with highly subsidized urea will only promote inefficient use of N and will leave the farmers with less than optimum crop yields and poor return to the farmers. Imbalanced use of plant nutrients due to present pricing policies will result in groundwater pollution and eutrophication of water bodies. Solution lies in maximization of N use in tandem with optimum application of the other nutrients.

This special issue on Nitrogen is one of the initiatives of FAI to highlight the importance of nitrogen in Indian agriculture. The theme assumes significance because the country is celebrating the Golden Jubilee of Green Revolution this year and N fertilisers had contributed immensely in success of Green revolution. The special issue includes nine lead papers covering important aspects *viz*. nitrogen fertility status, site-specific nitrogen management, biological nitrogen fixation, integrated nutrient management, nitrogen in agriculture and environment, conservation agriculture and policies for nitrogenous fertilisers. We hope that all those concerned with agriculture including scientists, policymakers, extension workers and farmers will find the content of special issue useful and relevant to present agriculture situation. ■