

## Nitrogen in crop production – Tough to curb liability

The discovery of synthesis of ammonia by Fritz Haber (1915) for which he was awarded the Nobel Prize in chemistry was the starter of N fertilizers all over the world. Today India claims the pride of place among the top three, China, USA and India, for production and consumption of fertilizers in general and nitrogen, in particular. Yet crop yields of the three major cereals of India by 1998–99, wheat, rice and maize, were only 65, 46 and 35%, respectively of those in China<sup>1</sup>.

The remarkable success in 'yield revolution' in India, where the fertilizer was the lynchpin reached a climax by 1984, but remained so only for a few years as yield fatigue had set in by 1990 and has since continued despite increasing use of fertilizers. The tropics (India) are an area of vast climatic potential for plant growth and agriculture (multiple cropping), but there is over-exploitation and mismanagement of nitrogen fertilizers through five practices, viz. increasing levels season after season, widening N : P ratio, absence of blending with organics, insisting basal application, and broadcast prilled form of urea. Such abuse continued to hedge out the entry of use efficiency<sup>2</sup>. Human interference of alteration of the N-cycle has grave consequences such as nitrate pollution of underground water, blue-baby syndrome, eutrophication of aquatic systems, a threat to sustainability of fish. Also, pollutants produce petrochemical smog which gives rise to respiratory problems. A host of environmental problems, including global warming, acid rain and loss in biodiversity are enough threats to challenge us for a long time<sup>3</sup>. Where added, N increases the productivity of the ecosystem and it also decreases their biological activity<sup>4</sup>.

What scientists learnt in the 20th century is science and technology, but the need for the 21st century is interaction of science and technology with farmers and consumers. Analyses of 30 agro ecosystems of the temperate zone showed that two-thirds of them had overall N recovery rates below 50%; while most efficient cropping recovered 70% of applied nitrogen. With new varieties of high harvest index value, recovery efficiency increased. With Asian flooded rice crop, nitrogen recovery was only 20 to 40%

and rarely touched 50%. It may be stated that half of all the N added annually to the world's crop land is lost from the world's agro ecosystems, most of it before it could be incorporated in the harvested biomass<sup>5</sup>.

By 1990, agriculture in the two very unequal segments of humanity, 1.2 bl. for the developed and 4.2 for the developing worlds, consumed an equal amount of 40 ml/t of N-fertilizers. By 1996 developing countries consumed 64% of N fertilizers which provided 55% of the total nutrient supply reaching the fields. An important consideration that will affect future demand for N fertilizer is declining response (or even no response) of crop yields with increasing nutrient applications. The three principal ways of human interference in the nitrogen cycle are synthesis of ammonia (130 ml/t/yr), legumes in cropping (30) and combustion of fossil fuels (20). There is as yet no substitute for nitrogen as fertilizer for growing crops, but improvement of use efficiency is possible only to reduce the losses resulting from field applications and to avoid environmental consequences<sup>6</sup>.

No correctives were applied to relieve yield fatigue, but the malady was fuelled further through policy measures under the pretence of helping the farmer and assuring the consumer of food needs: First raise the subsidy for urea by 23% per year and then enhance the procurement price by 15% for paddy and 17% for wheat and energy supply at gratis for small farmers.

The public distribution system enjoyed such increases in price, though the system operates only in urban areas<sup>7</sup>. All this ended in increased costs of production at the farm level without extra grain yield. Farmer's profit decreased and consumer price increased far beyond purchase capacity. Hence 70 ml/t of grains remained in storage with no demand, while 300 million remained hungry and starved with sporadic deaths. Each intervention by man has an associated energy and monetary cost and damaged its stability. There is no assurance that this would not be repeated in future. As long as subsidy for urea continues and fertilizer use is not corrected for levels, product pattern, time and method of application,

the situation would continue – batting on the fertilizer front with no score on the food front. The rule of a mercantile society, the industry and traders, without soul, however successful it may be in material terms and production and consumption on par with the US and China, will not succeed in reducing poverty and hunger.

Currently the world produces 150 ml/t of fixed nitrogen per year, 1.5 times the natural terrestrial amount. As on 2000, the developing world has overtaken the developed for fertilizer consumption, only to overuse and waste nutrient and to deprive the farmer and the consumer of their legitimate dues. Nearly all this goes to the traders – a big pay-off for all the unscrupulous indulgence for a 'harvest without sowing'. While the world feels that the major stakeholders in agriculture are the government, input manufacturers, traders, farmers, and consumers all work hand-in-glove without the knowledge of farmers and consumers. The most precious and timely caveats were ignored, both overtly and covertly<sup>8,9</sup>.

Developed countries are much concerned about the grave consequences of over use and abuse of nitrogenous fertilizers and have applied corrections to decrease levels, alter product pattern time and placement with change in cultural practices. Based on principles of ecology, ecosystem services and traditional wisdom of crop rotations and organic amendments have been adopted. This improved the economics and reduced environmental injuries. Studies on intensive wheat systems of Mexico, lower fertilizer applications and reduced loss of fertilizers were equivalent to 12 to 17% savings in farming costs. A knowledge-intensive approach to fertilizer management can substitute for higher levels of inputs, saving farmer's money and reducing environmental costs<sup>10</sup>. The relative impact of different cropping systems upon Global Warming Power (GWP) reveals that no till management has the lowest global warming power followed by organic and low input management with legume cover which is widely in practice<sup>11</sup>. Fertilizer use, specially nitrogen as urea is climbing, while the yields have stagnated and refuse to respond to additional doses. The increasing subsidy for urea, increas-

ing the procurement price for grains and free energy supply have monetarily helped everyone, except farmers and consumers. This physical availability without economic access appears as surplus and more recently the government was compelled to reduce the price of stored grains. That is the visible tip of the iceberg. The policy decisions are already published to increase fertilizer use for consumption at levels of 207 kg/NPK/ha by 2011–12 from current 100 during the year 2000 (ref. 12).

To illustrate the global concerns for excessive nitrogen use as global pollutant, a reference to the Second International Nitrogen Conference, at Potomac, Maryland, USA during 14–18 October 2001, and its lessons for India deserve emphasis. (i) Progress to curb nitrate and ammonia leak from farmer's fields and animal wastes. (ii) Nitrate pollution is large in the developed world. But Asia now contributes 35% of the world's total synthetic nitrogen; its output is expected to double by 2030 to 100 ml/t of nitrogen per year. (iii) Even USA is working on new policies to reduce fertilizer N and crackdown on run-off from farms into rivers. (iv) Reduce meat consumption

and reduce the N animal's release through a change in feed composition. The Netherlands is the best example to this end, in addition a drastic reduction in fertilizer use on wheat crop with no loss in yield. (v) Finally, the conference unanimously endorsed 'nitrogen as a global pollutant' to rank with greenhouse gases. An integrated policy to address the entire N-cycle, including the creation of an international scientific body for nitrogen on par with the Intergovernmental Panel on Climate Change (IGPC) was adopted. The conference concluded that 'confronting the unyielding economics of the Haber-Bosch process (synthesis of ammonia) may be the policy-makers biggest challenge'<sup>13</sup>. Even the well-intentioned champion for the cause of fertilizer use in developing countries, perhaps out of despair, observed 'force on them (farmers) cruel doses of fertilizers and chemicals, farmers will die quickly while political barons live longer through food imports' (Norman Borlaug<sup>14</sup>).

1. Jim Jiyun *et al.*, *Nutrient Disequilibria in Agro Systems*, CAB Int., 1999, pp. 157–173.

2. Sankaram, A., *Indian Farming*, 2001, 7–10.
3. Isherwood, K. F., UNEP & IFA Pub., W.W. Norton, New York, 2000, pp. 1–50.
4. Tilman, D., *Ecol. Monogr.*, 1987, **57**, 189.
5. Smil Vaclav, *Sci. Am.*, 1997, **277**, 76–81.
6. Vitousek, P. M. *et al.*, *Science*, 1997, **277**, 494–499.
7. *Fertilizer Statistics*, FAI, New Delhi, 2000.
8. Hannah John, Keynote Address, Annual Seminar, FAI, New Delhi, 1977.
9. Brown Lester, *State of the World*, 1998, pp. 79–86.
10. Matson, Pamela A., *Science*, 1998, **280**, 112–114.
11. Kenneth, Dahlberg A., *ibid*, 2000, **290**.
12. IX, X and XI Five Year Plan, Planning Commission, GOI, New Delhi.
13. Jocelyn Kaiser, *Science*, 2001, **294**, 12669.
14. Borlaug, N., 15th International Soil Sci. Congress, Mexico, 1994.

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## Unequal opportunity!

This is with reference to an advertisement by National Institute of Immunology (NII) published in national dailies (see, for example, *The Hindu* dated 3 March 2002) inviting applications from students of biology and related sciences for admission to the NII Ph D programmes. According to the advertisement, candidates fulfilling the minimum requirements will be invited for a written test on 31 May 2002 at NII, New Delhi. Short-listed candidates will be called for an interview on 1–2 June 2002 at NII. M Sc (any branch of science), M Tech, MBBS, MVSc or M Pharm candidates who have secured first class or 60% of aggregate marks in all major exams from plus-2 onwards will be called for a written test 'at their own expense'. Out of possibly a large number of candidates only a few students will be selected for interview for the final selection. NII has been making

the same type of announcement for the past many years.

I am sure there will be many students from all over the country desirous of joining NII which is the premier national institution in the country doing 'cutting-edge research' (to quote NII) in immunology. But even for the preliminary written test, students from all parts of the country (e.g. Kanyakumari, Imphal, etc.) have to travel thousands of kilometres and stay in New Delhi for two or three days at their own expense. I think this is a very unfair treatment to all the students who happen to live far away from New Delhi. This requirement of NII is not at all a problem for students from Delhi, UP, Punjab, Haryana, Himachal Pradesh, etc., but it will be a deterrent for students living far away from New Delhi and who may also hail from economically poor families.

Similar national institutions like Indian Institute of Science (IISc), Bangalore, and JNU, New Delhi conduct preliminary tests in a large number of centres across the country for the benefit of students from all over the country (for example, IISc in its recent announcement inviting applications for admission to Ph D provided 18 centres evenly distributed across the country). Equal opportunities must be provided to all the brilliant young men and women of this country who want to do 'cutting-edge research' in immunology.

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