

## Nitrogen management for sustainable development\*

Nitrogen cycle is the most anthropogenically altered nutrient cycle, with adverse impacts on food security, energy, industry, health, biodiversity, environment and climate change. As carbon cycle dominates the mainstream debates on energy, environment and climate change, nitrogen is increasingly emerging as a matter of concern. This was discussed by over 400 delegates from 36 countries who participated in the 5th International Nitrogen Conference held for the first time in India.

Nitrogen is an essential element for all forms of life on earth. Though it constitutes 78% of air, it cannot be utilized in its elemental form by the plants and has to be converted into reactive nitrogen. The Society for Conservation of Nature (SCON) facilitates a series of nationwide consultations on the need for an integrative approach to research and policy regarding reactive nitrogen in Indian agriculture, industry and environment. A network of nitrogen researchers and experts called Indian Nitrogen Group (ING) under the umbrella of SCON realized the need for international coordination and began to make efforts to harmonize the national, regional and international concerns and priorities of reactive nitrogen. The coordinated efforts of ING-SCON in collaboration with the International Nitrogen Initiative (INI), led to the organization of the International Nitrogen Conference to deliberate on the issues related to science, technology and policy of reactive nitrogen management for sustainable development. The conference theme was covered comprehensively under five sub-themes of social relevance: nitrogen in food security; ecosystem services and biodiversity; health; energy security and industry, and climate change, along with a separate session that integrated all these sub-themes.

The conference provided an ideal platform to strengthen the Global Partnership on Nutrient Management (GPNM) facilitated by UNEP that not only solely discussed nitrogen, but also its interactions with other major nutrients, including phosphorus, potassium and sulphur through special sessions. This special GPNM session was held as a parallel event and was attended by over 120 delegates from over 17 countries. Shailesh Nayak (Secretary, Ministry of Earth Sciences, GoI) spoke on 'Earth system science: a perspective'. Satish Chander (Fertilizer Association of India) spoke on nutrient management in the context of Indian agriculture. There were other speakers covering a variety of interesting themes such as: 'Dilemma of economic development and environment protection', 'Why Africa missed the first Green Revolution?' and 'India: balanced plant and nutrition towards food security and sustainable'. The presentations were followed by an open interactive round-table session to elicit comments from the present GPNM partners and potential partners from other countries. The discussion endorsed the formation of an Asian platform and the need for bringing more countries on-board through governmental and/or non-governmental initiatives as part of GPNM for development of local capacities for global partnerships through regional coordination.

There were some important side events on synergizing the South and East Asia nitrogen processes into a common Asia platform for facilitating regional coordination with endorsement of the Indian Union Ministry of Earth Sciences to bring in technical expertise to review the Indian time-series data on coastal/marine water quality and development of 'backward linkages' with other actors to evaluate land-based activities, sources and flows of reactive nitrogen into the sea. Another side event was sponsored by the Bill and Melinda Gates Foundation on biological nitrogen fixation with a special focus on Africa and the developed countries. Two meetings of the INI Steering Committee and Advisory Group were also held on the sidelines where the discussion centred around the current

progress in reactive nitrogen management in terms of the five pillars of the conference themes and consensual organization to hold the next International Nitrogen Conference in Africa.

The concluding session highlighted achievements of the conference. While appreciating the selection of sub-themes for the discussions, it was seen that since the last Conference (2007, Brazil) substantial progress has been made on reduction of emissions of nitrogen oxides ( $\text{NO}_x$ ), linking nitrogen and carbon cycles, establishment of the GPNM, planning for regional nitrogen assessments, and development of communication tools, such as the nitrogen footprint calculator. An open session was organized in the end with participation of all delegates for the discussion and mutual approval of the Delhi Declaration, which was put together by N. Raghuram (ING-SCON) based on the deliberations that took place during the conference. The declaration called upon the UN agencies, national governments, scientific bodies and civil society to address nutrient deficiencies and move towards increased efficiencies in each segment of nitrogen cycle management, to reduce the adverse effects. Some of the recommendations made were:

- The nutritional inequities related to nitrogen necessitate better management of food chains and food security, particularly intensively managed livestock production systems, which cause excessive losses from nitrogenous excreta (urine, dung and other biological wastes), unless properly recycled.
- Leakage of reactive nitrogen from crop, animal, aquatic and industrial production systems into the environment is a cause for concern. This is regardless of whether the leakages are of chemical, biological or organic origin. It is possible to minimize these leakages through scientific and technical solutions and enabling policies. This includes ways to optimize the efficient use of inorganic and organic fertilizers wide-world, and to facilitate enhanced access and sus-

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tainable use of nitrogen inputs in the predominantly nitrogen-deficient soils of Africa, and parts of Latin America and Asia.

- Fossil fuel and biomass combustion are currently necessary to meet demands for electricity, transportation and energy. Reactive nitrogen by-products from these sources are a serious cause for concern. However, business-as-usual scenario of inefficient production and use of reactive nitrogen will multiply in the coming years, as the demand for food, especially animal proteins, and biofuels, fossil fuel and biomass burning increases, and growing urban populations produce more waste. It is important to recognize that the anthropogenic releases of reactive nitrogen vary widely between countries of the world, between regions within countries and between different economic sectors, and that the responsibility to mitigate the damage varies proportionately.
- There is a need for the UN bodies, regional organizations, national governments, scientific communities, including Consultative Group on International Agriculture Research (CGIAR), industries, policy makers, INI and the civil society to address nutrient deficiencies move towards increased efficiencies in each segment of nitrogen cycle management. Approaches should consider the use

of incentives, make full use of recycling and ensure the treatment of discharges.

- There is a need to encourage coordination for interdisciplinary research, capacity building and policy within and between countries, inter-governmental bodies, the INI and civil society to ensure adequate nitrogen availability for food and nutrition security in different regions, and to understand, and mitigate the adverse impacts of accumulation of excess reactive nitrogen. Policies need to be 'nitrogen proofed' to maximize benefits and minimize negative effects of reactive nitrogen. There is a pressing need for national governments to develop more integrated, rigorous and multidisciplinary approaches for the management of sources, sinks, flows and effects of nitrogen and other nutrients at the local and national level. These approaches must be based on consolidation and synthesis of existing data, identification of gaps to undertake necessary research, and the use of information to promote appropriate practices and technologies, with the accompanying policies encouraging adoption of 'nitrogen proofed' best practice.

Regional assessments are required to frame issues of nitrogen deficiency and excess, and mitigation options in policy-relevant contexts based on expert judge-

ment of scientific knowledge and uncertainties. These regional assessments should lead to a similar framing of issues and options in a comprehensive global assessment for policy makers. Identification, communication and promotion of best practices require collaboration among many stakeholders, including governments, scientists, practitioners and policy makers at global, regional and national levels. The formation of GPNM facilitated by UNEP is a welcome development in this regard. Nitrogen is one of the most important nutrients already identified by GPNM. In close partnership with INI and its regional centres, GPNM offers scope for further expansion of partnerships to address the issues of managing reactive nitrogen as a part of comprehensive plans for sustainable development. The Conference reaffirmed the Nanjing Declaration on Nitrogen Management (2004) that reactive nitrogen is a critical nutrient for food, feed and fibre security. Organization of international conferences on nitrogen reiterate the commitment of scientists and their concerns related to nitrogen cycle in India.

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## MEETING REPORT

### History of S&T in 20th century India\*

In the 20th century science progressed at a rapid pace. India witnessed the works of C. V. Raman, S. N. Bose, M. N. Saha, G. N. Ramachandran, among others. Raman also received the Nobel Prize in Physics in 1930. India celebrates his Nobel-winning discovery of the 'Raman effect' as National Science Day every year on 28 February. But not all the sci-

entific contributions of our forefathers were well-recognized. Even now, while reading habits are plummeting, particularly among the young, they are even more untouched by the rich history of science.

Some historians of science hail from a science background, while others do not. Those who have a science background are often accused for being biased and narrow in their approach, and those who do not are warned they lack the understanding of science to look into its past. One can still find historians who have successfully researched science history despite their science/non-science back-

ground. A one-day seminar drew a few historians and other experts to review the history of science and technology in India during the 20th century.

Historian Deepak Kumar (Jawaharlal Nehru University (JNU), New Delhi) presented a critical analysis of science and society in the 1900s. He noted that at the turn of the century, though there was some diffidence because India was under the colonial rule, good debates were still being held in the society, the sort not seen anymore. P. C. Ray who displayed extraordinary historical sense is largely forgotten; there are no celebrations in the country outside West Bengal to mark his

\*A report on the seminar 'The History of Science and Technology in 20th Century India', held at the Centre for Contemporary Studies, Indian Institute of Science, Bangalore, on 15 October 2011, and sponsored by the Indian National Science Academy, New Delhi.