

The Indian Nitrogen Assessment: Sources of Reactive Nitrogen, Environmental and Climate Effects, Management Options, and Policies. Yash P. Abrol *et al.* Woodhead Publishing, an Imprint of Elsevier, The Officers' Mess Business Centre, Royston Road, Duxford, CB224QH, UK. 2017. 568 pages. Price: US\$ 185. ISBN 978-0-12-811836-8.

This is a comprehensive reference volume that summarizes all the available knowledge regarding the sources of reactive nitrogen in India, its environmental and climate effects, management options and policies. Its 31 chapters cover diverse sectors such as agriculture, animal husbandry, fisheries, industries, transport, etc. and quantify their contribution to air, water and soil pollution. This interdisciplinary work required the participation of over 129 authors and eight editors, backed by many more scientists from the Indian Nitrogen Group (ING), a voluntary body of scientists established in 2004. This group's work dates back to its first book¹ on agricultural nitrogen use in 2007 and a special issue of *Current Science*² in 2008, as well as a series of 20 sector-specific 'ING bulletins on regional assessment of reactive nitrogen'. However, this book is the most comprehensive assessment of all aspects of reactive nitrogen in India. Unlike the official reporting of nitrogen pollution that is limited to nitrous oxide (N₂O) and NO_x, this book also includes ammonia and other compounds of reactive nitrogen. The information is presented in a reader-friendly manner with 85 tables, 93 figures and flow charts covering the past, present and future outlook in every area. This makes it a comprehensive single source of reference not only for scientists and researchers involved with any area of reactive nitrogen, but also for stu-

dents, environmentalists, journalists, bureaucrats, policy-makers and corporate managers, apart from international and inter-governmental organizations.

All the 31 chapters of the book have been contributed by well known authors with proven expertise in their fields of contribution. These chapters are grouped into six thematic sections dealing with nitrogen in India from a global perspective (A), nitrogen in biosphere (B), nitrogen flows in air, soil and water (C), environmental and climate impacts (D), managing nitrogen in societal effects (E), and finally policies and future challenges (F). Most of the chapters (16) are included under section B, with details of nitrogen in various agricultural sectors, as agriculture is the single largest contributor of reactive nitrogen pollution. The editors seem to have ensured that the authors have clear focus on their topics with minimal overlaps, but some genuine overlaps are unavoidable as all the topics are interrelated.

For the benefit of those who need only an overview rather than in-depth understanding, the first chapter provides a technical summary about the different forms of nitrogen, their effect on the environment and agro-ecosystem. Following this, the chapters in section A deal with the global nitrogen cycle and nitrogen cascade which explore the global nitrogen challenge that the world is facing at present. Here the impact of excessive reactive nitrogen on human health and the environment is presented in tabular form for the year 2011. India's role as a potential global champion for nitrogen assessment and management has been highlighted. Another exclusive chapter highlights the factors considered in the design of an integrated nitrogen assessment. Also there is an overview on the demand–supply scenario of nitrogen fertilizer production and consumption in India. The economic case for fertilizers, societal challenges, and implementation of latest technology in making and using fertilizers are important aspects for nitrogen challenge in the country from the supply side. Fortunately, India has become self-sufficient in urea production, relieving the country and our food security from the import burden. To fulfil the food demand of a fast-growing population, there is an excessive use of fertilizers in Indian agriculture which adversely affects the environment and human health.

Chapters of section B deals with different aspects of nitrogen management, including nitrogen cycle, positive and negative effect of pre-green revolution and post-green revolution technologies with the main focus on Punjab and Haryana, where rice and wheat are intensively cultivated. Overall this section deals with different types of agronomic practices available for enhancing nitrogen use efficiency (NUE) in crops. The suggested focal areas for research include fertilizer product research, water-soluble fertilizers to improve NUE and integrated plant nutrient management apart from fertilizer nitrogen management protocol. Nitrogen management is an interdisciplinary work and scientists belonging to different disciplines, including soil science, agronomy, crop improvement, microbiology and crop physiology should work together for a significant outcome. This section also includes chapters related to the important roles of biological nitrogen fixation, recycling of crop residues, animal manures along with the applied synthetic fertilizers and their effect on the environment. The production of reactive nitrogen by humans is much greater than the production from all natural terrestrial systems.

Section C mainly focuses on the effect of accumulation of reactive nitrogen compounds in soil, air and water, their management, sources and contribution to nitrogen pollution/environmental issues. To overcome these issue, improved nitrogen fertilizer management in different agro-ecosystems will help reduce nitrate load on the environment. One of the most important topic about assessment of nitrogen in Indian mangrove and coastal system has been also explained in this section. All the land-based anthropogenic activities are disturbing coastal nitrogen balance, and causing eutrophication and hypoxia of the coastal waters. These chapters provide an overview of the scale of damage caused to the Indian environment by various sources of reactive nitrogen for the attention of all concerned. To overcome this situation, positive synergies are needed among interdisciplinary sciences, sectoral policy-implementing agencies, firm commitment of policy-makers and public awareness.

Section D emphasizes on the impact of reactive nitrogen on climate change and air quality in India. Increasing population increases food production, agricultural practices, application of fertilizers,

livestock industries, number of vehicles, roads, industries and economic development, and these lead to huge increase in NH_3 and NO_x that adversely affects climate. Emission of NH_3 and NO_x should be measured to monitor their role at national level. The quantification of different sources of nitrogen and their relative contribution towards various sinks have been discussed in detail. This would pave the way for better management of the nitrogen cycle. Although some recent efforts to summarize the available knowledge in this area have been done, there is still a need to add more from the peer-reviewed literature with institutional publications, local reports and other available documents. There is a lack of comprehensive source for reliable data on various aspects of reactive nitrogen at the national level. Books such as the one under review will hopefully catalyse that process. Some rudimentary data are already available from localized surveys and estimates from many regions.

Section E describes the contribution of transport, energy and industry sector to reactive nitrogen emission, and implications of changing diets on reactive nitrogen. Coal and diesel contribute in large measure to nitrogen emission from fossil fuels in India, especially due to their poor quality. There seems to be a growing policy shift towards renewable energy sources, but it will take determined pursuit for over a decade to have an impact on the ground. For now, the overall nitrogen-use efficiency is quite low in India and an average of more than 80% of nitrogen is lost to the environment. Overall, this section underscores the need for a comprehensive assessment of reactive nitrogen emission from both natural and anthropogenic sources to understand the scale of anthropogenic damage for informed decisions and actions on the ground.

Section F consists of a single chapter on the managerial issues and policies for reactive nitrogen management in India. This chapter captures the growth trends of each of the major pollutants of reactive nitrogen such as nitrous oxide, NO_x from various sectors in a business-as-usual scenario, and the extent to which such trends can be moderated or reversed through various policy interventions. Some of these policies such as the mandatory neem-coating of urea and reduction of urea bag size are already under implementation, and have made a major

impact in arresting the growth of urea consumption in the country. Some other such policy options either need adoption or effective implementation to see real results on the ground. Further determined efforts from policy-makers within the country are necessary in order to prevent and mitigate nitrogen losses to the environment.

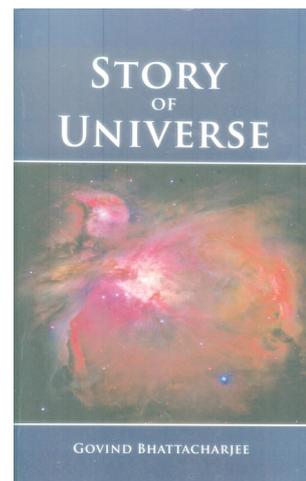
Although the book covers all the sectors, the time period considered is not uniform for all of them. This could be due to the uneven research intensity or publication of primary data in different sectors. Hopefully this book will catalyse researchers to bring out updated information in sectors that need to catch up with frontline sectors such as the fertilizer sector, which has data up to 2016–17. References in all chapters are comprehensive, updated and given with full titles, making it a valuable sourcebook. The thousand entries in the index are excellent. An interesting aspect of the book is that each chapter ends with conclusions, which are helpful in understanding the overview of the topic discussed in them.

Overall, the first ever comprehensive Indian nitrogen assessment is an excellent and pioneering effort. As the publisher indicates on the cover, this is the first edition, and there is ample scope and need for updated revised editions of the book to be published every 3–5 years. This ensures regularly updated information for informed decisions towards sustainable development.

1. Abrol, Y. P., Raghuram, N. and Sachdev, M. S. (eds), *Agricultural Nitrogen Use and its Environmental Implications*, IK International, Delhi, 2007, p. 552.
2. Abrol, Y. P., Raghuram, N. and Hoysall, C., *Curr. Sci.*, 2008, **94**(11), 1343–1344.

SUPRIYA KUMARI*
AAKANSHA MALIK

*School of Biotechnology,
GGs Indraprastha University,
Dwarka,
New Delhi 110 075, India
e-mail: supriyapavas@gmail.com



Story of Universe. Govind Bhattacharjee. Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida 201 309, 2017, xvi + 280 pages. Price: Rs 150.

‘Cosmologists are often in error but never in doubt’

—Lev Landau

In this century cosmology has obtained a lot of very precise data, many of them with special satellites, heralding ‘precision cosmology’. Cosmology, however, still continues to be speculative and controversial. In 1964, the discovery by Penzias and Wilson of the ‘cosmic microwave background radiation’ (CMBR), ushered in the dominance of ‘Big bang cosmology’, based on the work of Gamow and his collaborators, on formation of light elements in the early universe. The starting point of the application of general relativity to cosmology was the assumption of a homogeneous and isotropic universe, often called ‘cosmological principle’. This led to the consideration of the Friedman–Robertson–Walker metric for description of the universe and for studying its expansion as observed by Hubble in 1917. The Hubble constant H relating the velocity of expansion to the distance and acceleration factor q the rate of change of H with time, were then identified as the key parameters to be fixed by observations. It took years to do this even approximately. The main difficulty was the need to know the absolute luminosity of the observed sources. In the 1990s, the supernovae 1a provided sources of known absolute luminosity, and led to the discovery of an accelerating universe and dark energy. The formation of structures