

India's Nitrogen Security: Challenges and Strategic Interventions

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Nitrogen (N) is the most critical major nutrient due to fundamental component of chlorophyll, amino acids, proteins, and nucleic acids (DNA and RNA). N is present abundantly in nature. However, being an inert element, its uptake by crop requires it to be present primarily in inorganic ionic form in the soil. The percentage of N absorption through natural process is very small. Therefore, industrial fixation of N plays the catalytic role in supplying N to improve farm productivity and cater to the foodgrain requirement of population of over 1.4 billion. N production in India started with a modest growth of 28.9 thousand metric tonnes in 1951-52 and reached 16.6 million metric tonnes (million MT) in 2025-26. The various products supplying N include ammonium sulphate, ammonium chloride, urea and various grades of NP/NPK complex fertilisers. Urea emerged as the dominant product due to its high N density, better agronomic efficiency and affordability. Share of urea to the N supply has been around 82% past several years.

During 2025-26, India produced 52 million MT and consumed 72.6 million MT of fertiliser products. Of this, production and consumption of urea was 29.3 million MT and 39.6 million MT, respectively *i.e.* around 55% of total fertiliser production and consumption. Feedstock for production of urea are ammonia and carbon dioxide (CO₂). Fossil fuels are used for production of ammonia. During the production of ammonia, CO₂ generated *in-situ* is captured and combined with ammonia to form urea. With the development of technology, the natural gas emerged as the most energy efficient and cleaner feedstock and energy source for production of ammonia. As a result of policy pushed toward efficient production process and limit subsidy budget, all urea plants based on naphtha and fuel oil were

converted to natural gas. The requirement of natural gas is met by both domestic natural gas and imported Re-gasified Liquefied Natural Gas (RLNG). Due to addition of new capacities based on natural gas and further changeover of feedstock, there has been considerable increase in requirement of natural gas. The domestic natural gas demand from city gas distribution, power, refineries, steel and other sectors have also increased over the years. This led to reduction in share of domestic natural gas supply to the urea plants. There has been some discovery of domestic gas from high pressure and higher temperature gas fields in Andhra Pradesh. However, about 77% of urea production is still dependent on imported RLNG. Recent geopolitical developments, including the Russia-Ukraine conflict and the continuing instability in West Asia have disrupted global supply chains, increased freight and insurance costs, and led to sharp increases in energy prices, thus highlighting the urgent need for a comprehensive fertiliser security strategy.

Recognising these vulnerabilities, the Government of India has launched several initiatives aimed at diversification and self-reliance. The revival of closed urea units and commissioning of new plants have significantly strengthened domestic N fertiliser production. Simultaneously, efforts are being made to secure long-term LNG supplies and to diversify procurement sources across multiple geographies.

Under National Green Hydrogen Mission, fertiliser sector is one of the leading sectors to utilize the green ammonia to substitute the import of grey ammonia. India imports about 2.5 million tonnes of grey ammonia for production of complex fertilisers. Fertiliser is a controlled sector, and MRP is regulated by the Government. To bridge the gap between green ammonia and grey ammonia, the Ministry of New and Renewable Energy and Department of Fertilizers have been providing financial support. The Solar Energy Corporation of India (SECI) is acting as an intermediary for aggregating the green ammonia demand and its supply to the fertiliser sector. The first tranche of green ammonia discovered a competitive price of weighted average ammonia price of about Rs. 54 per kg. The green ammonia purchase and supply agreements for offtake of 6,70,000 metric tonnes

Nitrogen is an important nutrient for crop production. Government of India has launched several initiatives aimed at diversification and self-reliance towards nitrogen security

of green ammonia has been executed for a period of 10 years. Procurement of 54,000 metric tonnes of green ammonia has been retendered.

Renewable hydrogen can be explored to gradually replace fossil fuel-derived hydrogen in ammonia production, reducing both carbon emissions and import dependence. Use of green hydrogen and green ammonia have both technical and viability challenges incorporating in the existing set-up. Production and use of green ammonia for urea production requires alternative source of CO₂. There are technical issues in use of green hydrogen as feedstock or fuel in the existing ammonia-urea process, equipment, boilers, gas turbines, which will require a careful technical evaluation. New projects initiated can take care of technical issues at the design stage. Further, India relies heavily on imports for critical renewable energy components like solar photovoltaic (PV) modules and electrolyzers. The economics and feasibility of operation of green ammonia and urea projects will vary from location-to-location. Production of green ammonia and capture of CO₂ near a consumption site will have better technical and logistic synergies. Industry is also exploring such possibilities and a pilot project of 150 TPD has been initiated for production of green urea. The commercial viability of these projects will depend on the price discovery of green urea and fertiliser policy for green urea of the government.

For promotion of direct application, green ammonia has been included as a provisional fertiliser product under Fertiliser (Control) Order for a period of three years. However, there are challenges in terms of storage, handling and use of ammonia. Ammonia is a gas and also toxic. The safe limit for exposure of ammonia prescribed under Factories Act is 25 ppm for 8 hours and 35 ppm for 15 minutes. Safety of ammonia during application has to be thoughtfully considered, otherwise farmers will be exposed to it.

An important component of the strategy is coal gasification, which uses India's abundant coal reserves estimated to be 400 billion tonnes to produce synthesis gas that can subsequently be

converted into ammonia, urea and other chemical products. India's National Coal Gasification Mission targets the gasification of 100 million tonnes (MT) of coal by 2030 to reduce high-value import dependencies and promote cleaner use of domestic reserve with an outlay of Rs. 37,500 crore. A 12.7 lakh MT per annum of urea plant is under commissioning at Talcher, Odisha.

The government has also announced National Investment Policy for Urea 2026 for targeted production of 10 million MT of urea using natural gas, which will create additional demand of 7-8 BCM of natural gas. Under this policy, active participation is seen from fertiliser industry and also leading gas suppliers. These projects are subject to evaluation and approval by a project approval committee. Setting up of such projects will also require securing the gas supplies for the long-term. The existing plant's long-term contracts are expected to be expired by end-2027/early-2028. Sustainable production of urea from natural gas will require a risk mitigating strategy on mechanism for alternate sourcing and supply continuity.

Urea contribution is most critical for N security. But due to its widespread application and affordability, it is also facing challenges of overuse and resulting in low nutrient use efficiency. This is affecting both soil and environment. For enhancing the nutrient use efficiency of urea, the Government of India has initiated coating all agricultural grade urea with *neem* oil in 2015. Further, initiatives are going on to promote nano-urea and development of sulphur coated urea. These efforts will help to improve use efficiency of N and optimise the requirement of urea in the long run.

Thus, a comprehensive roadmap for N security must combine short-term, medium-term and long-term interventions for availability and its judicious use. In the short-term, N application through other straight nitrogenous and complex fertilisers needs to be encouraged. India should establish strategic reserves of natural gas, diversify gas supplies and secure long-term supply contracts and strengthen monitoring of geopolitical risks. In the medium-term, investments should focus on coal gasification, improving reliability and efficiency of existing urea plants. In the long-term, development of a resilient green fertiliser ecosystem based on renewable hydrogen, green ammonia and advanced nutrient technologies will help in achieving sustainability in agriculture sector. ■