Innovations in Fertilizer and Agriculture Sectors

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Indian fertilizer industry has come a long way from single nutrient products to multi-nutrient products. The initial developments of products mainly included ammonium sulphate, urea, single super phosphate and Di-ammonium phosphate. Then to cater to crop requirements, other grades of NP/NPK products were developed including fortification with secondary and micronutrients followed by customized fertilizers. The use of large scale fertilizers to support high yielding varieties of crops led to Green Revolution. This helped India to become self-reliant in food grain production. India has now accomplished the second position in production of nitrogenous and phosphatic fertilizers in the world. However, due to large requirement of nutrients, we are also the second largest consumer of fertilizers. India does not have many natural resources like natural gas, rock phosphate and potash required for production of fertilizers. We are dependent on import of raw materials as well as finished products. Therefore, R&D efforts are required to develop indigenous products to supply vital nutrients. More exploration efforts are needed for identifying mineral resources.

India is positioned as an Agrarian economy. Agriculture and allied activities significantly contributed to the country's overall growth and development by ensuring food security to the country. Indian agriculture sector has been growing at an average annual growth rate of 4.6 per cent during the last six years. As per the Indian economic survey 2022-23, 47% of the population is dependent on agriculture for livelihood. During 2022-23, agriculture and allied sector contributed 18.4% to the country's GDP. The average yield of food grain production increased from 2078 kg ha^{-1} in 2011-12 to 2494 kg ha^{-1} in 2022-23. However, application of fertilizer nutrient reduced from 142.12 kg ha^{-1} to 138.10 kg ha^{-1} during the same period. The NPK use ratio which was corrected a bit during 2010 after introduction of Nutrient Based Subsidy (NBS) has again distorted and skewed towards nitrogen. The NPK use ratio has distorted from 4.7:2.3:1 during 2010-11 to 11.8:4.6:1 during 2022-23. The share of urea in nitrogen is 81 per cent although nutrient use efficiency of nitrogen through urea has been reported to be about 35% in waterlogged rice and nearly 50% in upland crops. The primary reason for high consumption of urea is the cheapest nitrogen available through it. The price ratio of Urea: DAP is about 1:5 which incentivise the farmers to use more urea at the cost of DAP and also other NP/NPK fertilizers. Therefore, there is a need to revisit the policy to correct the NPK use ratio.

Fertilizer has played and will continue to play a vital role in enhancing agricultural production in the country. Balanced fertilization that leads to balanced crop nutrition is linked to concepts of fertilizer use efficiency and efficient nutrient management. The need is to use fertilizers on soil test based fertilizer recommendations along with organic sources and bio-fertilizers. The practice will enable to increase nutrient use efficiency, reduce losses to the environment, boost farm productivity, farmers' income and sustain soil health. It also helps in improving physical and biological properties of soils which should be promoted for sustainable agriculture.

There have been efforts to improve the nutrient use efficiency of fertilizers, more importantly the nitrogen. Introduction of 100% *neem* coated of urea has some effect in improving use efficiency. Introduction of nano-fertilizers products would further help to reduce use of high analysis conventional fertilizers. Use of alternate fertilizers like bio-fertilizers, organic fertilizers, bio-mass, etc. will help to improve the soil condition and supplement the use of conventional fertilizers. Government has now taken steps to promote sulphur coated urea. The use efficiency of nitrogen through sulphur coated urea is higher than that of conventional urea. Besides, it will also provide sulphur which is considered as a secondary nutrient and about 41% of the Indian soils are deficient in it.

Last mile delivery of fertilizers at affordable prices have been focus of the government. One of the key objectives of One Nation One Fertilizers is to avoid criss-cross movement of larger segment of N and P

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and save associated costs. Agriculture is a labour intensive process. Use of innovative products like water soluble fertilizers and nano –fertilizers through manual application would not be cost effective. Therefore, farm mechanisation and use of technology such as drone will play vital role in making farming easy and cost efficient.

Indian fertilizer plants are operating at very high efficiency level despite being very old. There have been continuous investments in these plants to improve reliability. Plants have carried out various in-house measures to improve the reliability and safety of the plants. As a result of the efforts, the energy consumption of all urea plants have reduced from 8.87 Gcal per MT in 1987-88 to 5.71 Gcal per MT urea in 2022-23. Energy consumption from ammonia plants was reduced from 12.48 Gcal per MT in 1987-88 to 8.08 Gcal per MT ammonia during the same period. There is an equivalent carbon dioxide reduction from 3.61 tonnes CO_2 tonne^{-1} ammonia to 1.96 tonne CO_2 tonne^{-1} ammonia which is about 46% over a period of 36 years.

Government of India has promulgated Green Hydrogen Mission wherein they envisage use of green hydrogen and green ammonia. Fertilizer industry will be the potential user of green ammonia. In order to create bulk demand and scale up production of green hydrogen, the Government of India will specify a minimum share of consumption of green hydrogen or its derivative products such as green ammonia, green methanol, etc. The mission document also mentioned that by 2034-35, it is targeted to substitute all ammonia based fertilizer imports with domestic Green Ammonia based fertilizers. There may not be infrastructure or technical barrier in replacement of grey with green ammonia in complex fertilizer plants. The green hydrogen and green ammonia projects are highly capital intensive and there is substantial gap between cost of green and grey ammonia. There is a need to provide the viability gap and incentive for use of green ammonia.

In case of P&K sector, country is dependent on imported raw materials and finished products. Prospecting in indigenous sources of rock phosphate has not yielded substantial result. Most of the reserves are low grade rock which require beneficiation for utilisation in phosphatic industry. Rajasthan contributed about 93% and Madhya Pradesh 7% to the total rock phosphate production. Some other States with rock phosphates reserves are Jharkhand, Uttar Pradesh and Uttarakhand. Such reserves need to be developed. There are chemical based technologies available which beneficiate low grade rock phosphate. These innovative technologies may be explored for higher production. Of late, the government of India is promoting the use of indigenously produced SSP fertilizers. These beneficiated rock phosphates can be used entirely by the SSP industry. Potash is another important mineral for which country is almost entirely dependent on import. There has been R&D efforts to recover potash from the sea bittern and molasses. Potash Derived from Molasses has also be brought under NBS scheme. Some PDM is now available from sugar industry. Though, all these may not be able to substitute the entire import quantity but can be a step towards self-reliance in this important mineral.

It has now been more than 100 years of application of fertilizers in the country. It is because of fertilizers that we are able to sustain the world's largest population. Affordability of fertilizers and extensive use have raised a few issues related to nutrient use efficiency, crop response, balance fertilization, soil health and impact on environment. There is a need for development of ecosystem which encourages research and development and commercialization of results of R&D. Government of India has already taken several initiatives to encourage production and use of alternative fertilizers which needs to be commended. The policy reforms in the fertilizer sector can accelerate the innovations which can change paradigm in terms of new products, higher use efficiency, better crop yields and farmers' income.

This year, FAI Annual Seminar is devoted to the theme **Innovations in Fertilizer and Agriculture Sectors** and there will be presentations related to Fertilizer Use – Myth and Reality (Interaction with the Farmers and Media); Policy Interventions in Fertilizer Sector; Innovations for Sustainable Agriculture; Transforming Fertilizer Production; and Fertilizer Marketing Innovations. It is hoped that the useful recommendations will emerge from the deliberations of the seminar which would be of immense help to the policy makers and all those concerned with farm and fertilizer sectors. The recommendations will be published in January 2024 issue of this Journal. ■