Nano

Dr. Ankita Bedi, *Research Associate, TERI,* **Dr. Braj Raj Singh,** *Fellow, TERI,* **Dr. Alok Adholeya,** *Director, TERI Deakin Nanobiotechnology Centre*

According to the United Nations, the population of world is expected to reach 8 billion by 2023. India accounts for 17.84% of the world's total population and by 2025 its population is likely to exceed 1.5 billion. This will naturally raise the demand for food grain. According to ICAR vision document, this demand is expected to increase up to 345 million tonnes by 2030, further indicating an increase at the rate of 5.5 million tonnes per annum in next 20 years. This could also lead to an increase in fertiliser consumption due to need for soil enhancement.

The current fertiliser consumption of Nitrogen, Phosphorous and Potassium has been registered at 27.2 million tonnes (2018-19). However, the removal of nutrients from soil is far higher than the nutrient additions, thereby creating a net negative balance of about 10 million tonnes from soil every year. Their production and use of fertilisers are extremely energy-intensive and a significant source of greenhouse gases and carbon emissions, and when nutrients especially the nitrogen and phosphorus aren't fully utilised by plants, they can leach into groundwater and runoff into waterways.

Therefore the unutilised nutrients can also cause eutrophication of algal blooms in the water bodies and deprive the oxygen in the water ecosystem, in turn causing the loss of wildlife and producing toxins that can be harmful for living systems. Therefore, it is important to develop innovative and sustainable fertiliser solutions to meet the soaring demand with fewer resources and less damage to the environment and climate. Several attempts have been made to increase the use efficiency (UE) of fertilisers through development of complex and water soluble fertilisers, but there has been little success. Here, nanobiofertilisers offer a viable solution. These fertilisers are biologically synthesized from natural mineral resources and in some cases, even chemical waste, using indigenous microbial resources. As they are not made from any chemicals, the dangers of toxic effects of fertiliser runoffs are non-existent. Further, they are required to be applied in small amounts of grams per acre as opposed to the many kilograms of chemical fertilisers that are neededi n fields. For example, owing to its antimicrobial and catalytic property, nano-zinc fertiliser will have triple mode of action i.e. provide sufficient amount of zinc nutrient to crop, protection from mineralization by microbes, and photocatalytic transformation of complex forms of other nutrients like iron, copper, nitrogen etc. into crop uptake and assimilation form. Furthermore, mesoporous nanocarrier can be used for delivery of nanofertilisers, and may be absorbed by plant system, which can enhance resistance to biotic and abiotic stress conditions thereby leading to improved crop yields.

In addition, nanofertilisers could be more useful for sustainable agriculture in a number of ways such as high nutrient use efficiency and lower application dose. Nanofertilisers also show enhanced stability in biotic and abiotic conditions. Apart from imparting high yieldand nutritional quality of produce, they are eco-friendly in nature and less toxic to soil health and environment. Undoubtedly, nanofertilisers will have a reflective impact on climate resilient sustainable agriculture by mproving soil health and environment. New avenues for plugging nanotechnology

Fertilisers

interventions into nanofertilisers should be explored with the knowledge of any potential hazards to soil health, environment and human health. The Indian government is committed to enhance agricultural production in the country through a nanotechnology-driven approach. Thus, several missions and programmes have been launched in past years, such as DST-Nanomission, DBT Nanobiotechnology task force, ICAR nanotechnology platform etc. to integrate nanotechnologies into agriculture.

The TERI-Deakin Nanobiotechnology Centre (TDNBC) is devoted to developing innovative nanonutrients products to address current challenges in the field of agriculture and the environment. During the past few years, TDNBC has acquired expertise in the biological production technology of nano zinc-iron, phosphorous, sulphur. The high use efficiency nature of nanofertiliser variants have been tested and validated through the field trials. The nanofertiliser products developed are under commercialisation and key features are listed below:

- Nanometer particle size range
- No occupational hazard
- Higher use efficiency (85 to 95%)
- Significant reduction of volume and weight actives
- Transportation and application ease
- Least energy for manufacturing

The social awareness of nanofertilisers is limited because its commercial-scale production and field application is yet to be achieved. Also, the revolution of fertiliser sector through stakeholder engagement, policy guidelines development, and public-private partnerships and linkages will be needed to utilise the full potential of nanofertilisers. The field applicaion of nanofertilisers could help reducenutrient losses and the pressure on resources and ecosystems. Besides that, we would be able to produce micronutrients-fortified produce for human health. Therefore, there is an urgent need for capitalisation of nanotechnology-based fertiliser products for the farmer's socio-economic prosperity by reducing the use of bulk chemical fertilisers by 20% by the year 2024.