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AGRI JOURNAL WORLD
VOLUME 3 ISSUE 3 MARCH, 2023

NANO UREA- A PIONEER INPUT FOR SUSTAINABLE AGRICULTURE

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ABSTRACT

Synthetic fertilizers boost crop output, but they can alter the mineral composition of the soil and reduce soil quality. As a potential substitute, the development of nano-scale fertilizer ensures higher agricultural productivity, profitability, and soil restorative capability without disturbing the environment. The demand for Nano-urea is considerably lower than that for prilled urea fertilizers to meet the plant's need for nitrogen since its absorption efficiency is usually approximately 80% versus the prilled version of urea.

INTRODUCTION

After the advent of high-yielding and fertilizer-responsive cultivars, fertilizers became progressively important in boosting agricultural production in developing nations. Despite this, it is generally known that inadequate fertilization and a drop in the amount of organic matter in the soil have contributed to a decline in crop yields for numerous crops. Since most Indian soils are low in nitrogen, the crop needs a lot of fertilizer, particularly nitrogen, which is crucial to many physiological processes in plants. More than 82 per cent of the nitrogenous fertilizers used for most crops are primarily urea. About 33 million tonnes of urea are applied to different crops annually. India bought more than 11 million metric tonnes of urea in the financial year 2021, continuing an upward trend in urea imports (Anonymous, 2020–21). Concerning rice's growth characteristics, nitrogen fertilizer has a beneficial impact on yield and yield-contributing components through the photosynthetic process, flowering, fruiting, and maturity phase (Nath *et al.*, 2018). The ministry of chemicals and fertilizers informed a standing Committee of Parliament that in 2025, eight plants are planned to generate 44 crore bottles of Nano- urea, replacing 44 crore bags, or roughly 200 lakh tonnes (1 bag is 45 kg urea) of urea, which is 55 to 60% of India's requirement of 300 to 350 lakh tonnes. However, low N levels may prevent realising the highest yield potential.

Worldwide, excessive and inappropriate nitrogen fertilizer use severely impacts soil and water quality (Bashir et al., 2020) and human and environmental health (Rathnayaka *et al.*, 2018). Consequently, lodging is created, which results in a surge in insect pest attacks, leading to inferior quality produce. According to the researcher, between 40 and 70 per cent of the nitrogen from applied fertilizers is lost to the environment and cannot be used by crops, resulting in losses that are significant in terms of economic and ecological impacts, as well as significant environmental degradation (Guo *et al*., 2005). These fundamental issues can be resolved by corresponding fertilizer availability and crop demand, which has the potential to lower nutrient losses while raising nutrient efficiency. The Nano-fertilizer would be the ultimate choice in the current situation.

Nano-fertilisers are one of the most promising customized substances being explored for soil or foliar applications. Under Atmanirbhar Bharat and Atmanirbhar Krishi, Ramesh Raliya, an Indian researcher, produced the first Nano- urea for farmers worldwide using a unique, trademarked methodology that relies on imports to feed its urea demands. The term "Nano- fertilizer" refers to compounds with Nano-particles enclosed in them that gently release nutrients to plants and are generally manufactured by using physio-chemical, biological techniques of Nano-technology, including several extracts of a plant part or microbial origin.

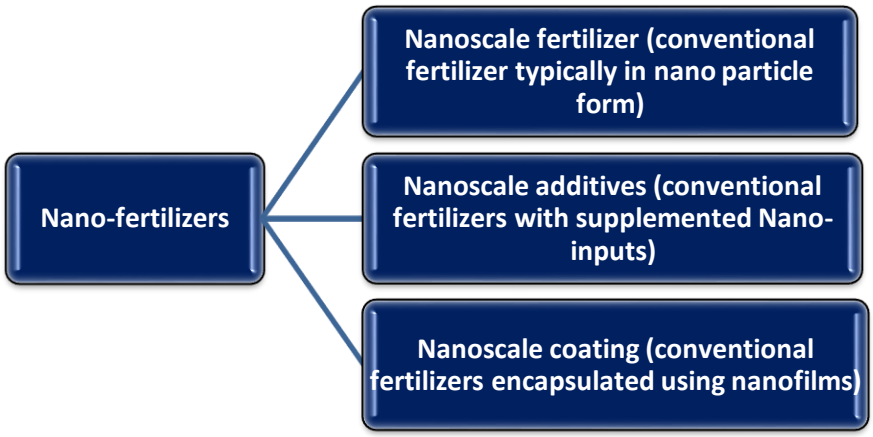
NANO-FERTILIZER- AN ESSENTIAL INPUT FOR AGRICULTURE

Due to various issues confronting agricultural scientists in the agriculture sector, the production system is facing notably decreased crop yields, falling soil organic material richness, increased levels of multi-nutrient shortages in the soil system, unfavourable climatic effects, arable land and water resources, etc. Moreover, farmers frequently use fertilizers several times to attain targeted yields. The excessive use of chemicals reduces soil fertility and raises salt concentrations, leading to crop injury. However, improper fertilizer application without control over nutrient release patterns degrades the overall product's quality. Therefore, manufacturing fertilizers with a gradual or controlled release is essential for increasing crop yield, productivity, and quality. They have great availability and absorbency because of their increased surface area per unit volume size ratio and Nano-scale dimension. Nano-fertilizers have particles less than 1-100 nm in at least one dimension, making them easier to absorb from the soil or leaves and increasing the amount of photosynthates and biomass needed for healthy crops. Both crop yields and nutrient utilization efficiency improved when traditional urea and nitrogen were applied in the foliar form at important crop growth phases (Kumar *et al*., 2020). Compared to conventional fertilizers, Nano-fertilizers have advantages in terms of treatment, low demand, a slowly released strategy, a decrease in transportation and deployment cost and lesser salt concentration in soil.

Based on the nutrient needs of plants, three aspects of Nano- fertilizer are defined below:

Macronutrient nano fertilizers	Micronutrient nano fertilizers	Nanoparticulate fertilizer
• Elevated concentrations of nutrients needed for traditional agricultural activities, are includes • Eg. N, P, K, Ca, S	• About <100 ppm of trace elements are required for metabolic activities of plant. • Eg. Fe, cu, zn	• It exhibited the capability to improve plant growth and deveopment. • Eg. Silicon dioxide, and carbon nanotubes

According to the types of formulations, Nano-fertilizers have been proposed:



WHY DOES NANO-UREA (liquid form) MUCH PREFERABLE OVER CONVENTIONAL UREA?

- *Better Efficiency:* Liquid Nano-urea can have an efficiency of up to 85% over traditional urea (approximately about 25%). Nano-structured fertilizers can be employed as an innovative strategy for supplying nutrients to plants because of their distinguishing qualities. The distinctive characteristics of nanoparticles, such as their high absorption, accessibility, prompt supply of nutrients, enhanced surface-to-volume ratio, and controlled-release dynamics to particular areas, make them a promising plant growth enhancer. In addition, nano-urea does not lose through gases form over prills form of urea.
- *Targeted supplying of nutrients to crops:* The plant absorbs liquid Nano scale urea sprinkled precisely on its foliage, leading to a targeted supply of nutrients to crops because it is absorbed through stomata and pores on the leaf's epidermis.

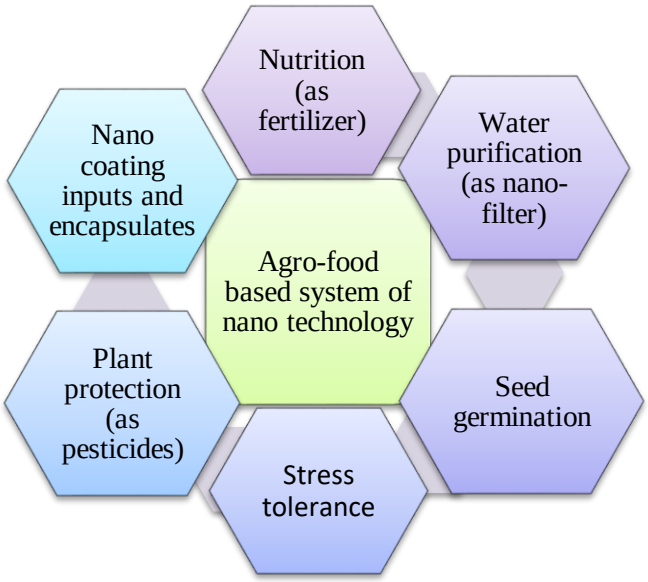


Fig 1- A**applications of nanotechnology increasing crop output** in **agro-food systems**

- *Fiscally feasible:* At least each sack of urea could be effectively replaced by a bottle of nano-scale urea. Currently, there is no subsidy on the half-litre bottle of liquid Nano-urea, which costs ₹240/-, over a sac of prilled urea, which costs approx. ₹242/- for 45 kilograms at a highly discounted rate, including a government subsidy. Compared to farmers' conventional methods, using Nano-urea boosted annualized returns by approximately 7% overall. In addition, the yields increased by 11% when evaluated in fields using organic agricultural methods (no chemical fertilizers other than Nano-urea).

APPLICATION TACTICS, TIME AND DOSES OF NANO INPUT MATERIAL

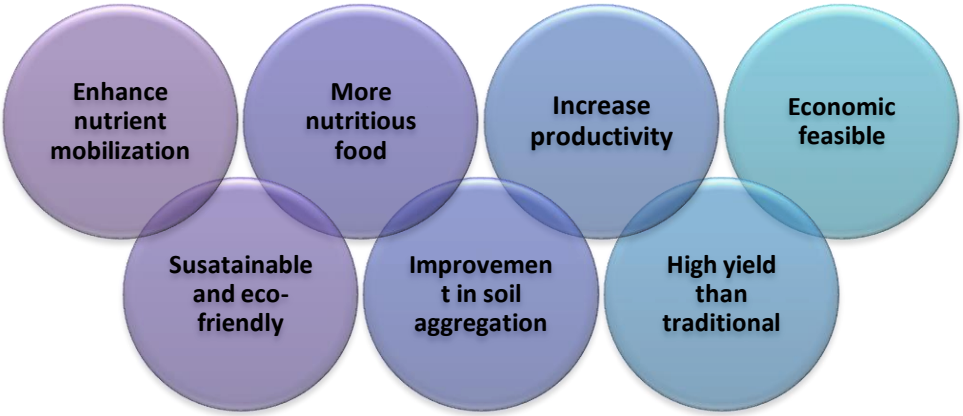
The first spray should be applied at the active tillering or branching stage (30-35 days after germination or 20- 25 days after transplanting), while the second application is applied 20-25 days later or before the crop is at the flowering stage. Nano-urea @ 2 ml to 4 ml mixed well in 1 litre of water sprinkled on plant foliage when the plant attains its critical stages led to efficiently fulfilling nitrogen requirements. Two foliar sprays should be applied to get the best response, and further, the number of sprays can be increased based on crop needs and demand.

HOW DOES NANO-UREA FUNCTION?

Stomata and other pores effectively absorb Nano-urea sprinkled on the leaf. From the source to the sink inside the plant, it is simply transferred by phloem as per the requirements. For proper plant growth and development, unused nitrogen is retained inside the plant vacuole and released over time. The nitrogen in Nano-urea undergoes hydrolysis within the plant system, converting to ammonical and nitrate forms. According to research, plants treated with Nano-fertilizer accumulated more nitrogen and improved soil

pH, soil moisture, CEC, and nitrogen availability over the prilled form of fertilizer. Even though the pattern of nutrients released by N appeared superior for Nano-fertilizer over traditional fertilizer

ADVANTAGES OF NANO-UREA



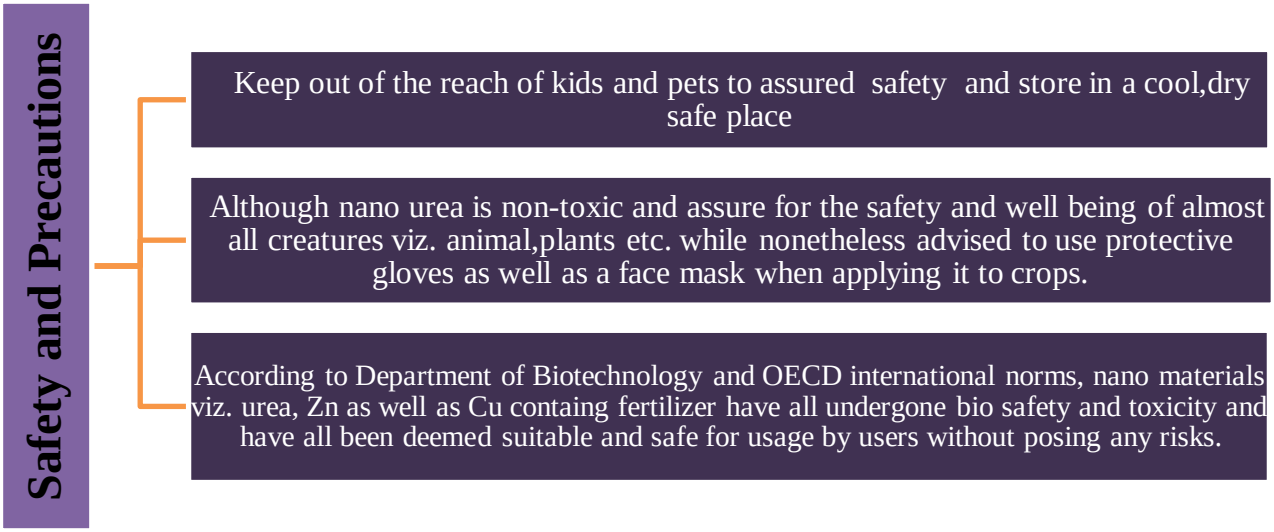
1) Minimize the necessity for prilled urea by at least 50%. A single bottle of Nano-urea (500 ml) has the same value as one urea bag in terms of nutrient status.
2) Urea is less expensive than conventional urea, so farmers' input costs are reduced, increasing their revenue.
3) It contributes to tackling climate change, and ecological development improves yield, soil quality, and the nutritional value of products.
4) Compared to a bag of subsidized urea fertilizer, one bottle of Nano- urea's weight contains the same amount of value (45 kg) and is offered to the farmers for 10% less in terms of monetary value.
5) The cost of warehousing and logistics would drop dramatically due to easier and more affordable transportation. As a result, it may reduce urea fertilizer imports.
6) As of 2019, across India, over 1,000 farmer field experiments have been conducted on more than 94 crops across 21 states to assess their effectiveness. The analysis revealed an average of about 8% enhancement in crop yield and higher efficiency approx. 80% rarely means wastes and extremely effective to utilize prilled form urea about 30-40%, which saves farmer's money approximately between ₹5,000/- and ₹10,000/- per hectare.

APPLICATION GUIDELINES

1. Shake well urea bottles thoroughly before use.

2. To sprinkle these Nano-molecules on the foliage, use a flat fan nozzle for spray in the early daytime or evening to escape dew.
3. It is suggested to reapply the Nano-urea spray if rain falls within 12 hours after the initial application.
4. Nano-urea must be applied within two years of its manufacturing date to achieve better results.

SAFETY AND PRECAUTIONS



FUTURE OUTLOOK

1. To accelerate towards sustainable agriculture, forthcoming research must concentrate on producing various understanding concepts in respective unexplored areas.
2. Studying and examining on a wider basis led to ensuring biosafety and toxicity must be prioritized and focused on the suitability of fertilizer for particular crops as well as soil types.
3. Precise studies and research must be prioritized concerning the residual effect of Nanoparticles in edible portions of the plant, which are critically essential for consumption.

CONCLUSION

The effect of foliar feeding of Nano- urea during the crucial vegetative phase of a plant efficaciously satisfies its nitrogen demand. It has been shown to boost seed germination, biomass production, plant height, many root systems, quality of soil, rate of return, and antioxidant composition in fruit, leading to enhanced crop yields over ordinary urea. Using nano-materials to consolidate biological control formulations is anticipated to have the biggest impact and will considerably minimize environmental risks. At the prescribed application amounts, Nano- urea seems to be fully safe for people, livestock, and rhizosphere microorganisms. To fully benefit from Nano- fertilizer and Nano- urea enable

sustainable agro–based practices in the scenario of climate change and the danger of causing environmental issues. Researchers and policymakers must accept responsibility by sharing more awareness and facts about the pros and cons of Nano- urea and Nano- fertilizers.

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