



## Current Agriculture Scenario: Nano Technology

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### Abstract

In the modern era every sector is gradually rising with the advancement of new technology. As the time changes researchers perform different methodologies to tackle the upcoming troubles in the world. Agriculture is one of the vastest sectors which faces numerous problems every day. Major issue is to fulfill the supply and demand of food because both fluctuate with non availability of sources. It is necessary to use the handy sources efficiently. Recently scientists have evolved a new technology which is nanotechnology. With the help of nanotechnology agriculture researchers develop nanofertilizers. Nanofertilizers are the nano products which completes the requirement to get more yields per unit area with efficient use of the resources. Moreover these technologies provide significant results and work as a sustainable agriculture tool to the farmers.

**Keywords:** IFFCO, Nano Urea, Nano DAP, Surface area, Affordable.

### Introduction

Nanotechnology phrase adopted from the Greek language, word “Nano” refers to a billionth and the word “technology” refers to skill, however it refers to the branch of science and engineering of designing and producing the atoms and molecules at nanoscale using different devices and systems. In addition, milli ( $10^{-3}$ ), micro ( $10^{-6}$ ) and nano means ( $10^{-9}$ ). Term “Nano technology” very first time was used by Professor Norio Taniguchi at Tokyo Science University and described in words as “*Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule.*” (Gupta S K, 2020).

The concept was introduced by famous American physician Sir Richard Feynman (Nobel Prize winner) presented a paper “There is Plenty of Room at the Bottom” during the annual meet of California institute of technology. He is also known as the “Father of Nano technology” (Singh, 2020). From 1958, a point of starting nanotechnology to nowadays - A modern world of nano technology developed at high scale, it becomes so popular in the various fields. This technology is used in formation of products in the large number of industries such as pharmaceutical industries (medicinal drugs), fertilizer industries, pesticides (agriculture), molecular imaging, biomarkers, biosensors, electronic gadgets, cosmetics material, sunscreens, polymers, paints and varnishes etc. Nano molecules size is manipulated at (1-100 nm) nano scale. Molecules and atoms are three dimensional, this property makes the atoms to more precisely site specified through practical application.

### Role of Nano Technology in Agriculture

Agriculture is the backbone of most developing countries, with more than 60% of the population reliant on it for their livelihood. In Indian agriculture growth rate is 3.59 % which is below than the targeted 4 % annual growth in agriculture sector by 2020 (Ministry of

Finance, Govt. of India). Since the green revolution came into existence, role of the chemical fertilizers are fastly increased in agriculture crops. As the chemical advancement rising, it causes some environment and human health consequences. Large amount loss of fertilizers due to leaching and gaseous emissions leads to climate change. Only 30 % nutrients from the applied fertilizers are taken by plants, remaining 70 % leached out in different forms (Kumar et al. 2021). It is necessary to change the conventional nutrient sources to a new method. Results in nano technology concept used in agriculture and food products. Utilizing the nanomaterials i.e. “*Nanofertilizers*”, it will enhance the fertilizer use efficiency, per unit area yield and complete the present scenario in agriculture.

### Nano Fertilizers

It may be defined as “*Nano-fertilizers are the nanotechnology based chemical fertilizers which are available in market in the form of liquid (mostly) nano sized particles with efficient use of per molecule of fertilizer available.*” These nano fertilizers are formed from bulky conventional fertilizers. Nano-fertilizers are extremely soluble, available in precise concentration and slow release of nutrients. Major property of its large surface area provides efficient use of every drop present as solublized form. Briefly explained as very tiny sized particles with a range between 1nm to 100 nm. These are much safer than the conventional inorganic fertilizers in way of soil and environmental degradation.

### Evolution of Nano Fertilizers

In the late 20<sup>th</sup> century, nanotechnology starts emerging attention in agriculture and food products. In the beginning of 2000s, researchers began focus in nano particles in soil and their interaction with plants. Numerous of studies demonstrated the nutrient uptake in nano size particles enhance crop productivity. Nano materials such as metal nano particles, metal oxide nano particles, carbon based nano particles or polymers discovered as carriers for nutrient delivery.

New researches started to determine the nutrient composition of crops, their specific targeted site and check controlled release of nutrients according to various crops need. By the 2010, researchers investigated and developed nano fertilizers which accelerated the concept of sustainable agriculture, now there is a requirement to improve nutrient management system. In the late 2010, various agriculture companies start commercialization of their nano fertilizers and make it available for agriculture use. Large number of field trials conducted to check their efficiency in farmer field and results in crop yield improvement, nutrient use efficiency, environmental impacts and their effects on soil health as well as ecosystem.

### Salient Features of Nano Fertilizers

1. **High surface area:** One of the most important feature of nano fertilizers are having surface to volume ratio is very high. Each big atom is broken into very small parts which easily covers entire leaf surface area.
2. **Eco-Friendly:** Nano fertilizers are environment friendly because it decline the gaseous content release by conventional fertilizers. Reduction of carbon footprints upto 50 %.
3. **Reduce Nutrient Loss:** These fertilizers avoid premature contact with soil and water owing to thin coating encapsulation of nanoparticles such as leading to negligible loss of nutrients. Moreover, these are readily available as it applied absorbed by plants.
4. **Cost effective:** Nano fertilizers are cheaper than the conventional fertilizers available in market. For eg. Price of a DAP bag is Rs. 1300-1400 (approx.), on the other hand one bottle of DAP costs Rs. 600 in market. Results in decrease farmer input costs.
5. **Portable:** Nano fertilizers are available in packing of bottle form. These are easy to carry in single hand and transport it anywhere due to its light weight i.e. 500 ml or 1000 ml

packing. In contrast, conventional fertilizer bags are of 45 Kg which is not transportable easily. Farmer needs to pay extra charges for its transportation.

- Shelf life:** Nano Fertilizers have 2 years of shelf life. Once it is opened, used up to 24 months, on the flip side conventional opened bags reacts with air particles and destroyed in a month. As a result, nano fertilizers are easy to store at room temperature.

### Crop Application and Action of Nano Fertilizers

- ❖ Foliar application is a best method of application among the root or seed treatments and sprayed on plant at active stages.
- ❖ One of the most efficient and effective way of providing nutrients, disease and pest protection to plants by directly spraying the required liquid chemicals, fertilizers, pesticides etc. on foliage of plants.
- ❖ Plants absorb liquids usually through stomata, cracks, water pores, ion channels, protein carriers, stigma, wound, stomata permeation and epidermal adsorption are the main ways in which foliage absorbs (Hong *et al.* 2020).



### Types of Nano Fertilizers

Nanofertilizers can be classified based on the material used. Some nano fertilizers are made with carbon nanotubes, while some with polymers or metals. Each type of nanofertilizers has different properties and can have different effects on plants (Yadav *et al.* 2023). Understanding the nature of nanofertilizers is essential to find the best application method. Nanofertilizers having major three types given in table 1.

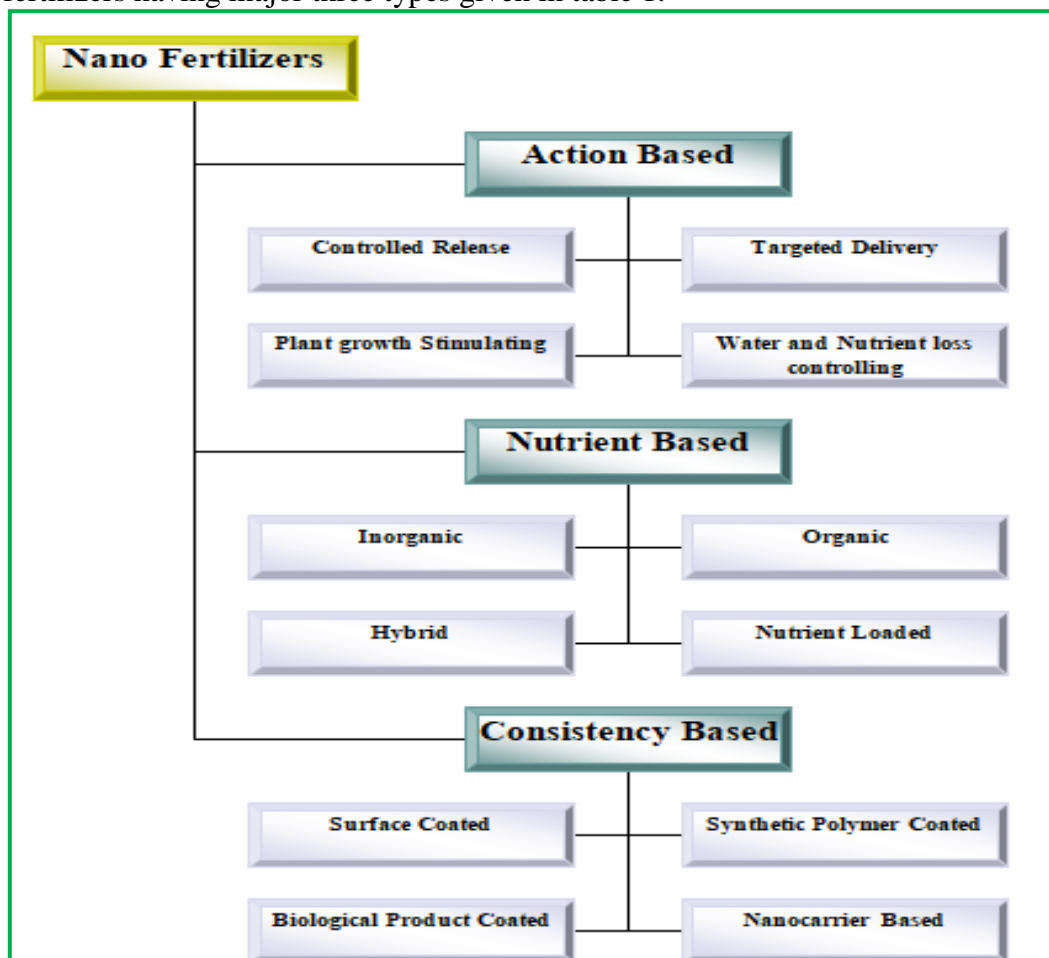


Table 1: Types of Nanofertilizers

## Nano Urea

Nano urea is a nano-fertilizer which fulfills the nitrogen requirement of the plants. IFFCO (India) launched nano urea 1<sup>st</sup> in the world in liquid form on June 2021. Nano urea has been notified under Fertilizer Control Order, 1985 (FCO, 1985) Government of India. It is a component of 4R principle because it promotes sustainable and precision agriculture. For testing of nano urea, multi location trials undertaken at 20 ICAR research institutes, state agriculture universities and KVK's on more than 94 crops succeed. It contains nitrogen content (4%).

### Important Features of Nano-Urea

- ❖ Environment friendly
- ❖ Reduce nutrient loss
- ❖ Reduce fertilizer input cost
- ❖ Highly portable and transport
- ❖ Easy to store
- ❖ Higher crop yield
- ❖ Cheaper than conventional urea bag. Price per 500 ml bottle Rs. 240
- ❖ More surface area (1mm conventional urea prill = 55,000 times nano particles)



**Mode of Action:** Particle size of nano urea is 20-50 nm it is sprayed on plant foliage, enters through stomata having the size of plasmodesmata is 40 nm or binds with carrier protein through aquaporin, ion channels and endocytosis. Due to its smaller size particle it easily penetrates and transported to internal parts of plants through phloem and complete nitrogen deficiency of plants.

**Recommended Dose:** Mix 2-4 ml (containing 4% N) in one litre of water and spray at active branching/tillering growth stages of crop period. For best results supply two sprays of solution.

## Nano DAP

Nano DAP is a nano source of available nitrogen and phosphorus. It is a novel and indigenous nano fertilizer notified under FCO (1985), Govt. of India on 2<sup>nd</sup> March 2023. Nutrient use efficiency is more than 90 %. It is sync with OECD testing guidelines (TGs) and guidelines for Testing of Nano Agri-inputs (NAIPs) and food products by Department of Biotechnology, Government of India. Independently, Nano DAP has been tested and certified with bio- efficacy, biosafety- toxicity and environment suitability by NABL-accredited and GLP certified laboratories. It contains nitrogen (8 % N) and Phosphorus (16 % P<sub>2</sub>O<sub>5</sub>).

**Mode of Action:** Nano DAP has an unique property that it can easily penetrates through seed surface as well as leaf surface.

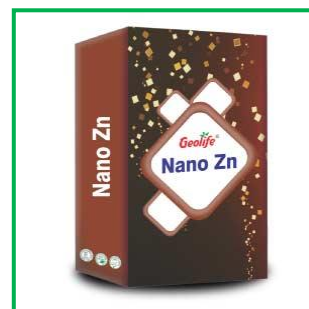
- ❖ **Seed Treatment:** When applied through seed surface/root treatment the biopolymers and surfactants activate and facilitates the entry of nitrogen and phosphorus, this leads to early and better germination.
- ❖ **Foliar Application:** When applied through foliar application it is transported through phloems whereas the amide form of nitrogen activate urease enzyme and converted it into ammonia and nitrate, further results in protein synthesis and available to plants.

**Recommended Dose:** Use @ 250-500 ml per acre per spray . With help of knapsack sprayer, then add @ 50-75 ml per tank.



### Nano Zinc

Zinc is an essential trace micronutrient. Still a micronutrient its deficiency is commonly found. It is a white powder formulation which is chelated with EDTA & Aminos. Nano Zn increases uptake of phosphorous content in roots. It helps plant in chlorophyll production and auxin growth hormone. Many trials monitored on nano zinc, it was found that it show major significant effects on pearl millet as well as mustard plants.(Kumar *et al.* 2022)



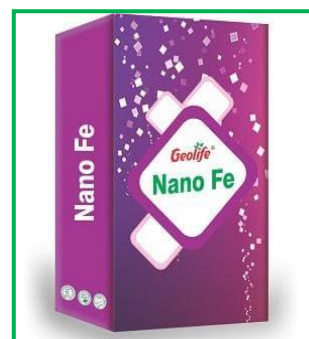
#### Mode of Action

ZnO exhibits significant antimicrobial activities when particle size is reduced it can interact with bacterial surface or bacterial core where it enters inside the cell, subsequently exhibits distinct bactericidal mechanisms. It is quickly available to plants instead of fixation with other particles. (Sirelkhatim *et al.* 2015)

**Recommended Dose:** Use 50 g per acre.

### Nano Iron

Iron is an important micronutrient for plant life cycle. Usually Fe content in soil is high, but a large proportion is fixed to soil particles in the form of insoluble Fe<sup>3+</sup>, especially in high-pH and aerobic soils therefore, these soils are usually deficient in the available form. (Ye *et al.*, 2015). In nano form it becomes soluble and absorbed by plants.



#### Mode of Action

Nano Fe sprayed on foliage during deficiency stages it enters through stomata to plant cells in available form. Further it transforms to whole plant through phloem tubes.

**Recommended Dose:** Foliar spray of 200 ppm nano iron (Dola *et al.* 2022).

### Different Trademark of Available Nano Fertilizers in Market

| Trademark Name  | Specification   |
|---|---|
| IFFCO (IFFCO Nano Biotechnology Research Centre, India) | Nano Nitrogen (Urea)  |
|   | Nano Phosphorus (DAP)   |
|   | Nano Copper   |
|   | Nano Zinc   |
| Geolife   | Combo of all micronutrients<br>NPK 19:19:19 water soluble<br>(nano) |
|   | Nano Iron   |
|   | Nano Manganese  |
|   | Nano Zinc   |
|   | Nano Magnesium  |
| Geetharam Agencies                                      | Nano Phosphorus   |
| TSR Organic Fertiizers                                  | Nano fertilizer for flower booster                                  |
| Fulgro Nano   | Plant growth promoter   |
| Infinite Biotech Nano                                   | Plant growth promoter   |

## Conclusion

Nano-fertilizers are the best alternative for conventional fertilizers. In case of Nano fertilizers, these are used in very minute amount particles and results in more FUE (fertilizer use efficiency) and reduces the fertilizers input cost. Moreover it does not affect our environment. It increases the crop yield per unit area as well as reduces the quantity of fertilizer.

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