

## Nanofertilizers

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### Introduction

Nanotechnology is a rapidly growing field globally gaining its impact in each and every field of science and technology. Nanotechnology is the art and science of manipulating matter at nanoscale ( $1\text{nm} = 10^{-9}\text{ m}$  *i.e.*, one billionth of a meter). Applications of nanotechnology has spread its wings over various sectors like textile industry, cosmetics, electronics, metallurgy, information technology, defense and security, medicine, transportation, energy, agriculture, food safety, biotechnology, environmental science and among many others.

In agriculture, Nanotechnology is being considered as a way for achieving a second green revolution with its applications ranging from crop stand improvement, controlled release of pesticides, nutrients and agrichemicals, reducing runoff, remediation, to detect bacteria and viruses ultimately increasing the crop yield.

### Nanofertilizers:

A nanofertilizer is any product that's created with nanoparticles or utilizes nanotechnology to improve nutrient efficiency.

Three categories of nanofertilizers are proposed:

1. Nanoscale fertilizer: Nanoparticles which contain nutrients in it.
2. Nanoscale additives: Traditional fertilizers containing nanoscale additives.
3. Nanoscale coating: Traditional fertilizers coated or loaded with nanoparticles.

Nanofertilizers also called smart fertilizers have a smart delivery system that would release the plant nutrients in a slow and controlled manner to the plants.

**Table 1: Some nanofertilizers that are commercially available.**

Commercial product	Company
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Nano Green	Nano Green Sciences, Inc., India
TAG NANO (NPK, PhoS, Zinc, Cal, etc.) fertilizers	Tropical Agrosystem India (P) Ltd, India
Nano Max NPK Fertilizer	JU Agri Sciences Pvt. Ltd, Janakpuri, New Delhi, India
IFFCO nano nitrogen, IFFCO nano zinc, IFFCO nano copper	IFFCO
Nano-Gro™	Agro Nanotechnology Corp., FL, United States
Nano-Ag Answer®	Urth Agriculture, CA, United States
Master Nano Chitosan Organic Fertilizer	Pannaraj Intertrade, Thailand

### Synthesis of nanofertilizers:

Nanofertilizers can be synthesized either by top-down (physical method) or bottom-up approach (chemical method). The top-down approach is based on the reduction of size to nanoscale from bulk material, wherein the bottom-up approach involves building up of atoms to reach nanoscale by using chemical reactions, hence bottom-up approach can produce nanofertilizers with more uniform particle size without much impurities. Most nanofertilizers are synthesized by a bottom-up approach. In addition to the chemical and physical methods, nanofertilizers can also be synthesized by using biological method (biosynthesis) which is called green synthesis.

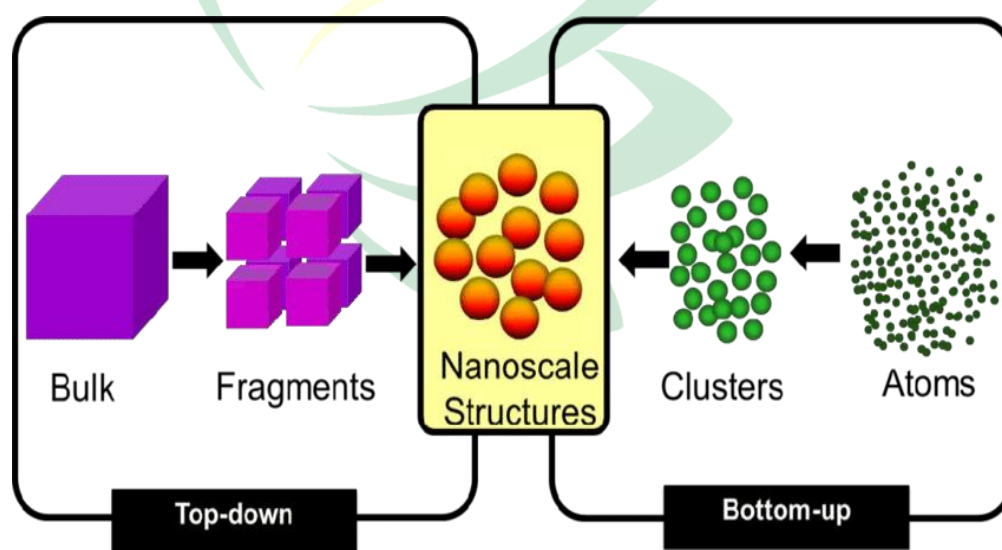
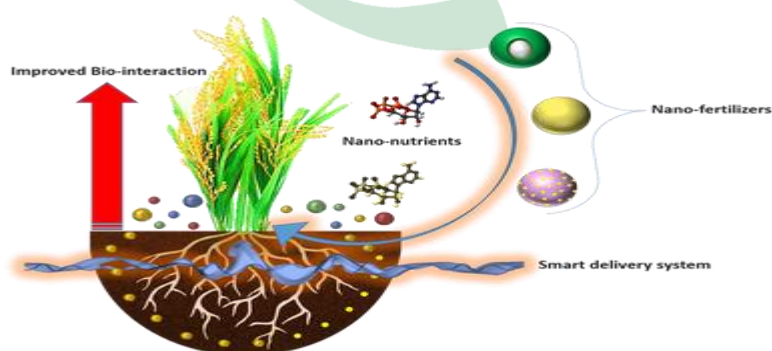


Fig.1: Top-down and bottom-up approach of nanoparticles synthesis

**Advantages of nanofertilizers:**

- A nanofertilizer releases nutrients in a slow and steady rate for a longer period thereby reducing the nutrient losses and improving the nutrient use efficiency.
- Nanofertilizers can be absorbed by either roots or foliage. Hence, suitable for soil application as well as foliar spray.
- Reduction in the requirement of conventional chemical fertilizer by 50%.
- Nanofertilizers are applied in small quantities, so, it reduces the need of transportation and application costs.
- The advantage of using smaller quantities is that the soil doesn't get loaded with salts as in conventional fertilizer application either on short or long term basis.
- Nanofertilizers can be synthesized or formulated as per the nutrient requirements of target crops.
- Integration of biosensors to the nanofertilizers will help in selective release of nutrients according to soil nutrient status, crop growth period and environmental conditions.
- They also increase the bioavailability of applied nutrients because of their high specific surface area, miniature size and high reactivity.
- By providing balanced nutrition, nanofertilizers enable the induced systemic resistance in plants for combating various biotic and abiotic stresses.
- Nano-biofertilizers: Encapsulation of beneficial microorganisms by nanotechnology can enhance plant health. As this could include bacteria or fungi that can improve nitrogen, phosphorus and potassium availability in the root zone.
- Increases crop production by 15-30 %.
- Reduction in the emission of greenhouse gases



**Limitations of nanofertilizers:**

- ✓ Phytotoxicity from nanomaterials is also a concern in this regard, as different plants react too differently to nanomaterials.
- ✓ Because of their smaller they can easily escape into the atmosphere causing environmental issues.
- ✓ In fact, the use of nanofertilizers derived from nanomaterials has sparked serious concerns about food safety, human health, and food security.
- ✓ Nanomaterials have a high degree of reactivity. As a result, when nanofertilizers are used in crops there are chances that they react with various components in the atmosphere, changing or transforming their physicochemical properties.

**Conclusion:**

Nanofertilizers provide tremendous potential in agriculture, but methods to deal with their accumulation and potential threats to human health and the environment must be developed in tandem with the benefits of using nanoparticles in crops. This young area of research is achieving significant milestones and presenting a promising future prospect.

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