

## Nanotechnology in agriculture, its role, favorable circumstances and pitfalls

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### Introduction

The idea of applied science was born in 1959 once man of science Richard Phillips Feynman gave a lecture exploring the concept of building things at the atomic and molecular scale, and from that terribly day the Nano method is afoot in 1974, Prof. Norio Tanaguchi, projected the particular term '*nanotechnology*'.

Nanotechnology is science and engineering at the size of atoms and molecules. it's the manipulation and use of materials and devices therefore little that nothing may be designed any smaller. Nanotechnology is outlined because of the study and use of structures between 1nanometers (nm) and 100 nanometers (nm) in size. To present you a concept however tiny that's, it'd take eight hundred nm particles facet by facet to match the breadth of a personality's hair. At nano scales, the essential rules of chemistry and physics aren't applicable. Nanotechnology has gained intense attention in recent years thanks to its wide applications in many areas like drugs, medical medication, catalysis, energy and materials. Those nanoparticles with tiny size to massive expanse (1–100 nm) have many potential functions. The event of Nano chemicals has appeared as promising agents for the plant growth, fertilizers and pesticides. In recent years, the utilization of nanomaterials has been thought of as an alternate answer to manage plant pests together with insects, fungi and weeds. Many nanomaterials are used as antimicrobial agents in food packing within which many nanoparticles like silver nanomaterials are unit in nice interest. several nanoparticles (Ag, Fe, Cu, Si, Al, Zn, ZnO, TiO<sub>2</sub>, CeO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and carbon nanotubes) are reportable to possess some adverse effects on plant growth except the antimicrobial properties. In food industries, nanoparticles are a unit leading in forming the food with top quality and smart nutrient price. Nanotechnology will increase agricultural production, and its applications include-

- Nanoformulations of agrochemicals for applying pesticides and fertilizers for crop improvement.
- The appliance of Nano sensors in crop protection for the identification of diseases and residues of agrochemicals
- Nano devices for the biotechnology of plants
- Disease diagnostics
- Animal health, animal breeding, poultry production
- Postharvest management.

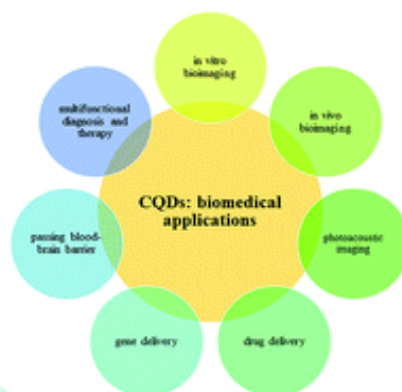
### **Nanoparticles and their functions**

Nanoparticles are created from Copper, Silver, Gold, oxide, silica, and noble metal additionally a great deal of beneath analysis. These particles are a billionth a part of each measurement. Those particles are smaller than viruses. They're principally oval and spherical forms. Once we convert any things in its nano particles then it shows its individual particles property.

Nanoparticles will function 'magic bullets', containing herbicides, chemicals, or genes that target explicit plant elements to unharness their content. Nano capsules will modify effective penetration of herbicides through cuticles and tissues, permitting slow and constant unharness of the active substances.

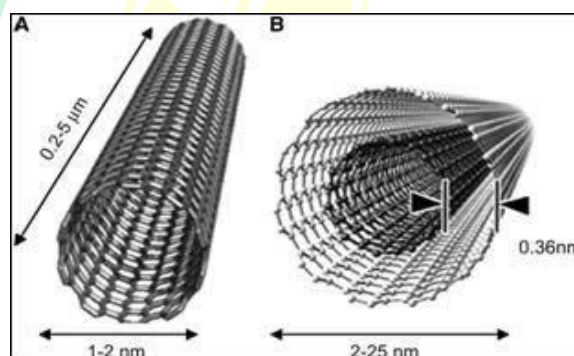
#### **1. Carbon Quantum Dots**

Generally, semiconductor QDs are high quantum yield and molar extinction coefficients, broad absorption spectra with narrow, symmetric fluorescence spectra spanning the ultraviolet to near-infrared, large effective excitation, high resistance to photo-bleaching and exceptional resistance to photochemical degradation. QDs have unique spectral properties compared with traditional organic dyes, thus recently, they have been applied as a new generation of fluorophores in bio imaging and bio sensing. QDs can be utilized for live imaging in plant root systems to verify known physiological processes.



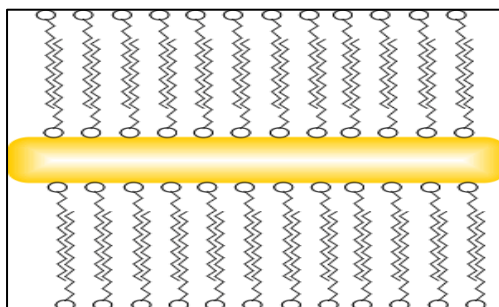
## 2. Carbon Nanotubes (CNTs)

It is a replacement sort of carbon, corresponding to two dimensional graphene sheets rolled into a tube. There are two main varieties of nanotubes: one is single-walled nanotubes and another is multi-walled nanotubes. It will conduct electricity higher than copper; one hundred times stronger than steel however just one sixth of its weight



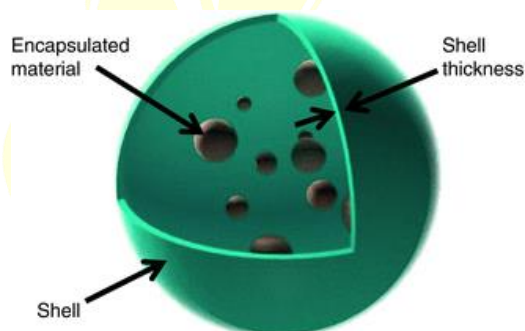
## 3. Nanorods

Multifunctional plasmonic materials which may couple sensing phenomena well and size tunable energy regulation, are often including MEMS, and induce specific field responses. The gold nanorods considerably physiological changes occurred of watermelon plant and confirmed phytotoxicity toward plant notably at high concentration and conjointly ability to move plant hormone phytohormone 2,4-D, that resulted during a vital influence on the regulation of tobacco cell culture growth.



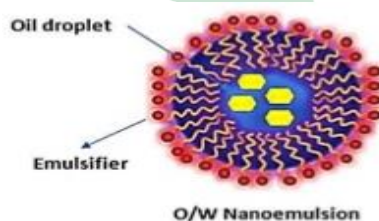
#### 4. Micro/Nano Encapsulation:

Encapsulation is outlined as a method within which the given object is encircled by a coating or embedded in a homogenized or heterogeneous matrix. Nanocapsules are sac systems within which the substances are confined to a cavity consisting of associate degree inner liquid core boxed in by a compound membrane. Some medicines like peptides or anti-inflammatory compounds are successfully nanoencapsulated. Nanocapsules will doubtless be used as MRI-guided nano nanoencapsulated.



#### 5. Nanoemulsions:

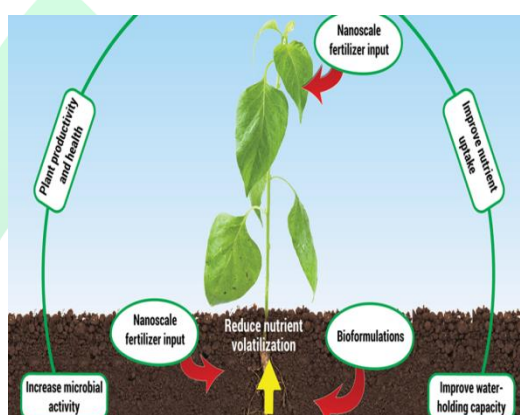
Nanoemulsions are fashioned by terribly tiny emulsion nanoscale droplets (oil/water system) exhibiting sizes below than 100nm. Due to the dimensions of droplets, the magnitude relation of expanse to volume, stargazer pressure and modulus of elasticity of nanoemulsions are considerably larger than that of standard emulsions.



#### 6. Nano fertilizer:

A Nano fertilizer is any product that's created with nanoparticles or uses engineering to boost nutrient potency. There are three categories of Nano fertilizers are proposed:

- Nanoscale fertilizer (nanoparticles that contain nutrients),
  - Nanoscale additives (traditional fertilizers with nanoscale additives), and
  - Nanoscale coating (traditional fertilizers coated or loaded with nanoparticles)
- Nanoemulsions are formed by very small emulsion nanoscale droplets (oil/water system) exhibiting sizes lower than ~100 nm.

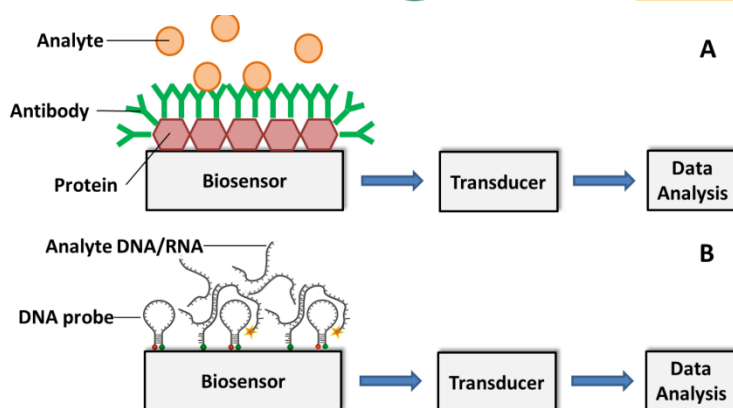


## 7. Biosensor

A biosensor is often outlined as a sensing device or a measure system designed specifically for estimation of a cloth by exploiting the biological interactions and so assessing these interactions into a decipherable type with the assistance of a transduction and mechanical device interpretation.

Types of biosensors

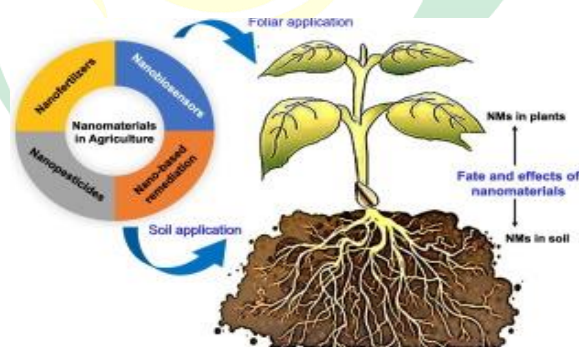
1. Calorimetric Biosensors
2. Potentiometric Biosensors
3. Amperometric Biosensors
4. Conductometric Biosensors.
5. Optical Biosensors.



### Why nanotechnology in agriculture?

In the current situation of agriculture wherever economic conditions and Hunger is increasing, there's an oversized demand for quick, reliable, low value systems for the detection, observance & identification for the biological host molecules in agricultural sectors. Chemically Synthesized Nanomaterials are thought-about to be nephrotoxic and thence Nanomaterials are synthesized from the plants and thus known as inexperienced engineering. The inexperienced engineering is:

- Safe method
- Reduces the waste created
- Lessens the emission of Greenhouse Gases.



### Role of Nanotechnology in agriculture and environment:

- Nanotechnology for Crop Biotechnology

Chemists have with success crafted three-dimensional molecular structures, a breakthrough that unites biotechnology and engineering. They created polymer crystals by manufacturing artificial polymer sequences that may self-assemble into a series of three-dimensional triangle-like patterns. The polymer crystals have “sticky-ends” or tiny cohesive sequences that may attach molecules in an organized fashion. Once multiple helices are connected through fiber sticky ends, there would be a lattice-like structure that extends in six totally different directions, forming a three-dimensional. This system can be applied in rising vital crops by organizing and linking carbohydrates, lipids, proteins and nucleic acids to those crystals.

### **Recycling of Agricultural Waste**

Nanotechnology is additionally applied to stop waste in agriculture, notably within the cotton business. Once cotton is processed into material or garment, a number of the polysaccharide or the fibers are discarded as waste or used for low-value products like cotton balls, yarns and cotton batting. With the utilization of newly-developed solvents and a method known as electrospinning, scientists manufacture a hundred nanometer-diameter fibers that may be used as a fertilizer or chemical absorbent. These superior adsorbents permit targeted application at desired time and site.

Ethanol production from maize feedstock has enlarged the worldwide worth of maize within the past two years. Plastic feed stocks are currently considered a viable possibility for biofuels production and engineering can even enhance the performance of enzymes employed in the conversion of polysaccharide into fermentation alcohol.

Rice husk, a rice-milling byproduct, is often used as a supply of renewable energy. Once a rice husk is burned into thermal energy or biofuel, an oversized quantity of high-quality nanosilica is created which may be additionally utilized in creating different materials like glass and concrete.

### **Nanotechnology in food packaging**

Food industries are a unit leading in forming the food with sensible nutritious worth. As an example, high impermeable packaging nanomaterials are used for cover of food from UV radiations and provide more strength to take care of the food shielded from the environment, increasing their shelf lives. Nanosensors units are used for the detection of chemicals, gases and pathogens in food. In trendy language, a word is given to such a sort of

packaging as sensible packaging. Some studies have shown that individuals aren't accepting the direct involvement of nanoparticles in food because of some risk factors. Therefore, it's required to produce some safety measurements to cut back the danger and human safety.

### **Nanotechnology in Antimicrobial activity**

Several nanomaterials are used as antimicrobial agents in food packing within which silver nanoparticles are unit in nice interest. This is often attributable to its extended use. Other nanoparticles presently used are area unit titania ( $\text{TiO}_2$ ), philosopher's wool ( $\text{ZnO}$ ), silicon dioxide ( $\text{SiO}_2$ ), mineral ( $\text{MgO}$ ), gold and silver. All of them have different functions, forexample, Zn nanocrystal has antimicrobial and antifungal activity. Silver was a disinfectant and sterilizing agent employed by NASA and Russian space laboratories for water, silver mineral and silver. Gold has warm temperature stability and low volatility and sensible antifungal and antimicrobial effects against one hundred fifty totally different bacteria. AgNPs also are found to be effective against penicillin resistant staphylococcus aureus. Alternative nanoparticles besides silver also are found to own antimicrobial characteristics like titanic oxide ( $\text{TiO}_2$ ). Zinc compound nanoparticles synthesized victimization dicot genus granatum peel binary compound extract have shown effectiveness as medicinal drug agents against commonplace strains of gram-positive *staphylococcus* and gram-negative *enterobacteria coli*.

### **Nanotechnology application as nano fungicides**

Nano-silver has been studied recently against the phytopathogen *Colletotrichum gloeosporioides*. Alternative nanoparticles (Fe, Cu, Si, Al, Zn,  $\text{ZnO}$ ,  $\text{TiO}_2$ ,  $\text{CeO}_2$ ,  $\text{Al}_2\text{O}_3$  and carbon nanotubes) are reported to own some adverse effects on plant growth aside from the antimicrobial properties. Sometimes, nanoparticles even have an impact on the expansion of helpful soil bacterium, like *Pseudomonas putida* KT2440. Numerous analysis teams targeted their interest in the usage of eco-friendly pesticides. the same as chemical pesticides, nanoparticle-based pesticides and herbicides are being explored for the appliance of the antimicrobial agents to safeguard crops from various diseases. The antifungal properties of nanoparticles will facilitate the formulation of nanoparticle-based pesticides.

### **Nanotechnology for controlling plant virus**

Plant virus significantly spherical virus is taken into account to be the natural nanomaterials. The littlest plant viruses known till date area unit satellite tobacco gangrene



virus measurement solely 18nm in diameter. Plant viruses are units created from single or double stranded DNA/RNA as ordination that is encapsulated by a macromolecule coat. Their ability to infect, deliver macromolecule ordination to a particular web site within the host cell, replicate, package macromolecule and are available out of the host cell exactly in associate degree orderly manner have necessitated them to be employed in Nanotechnology.

### **Role of nanotechnology in agronomy**

If things are through with exactitude the outcomes are increased and fewer time and economic resources are consumed. With the help of Nano sensors, we can, we are &we will be able to monitor agriculture i-e elements of the sphere are receiving less plant food, chemical or water. By knowing concerning the condition, we are able to allot our resources in such a way that every part of land gets optimum chemicals etc. within the same approach, we are able to perform physical manipulations as tillage by knowing these physical conditions of a field.

### **Role of nanotechnology in animal sciences**

This technology finds its application in animal sciences in numerous aspects. Vaccines, probiotics and medicines once delivered at the nanoscale will be a lot of economical. At such a tiny low scale, they'll undergo numerous biological hurdles thus economical action at the targeted web site. Unleash of chemicals at a correct time and self-regulatory actions are some main necessary edges. Silver that could be a sensible antiseptic that work terribly expeditiously once delivered at nanoscale

### **Role of nanotechnology in environment**

Nanotechnology is taking part in a subordinate role within the protection of the surroundings. The same subordinate as a result of the environmental engineering firms don't seem to be paying a lot of heed towards the utilization of this technology however still, it's a great deal of applications in utilization and saving raw materials, water and energy. It helps to mitigate the results of venturesome waste and endeavor greenhouse effects.

### **Advantages of nanotechnology**

1. Nanotechnology helps to deliver agricultural chemicals like plant growth regulators, fertilizers, pesticides, herbicides etc.
2. It helps to monitor the environmental stresses and crop condition.

3. Nano sensors to find out the contamination in the food before packaging and distribution.
4. Nano engineered materials in the food industry involve nanocomposites, Nano encapsulation in food containers.
5. Resource management in agriculture.
6. It helps to maintain soil fertility.
7. It helps to enhance food packaging and food processing systems and also yield.
8. Risk assessment.
9. Aids in improving the efficiency of microorganisms in degradation of waste & toxic materials.
10. Monitoring of contamination in soil & water.
11. Biochemical sensors, electrochemical sensors, optical sensors for detection of heavy metals.

#### **Disadvantages of nanotechnology**

1. Nanoparticles can enter the body through lungs, skin, digestive system and create free radicals that can cause cell damage.
2. It can be able to cross the blood - brain barrier.
3. Loss of employment jobs.
4. Very expensive.

#### **Conclusion**

Nanotechnology can play a significant role within the development of the agricultural sector, because it is capable of getting used in agricultural products that shield plants and monitor plant growth and discover diseases. Scientists are working towards exploring new applications of nanotechnology in agriculture and therefore the food industry - if these discoveries are applied sensibly, the setting, the agricultural sector and therefore the food business can so see tremendous changes for the higher within the coming back years. In spite of being relative blessings in the agriculture method, still developing countries are plagued by an absence of high importance of food products. Despite heaps of knowledge regarding individual nanomaterials area unit obtainable, however the toxicity level of the many NPs continues to be indefinable, so the appliance of those materials is proscribed because of the dearth of information of risk assessments and effects on human health.