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Nanotechnology: A New Approach in Agriculture World

Rachana[1], Shraddha Singh[2]

[1]Department of Agronomy,
[2]Department of Industrial Microbiology,
SHUATS, Prayagraj (U.P.)

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INTRODUCTION

Nanotechnology in agriculture has gained momentum in the last decade with an abundance of public funding, but the pace of development is modest, even though many disciplines come under the umbrella of agriculture. Nanotechnologic intervention in farming has bright prospects for improving the efficiency of nutrient use through nano formulations of fertilizers, breaking yield barriers through bionanotechnology, surveillance and control of pests and diseases, understanding mechanisms of host-parasite interactions at the molecular level, development of new-generation pesticides and their carriers, preservation and packaging of food and food additives, strengthening of natural fibers, removal of contaminants from soil and water, improving the shelf-life of vegetables and flowers, clay-based nano resources for precision water management, reclamation of salt-affected soils. Nanotechnology will play a vital role in the development of the agricultural sector, as it is capable of being used in agricultural products that protect plants and monitor plant growth and detect diseases. Nano technology devices and tools, like nanocapsules, nanoparticles and even viral capsids, are examples of uses for the detection and treatment of diseases, the enhancement of nutrients absorption by plants, the delivery of active ingredients to specific sites and water treatment processes. The use of target-specific nanoparticles can reduce the damage to non-target plant tissues and the amount of chemicals released into the environment. Nanotechnology derived devices are also explored in the field of plant breeding and genetic transformation. Nano materials and nanostructures with unique chemical, physical, and mechanical properties like electrochemically active carbon nanotubes, nanofibers and fullerenes have been recently developed and applied for highly sensitive bio-chemical sensors. Nanotechnology is considered as one of the possible solutions to problems in food and agriculture.

WHAT IS NANOTECHNOLOGY?

Nanotechnology is defined as the science of understanding and control of matter at dimensions of roughly 1–100 nm, where unique physical properties make novel applications possible. Other attempts to define nanoparticles from the point of view of agriculture include particulate between 10 and 1,000 nm in size dimensions that are simultaneously colloidal particulate. The application of nano materials in agriculture aims in particular to reduce applications of plant protection products, minimize nutrient losses in fertilization, and increase yields through optimized nutrient management.

What are Nanoparticles?

The simple answer to this question is any particle less than 100 nm. But like most things in particle technology a more thorough discussion is required to achieve an unambiguous and complete response. The experts from the ISO and ASTM standards shown below provide additional nuances to the definition. The current agreement among the standards groups is that the scale from 1 – 100 nm defines the size range of nanoparticles. Below 1 nm may be excluded in order to avoid calling clusters of atoms a particle, but the literature contains references to particles < 1 nm. Role of nanotechnology in different domain of agriculture sciences.

1. Role of nanotechnology applications in agriculture

Nature is a great teacher, and nanotechnology applications in agriculture can be successful if natural processes are simulated in greater scientific sophistication/articulation for successful implementation. For example, the goal might be to make soils more capable in order to improve efficient nutrient use for greater productivity and better environmental security. Nutrient management with nanotechnology must rely on two important parameters, ions must be present in plant-available forms in the soil system, and since nutrient transport in soil-plant systems relies on ion exchange (eg, NH_4^+ $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}, Zn^{2+}), adsorption-desorption (eg, phosphorus nutrients) and solubility-precipitation (eg, iron) reactions, nonmaterial's must facilitate processes that would ensure availability of nutrients to plants in the rate and manner that plants demand. Nanofabricated materials containing plant nutrients can be used in aqueous suspension and hydrogel forms, so as to enable hazard-free application, easy storage, and a convenient delivery system.

2. Role of nanotechnology in animal production and health care

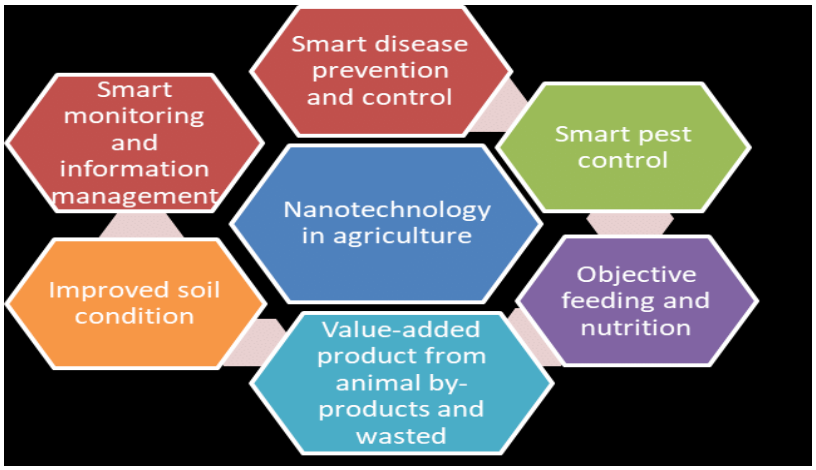
Livestock, poultry and aquaculture are related with agriculture, and have an important role and will continue to play an important role in human nutrition. There are a large number of constraints in animal production such as production efficiency, animal health, feed nutritional efficiency, diseases including zoonoses, product quality and value, by-products and waste, and environmental footprints. Nanotechnology can provide state-of-the-art remedies for these challenges.

3. Role of nanotechnology in improving feeding efficiency and nutrition

The main challenge in sustainable agriculture is to minimize the inputs and to maximize the output. Feedstock is the most important input in animal production. Feeding efficiency is inversely related with demand of feed, discharges of waste, environmental burden, production cost and competing with other uses of the grains, biomass and other feed materials. Nanotechnology has the potential to improve the profile of nutrients and their efficiency. To supplement them with nutrients is an efficient way of elevating the efficiency of protein synthesis and utilization of minor nutrients in animals. Similarly, cellulosic enzymes can help in better utilization of the energy in plant-derived materials. Moreover, micronutrients and bioactives can help improve the overall health of animals, ultimately achieving and maintaining optimal physiological state.

4. Role of nanotechnology in water quality

Currently, provision of clean and abundant fresh water is one of the most important challenges faced by the world for human use and industrial applications such as agriculture. According to a survey, more than one billion people in the world are deprived of clean water and the situation is getting worse. In the near future, it has been estimated that average water supply per person will drop by a factor of one third, which will result in the avoidable premature death of millions of people. A large amount of fresh water is required in agriculture, but in turn, it contributes to groundwater pollution through the use of pesticides, fertilizers and other agricultural chemicals. During the treatment of wastewater, critical issues like water quality and quantity, treatment and reuse, safety due to chemical and biological hazards.



Benefits of nanotechnology

NANOTECHNOLOGY AND AGRICULTURAL SUSTAINABLE DEVELOPMENT

The nano technology cans takes an important part in the productivity through control of nutrients as well as it can also participate in the monitoring of water quality and pesticides for sustainable development of agriculture. Nano-materials have such diverse assets and activities that it is impossible to deliver a general assessment of their health and environmental risks. Properties (other than size) of NPs have the influence on toxicity include chemical composition, shape, surface structure, surface charge, behavior, extent of particle aggregation (clumping) or disaggregation, etc. may associate with engineered NPs. For this reason even nano-materials of the same chemical composition that have different sizes or shapes can exhibit their different toxicity. The implication of the nanotechnology research in the agricultural sector is become to be necessary even key factor for the sustainable developments. In the agri-food areas pertinent applications of nanotubes, fullerenes, biosensors, controlled delivery systems; nano-filtration, etc. were observed. This technology was proved to be as good in resources management of agricultural field, drug delivery mechanisms in plants and helps to maintain the soils fertility. Moreover, it is being also evaluated steadily in the use of biomass and agricultural waste as well as in food processing and food packaging system as well as risk assessment. Recently, nanosensors are widely applied in the agriculture due to their strengths and fast for environmental monitoring of contamination in the soils and in the water. Several sensors based on nano-detection technology such as viz. biosensors, electrochemical sensors, optical sensors, and devices will be the main instruments for detecting the heavy metals in trace range. Nan materials not only directly catalyze

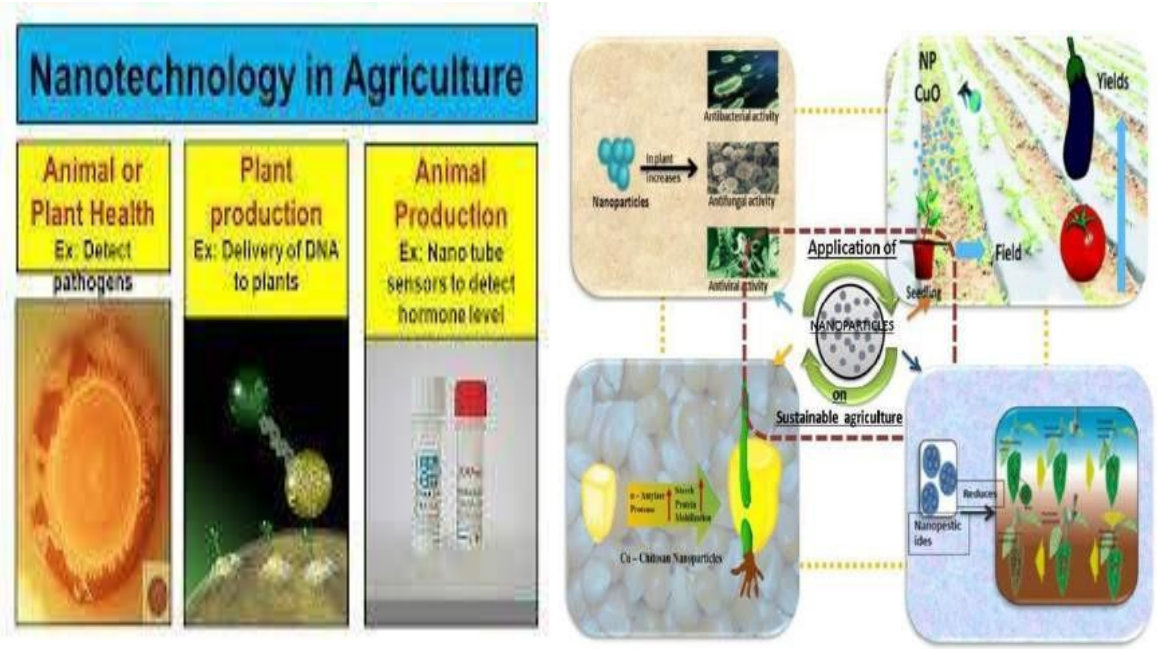
degradation of waste and toxic materials but it also aids improve the efficiency of microorganisms in degradation of waste and toxic materials. Bioremediation uses living organisms to break down or remove toxins and harmful substances from agricultural soil and water.

Nano fertilizers

In the recent decade nano fertilizers are freely available in the market, but particularly the agricultural fertilizers are still not shaped by the major chemical companies. Nanofertilizers may contain nano zinc, silica, iron and titanium dioxide, ZnCdSe/ZnS core shell QDs, InP/ZnS core shell QDs, Mn/ZnSe QDs, gold nanorods, core shell QDs, etc.as well as should endorse control release and improve the its quality. Studies of the uptake, biological fate and toxicity of several metal oxide NPs, *viz.* Al_2O_3, TiO_2, CeO_2, FeO, and ZnONPs were carried out intensively in the present decade for agricultural production. The deficiency of zinc has been documented as one of the main problems in limiting agricultural productivity in the alkaline nature of soils.

Nan pesticides

The use of nano materials in plant protection and production of food is under-explored area in the future. It is well known that insect pests are the predominant ones in the agricultural fields and also in its products, thus NPs may have key role in the control of insect pests and host pathogens. The recent development of a nano encapsulated pesticide formulation has slow releasing properties with enhanced solubility, specificity, permeability and stability. These assets are mainly achieved through either protecting the encapsulated active ingredients from premature degradation or increasing their pest control efficacy for a longer period. Formulation of nano encapsulated pesticides led to reduce the dosage of pesticides and human beings exposure to them which is environmentally friendly for crop protection. So development of non-toxic and promising pesticide delivery systems for increasing global food production while reducing the negative environmental impacts to ecosystem.



Application of Nano Particles on Sustainable Agriculture

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CONCLUSION

Nanotechnology has great potential as it can enhance the quality of life through its applications in various fields like agriculture and the food system. Around the world it has become the future of any nation. But we must be very careful with any new technology to be introduced about its possible risks that may come through its positive potential. However, it is also critical for the future of a nation to produce a trained future workforce in nanotechnology. In this process, to inform the public at large about its advantages is the first step, which will result in tremendous increase in the interest and discovery of new applications in all the domains. With this idea in mind, this article has been written by referring many numbers of articles and papers form different domain. The theme of this articles paper is based on the provision of basic knowledge about the applications of nanotechnology in agriculture and their prospects in the near future with reference to the current situation around the world.