



Nanotechnology in Agriculture: benefits, risks and challenges

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ABSTRACT

Due to the increasing population and decreasing the cultivable land, it is a challenge for our researchers to feed such a huge population. Injudicious use of fertilizers and chemicals has made our soil and environment deteriorating day by day and due to that productivity is decreasing at a faster rate. To overcome this problem use of nanotechnology is one of the . Due to its nano-size, it can be used very conveniently in the crop field which will increase productivity and maintain the soil and environment health.

In India agriculture is facing a wide range of constraints such as continuous increment in population and decrement in cultivating land areas, crises in water availability, imbalanced deterioration in soil health, and most seriously by climate change (Rajkishore *et al.*, 2012). To combat these challenges and contrast we should think of an alternate technology such as "nanotechnology". The word "nano" refers to the size of one – a billionth of a meter or one – millionth of a millimeter in any one of the dimensions. We know very well that all materials are made up of atoms which are the smallest unit and for example. Ten atoms put together will measure one nanometer. The word "nano agriculture" refers to the infusion of nanotechnology concept and principles in agriculture science to develop processes and product that delivers inputs and promote productivity without harming the environment (Selvarajan, 2013). Among the many scientific advancements, nanotechnology (NT) has been identified as a potential technology for reviving the agriculture and food industry and can improve livelihood of poor (Pramanik *et al.*, 2020).

Nanotechnology may be used in the field of agriculture, food processing, dairy industries, packaging, transportation, and quality control of the agricultural product. It has an enormous prospective in making agriculture more profitable and resourceful by using nanoparticles to improve nutrients availability a specific pout at a specific time. It makes conventional agriculture are proficient and transform them into scientific agriculture by fusion of the nano-based agrochemicals, ceramic devices, filtration methods, etc. The nanotechnology improves the agricultural practices

by exploited some specific principles in termsNano-pheromone for effective pest monitoring. Enhanced inputs use efficiency .nano- fertilizers and balanced crop nutrition, nano- herbicides for effective weed control, nano- insecticide, smart - delivery system, nanodevices for identity preservation, nanobiotechnology, nano-food industry, nanotechnology for environmental safety & sustainable forming, etc (Subramanian, 2011). Engineered Nano materials are another important products, have become prominent in the industrial and scientific fields. Global market value for engineered nano materials is increasing day after day (Kundu *et al.*, 2019).

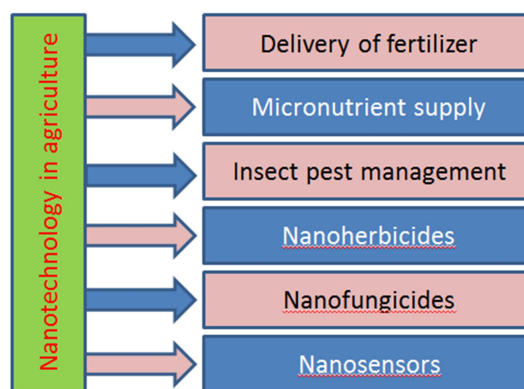


Figure 1. : Nanotechnology in agriculture

Benefits of Nanotechnology

Following are the benefits of nanotechnology (Tarafdar, J.C. and Raliya, R. 2013)



- a. It is user – friendly and eco- friendly. It provides the absolute minimum risk of environmental damages by the use of chemicals.
- b. The implementation of nanotechnology in the form of small sensors and monitoring devices will create a positive impact on agriculture practices.
- c. The nanotechnology in the agricultural sector will benefit greatly to detect diseases rapidly, improve the ability of plants to absorb the nutrient, and promote molecular treatment of the diseases.
- d. Nanotechnology may be used in maximizing crop yield and minimizing the usage of pesticides and fertilizers for their efficient monitoring procedures.
- e. It also establishes remote sensing devices, computers and a global satellite positioning system to analyze various environmental conditions to determine the growth of plants under these conditions and identify their problems.
- f. Nanotechnology is believed to enhance agriculture productivity through genetic improvement and make crops more resistant to heat and waterlogging.
- g. Nanotechnology is also used in water treatment and remediation such as water purification, detection of contamination, the water quality of irrigation as well as drinking water and wastewater treatment.
- h. Nanotechnology also enables the successful development of renewable energy solution and reduce our dependence of fossil fuels etc.
- i. Different engineered nano materials used in agriculture have the potential for precise delivery of agrochemicals for improving disease resistance, plant growth, and nutrient use (Kundu et al., 2019).
- j. Research on nanotechnology indicates that it has tremendous potential in increasing the efficiency of products. It can offer a wide range of products in agriculture in an affordable price range for resource-poor farmers (Mukherjee et al., 2019).
- k. Environmental remediation is possible through use of nano technology (Mridha et al., 2017)

Risk in nanotechnology

Following point are considered as a risk of nanotechnology application (Maynord, 2006).

- a) The risk is heterogeneous as the field of nanotechnology itself & include environmental, health, occupational, and socio-economic risks.
- b) Nanoparticle /nanomaterial will induce toxicological effects on an organism upon contact.
- c) Due to the great potential for application in areas where the nanoparticles can come in to direct humans contact and can cause unfavorable or undesirable toxic effects.
- d) Early research also indicates that nanoparticles could reach various parts of the body where they may exert adverse effects.
- e) It is also might be able to disrupt cellular, enzymatic, and other organ-related functions posing health hazards.
- f) The nanoparticles are also non - biodegradable and on disposal, these disposed of materials might form a new class of non- biodegradable pollutants.
- g) Nanoparticles or the use of nanotechnology enhances the chance of environmental pollution (water, soil, air) and health hazards.
- h) The Nanotoxicity studies in agriculture are very limited and it causes a potential risk to plant, microbes, animals, and even humans.
- i) The nanotechnology appears that the greatest current risk is to the occupational health of the workers involved in the production, packaging, or transport of the nanomaterials.
- j) Due to health hazards, it asses the different types of environmental as well as no – environmental risk.

Challenges in nanotechnology (Rajkishore and Lakshmanan, 2012)

- a) To produce nanomaterials in large enough volumes with standard quality and at an acceptable cost.
- b) To supply this nano - materials in a form (such as proper particle size, surface chemistry, compatibility, etc) that would allow integration into the processes.
- c) To establish an engineering and customizing the nano-based system to local requirements.
- d) Protect the environmental health and safety concerns in the use and disposal of nano products/materials.
- e) The gap between basic research and application is another challenge in nanotechnology like several technologies.



f) Due to high cost and risk intensive & lack of technical knowledge also a concern in the application of nanotechnology.

g) The main challenges faced by regulatory institutions & absence of inter-agency coordination.

Conclusion

In India the great challenges we will be facing, in particular due to a growing global population and climate change. The application of nano technology improves the agricultural practices and soil health. In fact, the efficient use of fertilizers and pesticides can be enhanced by the use of nanoscale carriers and compounds, reducing the amount to be applied without impairing productivity. Under the nano technology throw we can increase the inputs use efficiency, nano-fertilizers and balanced crop nutrition, nano-herbicides for effective weed control, nano-insecticide, smart-delivery system, nano-devices for identity preservation, nano-technology, nano-food industry, nano-technology for environmental safety & sustainable farming etc.

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