Agri-Nanotechnology: A prosperous Approach to Indian Agriculture

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Abstract

Among the much advancement in sciences, nanotechnology is being visualized as a rapidly evolving field that has potential to revolutionize agriculture and food systems and improve the condition of the farmer. According to the US Environmental Protection Agency, nanotechnology is defined as the science of understanding and control of matter at dimensions of roughly 1-100 nm, where unique physical and chemical properties make novel applications possible. Nanotechnology when applied as a tool, can address some of the world's most critical sustainable development problems in the areas of water, energy, health, environment, agriculture, biodiversity and ecosystem management. Taking research in nanotechnology into agriculture and it's allied sectors is based on evidence from research in the developed countries in promising areas of agriculture and food production systems. Studies in these countries over the past few years indicate that nanotechnology has the potential to advance agricultural productivity through genetic improvement of plants and animals, delivery of genes and drug molecules to specific sites at cellular levels in plants and animals and nano ray based gene technologies for gene expressions in plants and animals under stress conditions. Nanostructures can be implanted into plants and animals during growth and development to collect and transmit vital real time data such as growth rates and physiological activities that provides clues on performance, productivity and exposure to environmental, chemical and physical hazards.

Keywords: Nanotechnology, emulsion, nanoparticles

1. Introduction

Among the much advancement in sciences, nanotechnology is being visualized as a rapidly evolving field that has potential to revolutionize agriculture and food systems and improve the condition of the farmer. Technical convergence across the fields of physics, engineering, chemistry, biology, agriculture and food sciences is the essential core of development of nanotechnology. According to the US Environmental Protection Agency, nanotechnology is defined as the science of understanding and control of matter at dimensions of roughly 1-100nm, where unique physical and chemical properties make novel applications possible. The Asia pacific Economic Cooperation (APEC) centre for Technology Foresight has predicted that nanotechnology will revolutionize all aspects of our economy and all aspects of society , with associated large- scale social upheaval. Nanotechnology when applied as a tool, can address some of the world's most critical sustainable development problems in the areas of water, energy, health, environment, agriculture, biodiversity and ecosystem management. These five areas collectively known as WEHAB, were identified in 2002 in United Nations Johannesburg summit on sustainable Development. A UN Survey on potential application of nanotechnology in developing countries identified agricultural productivity enhancement as the second most critical area of application for attaining the millennium development goals while energy conversion and storage was ranked first and water treatment as the third areas needing focus.

2. Nanotechnology and Agriculture

Taking research in nanotechnology into agriculture and it's allied sectors is based on evidence from research in the developed countries in promising areas of agriculture and food production systems. Studies in these countries over the past few years indicate that nanotechnology has the potential to advance agricultural productivity through genetic improvement of plants and animals, delivery of genes and drug molecules to specific sites at cellular levels in plants and animals and nanoarray based gene technologies for gene expressions in plants and animals under stress conditions. Nanotube devices can be integrated with other chemical, mechanical, or biological systems, and can be excellent candidates for electrical sensing of individual biochemicals. Nanotube electronic devices have been shown to have

function very well under extreme biological conditions such as saline water and have dimensions comparable to typical biomolecules. These devices have the potential to revolutionize site specific and process exact diagnosis, drug delivery and in live stock disease and health management as well as in the identification and site specific control of plant pests and diseases.

Nanostructures can be implanted into plants and animals during growth and development to collect and transmit vital real time data such as growth rates and physiological activities that provides clues on performance, productivity and exposure to environmental, chemical and physical hazards. Development of miniaturized micro electro machinery for agricultural mechanization is another exciting application of nanotechnology in agriculture. The prospect of scaling transistors all the way down to the size of individual molecules and incorporating this into future agricultural machinery will led to precisional control of agricultural operations.

By connecting global positioning systems with satellite imaging of fields, farm managers could remotely detect crop pests or evidence of drought. Information about these pesticide conditions would trigger an automatic adjustment of pesticide applications or irrigation levels. To achieve this task, a network of sensors which are disposed throughout fields, would relay detailed data about crops and the soil. These sensors would need to have nanoscale sensitivity to monitor conditions such as the presence of plant viruses or the level of soil nutrients. All farm inputs – seeds, fertilizers, pesticides and labour – will become increasingly technologically modified. Nanotechnology will take the genetic engineering of agriculture to the next level down – atomic engineering. Atomic engineering could enable the DNA of seeds to be rearranged in order to obtain different plant properties including colour, growth and yield etc., Highly potent atomically engineered fertilizers and pesticides will be used to maintain plant growth. Nano-sensors will enable plant growth, pH levels, the presence of nutrients, moisture, pests or disease to be monitored from faraway, significantly reducing the need for on-farm labour inputs.

In India, agriculture sector still employs nearly 60% of the work force and nearly 2/3 of the farm lands are in some measure either degraded or sick. The difficult situation in India agriculture is increasingly being ascribed to a "technology fatigue." Future food security of India has been facing the threat again. Vertical improvement of farm yields has already reached saturation as further exploitation of genetic improvement is meager. Biotechnological interventions are only improving certain traits rather than yields. Agronomic management and it's manipulation for boosting crop yields were over exploited. Moreover, agricultural growth in India has declined from about 3.6% during 1985-95 to less than 2% in the decade 1995-05. This is against a targeted average annual growth of 4% for the agricultural sector to 2020. A particular area of concern is production levels of food grains. With the limited availability of land and water resources, the goal of 4% growth in agriculture can be achieved only by increasing productivity and incomes per unit of these scarce natural resources through effective use of improved technology.

3. Potential applications in Indian Agriculture

- Nano fertilizers for slow release and efficient use of water and fertilizers by plants.
- Nanocides- pesticides encapsulated in Nano particles for controlled release and nano emulsions for greater efficiency.
- Nano particles for soil conservation.
- Delivery of drugs and nutrients for livestock and fisheries.
- Nano brushes and membranes for soil and water purification, cleaning of fish ponds.
- Nano sensors for soil quality and for plant health monitoring, and for precision agriculture, controlled environment agriculture.
- In food processing, nanocomposites and nanobiocomposites for plastic film coatings used in food packaging.
- Anti-microbial nanoemulsions for application in decontamination of food equipment, packaging or food processing.

4. Conclusion

If Indian agriculture is to attain it's broad national goal of sustainable agricultural growth of over 4%, it is important that the nanotechnology research is extended to the agricultural total production-consumption system. Application of nanotechnology to agriculture and food systems even at the global level is at infancy stage and its success will be based on its ultimate acceptance by the stakeholders. Thus adoption of the nanotechnological innovations in Indian agriculture would pave the way to attain sustainable growth in crop production, and food security and in turn this would lead to the secured economic position of the country.