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Nanotechnology can provide sustainable agriculture and second green revolution

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Nanotechnology is the study of manipulating matter on an atomic or a molecular scale that deals with particle sizes between 1 and 100 nanometer at least in one dimension. Materials reduced to the Nanoscale show some unusual properties which are different from what they exhibit on a macro scale, enabling unique systematic applications. The interesting and sometimes unexpected properties of nanoparticles are broadly due to the large surface area of the material, which dominates the contributions made by the very small quantities of the material. Nanoparticles, thus, take advantage of their dramatically increased surface area to volume ratio. This frontier area of technology has the potential to revolutionize the agricultural and food industry.

The advantage of nanotechnology approach is particles in nanoform have more surface area and high reactivity; they are effective catalyst of plant/microbial metabolism, better penetration into the cell which may increase both plant and microbial activities. Nanotechnology opened doors to new ways of identifying and quantifying bio-molecules through use of nanosensors and nanoprobes and offers the tools to understand and transform biosystems. They have strong impact on sub-cellular dynamics, regeneration mechanisms, genome description and food characterization.

Nanoparticles can be prepared by physical, chemical, biological and aerosol technique. It has different sizes (1-100nm) or shapes (nanocube, nanoplate, nanowire, nanocages). High energy ball mill and pot mill is generally use for physical synthesis of nanoparticles. Precipitation technique and Poly Vinyl Pyrrolidene (PVP) method is popular for nanoparticle synthesis by chemical means. Microbial ball is prepared for biological synthesis of nanoparticles. There are five different aerosol methods in use for nanoparticle synthesis. They are (i) furnace method (ii) flame method (iii) electro spray (iv) chemical vapor deposition and (v) physical vapor deposition method. Nanoparticle may characterize after using Particle Size Analyzer, Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Fourier Transform Infrared Spectroscopy, Lithography, UV-VIS Absorption Spectroscopy and X-ray diffraction.

The intense problems confronting productivity in agriculture, such as several abiotic and biotic stress factors, require more precise and effective solutions; and products with higher efficacy are further required to mitigate the stress. Nano-technology can improve our understanding and also deliver better products. It can contribute to the development of improved systems for monitoring environmental conditions and delivering nutrients or appropriate pesticides and thus potentially enhance yields or nutritional values. Thus, nanotechnology can be an important part of the further agriculture, food systems and industry. This frontier area of technology has potential to revolutionize in every sector of agricultural and food industry after providing Nanosensors for contaminant detection, water flow detection, disease diagnosis and tracking use of elite lines, breeds as well as cultivars; Nanomembranes for purification, desalination and detoxification; Nanoparticles for preparation of nanofertilizers, robust water tanks to prevent seepage, liquid and gaseous fuels-based lighting, cooking materials, pesticides, hormones, vaccines, solar cell panels; Nano-catalysts for hydrogen generation etc.; Nanozeolites for efficient release of water, slow release of fertilizer particles; Nanomagnets for soil health testing, removal of soil contaminants; Nano-emulsions for enhancing shelf-life; Quantum dots for diagnosis; Nanoscale formulations of different food products for flavoring, refining catalytic devices in oils, dairy, meat, poultry products; Nanocomposite particles in packaging materials; Nanocapsules for better nutrient delivery, bioavailability. Nanotechnology gives strong impact on food preparation and conservation. It has great promise of sustainable development in long term and second green revolution.

***Dr. J.C. TARAFDAR**, did graduation from university of Kalyani (West Bengal) and M. Sc. as well as Ph. D. from IARI, New Delhi and Post Doctoral Research in Germany as DAAD Fellow. He worked his carrier in the Agricultural Research Service of the ICAR as Scientist and subsequently worked as Senior Scientist and Principal Scientist. At present he is working as ICAR National Fellow since 1999. He was a visiting scientist for two years in Germany after receiving most prestigious Alexander von Humboldt (AvH) fellowship. He also worked in USA on Nanotechnology.

Dr. Tarafdar has developed an in-vivo filter paper technique for phosphatase estimation, biological phosphorus (bio-phos) fertilizer, sequential P fractionation scheme, rapid method for assessment of plant residue quality, potential biological indicator, soil solarization technique for mass scale AM fungi production, freeze drying technique to understand nutrient movement, electrofocusing technique to demonstrate origin of enzymes, technique for biological nanoparticle production and nanoinduced polysaccharides. Dr. Tarafdar has published 256 research articles in National and International journals including two books. In recognition of his professional contribution, Dr. Tarafdar received many awards most notable are Bharat Jyoti Award, IMPHOS-FAI Award, Sukumar Basu Memorial Award, Prof. S. K. Mukherjee Memorial Award and Prof. R. S. Murthy Memorial Award. He is fellow of most prestigious NAAS of India, ISSS, and ISSRS.