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REVIEW PAPER

A synoptical overview of nanotechnology for agriculture and health security

VIRENDRA SINGH GAUTAM*, VAISHALI AND TANU PRIYA
Department of Biotechnology, Sardar Vallabh Bhai Patel University of Agriculture and Technology, Modipuram, MEERUT (U.P.) INDIA (Email : vgbiotech@gmail.com)

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The current global population is more than 6 billion with 50 per cent living in Asia. A large proportion of those living in developing countries face daily food shortages as a result of environmental impacts or political instability, while in the developed world there is a food surplus. For developing countries the drive is to develop drought and pest resistant crops, which also maximize yield. Nanoscale science, engineering, and technology, which is more widely known using the novel term 'nanotechnology', is an emerging multidisciplinary field that can have enormous potential impact on our society. Globally, an estimated $9 billion per year is allocated to research and development in nanotechnology, with the expectation that this investment will lead to significant advances in a variety of applications including medicine, material science, computing and electronics, industrial manufacturing, environmental remediation, energy production, military applications, among others. The agricultural industries are no exception. So far, the use of nanotechnology in agriculture has been mostly theoretical, but it has begun and will continue to have a significant effect in the main areas of the food industry, development of new functional materials, product development, and design of methods and instrumentation for food safety and bio-security. The effects on society as a whole will be dramatic (Fig.1).

The term 'nano' is used as a prefix "nano" which is from the Greek word meaning "dwarf". Idea of nanotechnology given by K.Eric Drexter in 1979, also wrote a book in 1986, entitled as engine of creation: the coming era of nanotechnology. The term coined by Norio, Taniguchi in 1974. In more technical terms, the word "nano" means 10^{-9}, or one billionth of something, For comparison, A leckocyctes has size of 10,000 nm, bacteria 1000-10,000, virus 75-100 nm, protein 5-50 nm, deoxynuclotude (DNA)~ 2 nm (width) and an atom ~0.1 nm.

The word nanotechnology is generally used when referring to materials with the size of 0.1 to 100 nanometres, however, it is also inherent that these materials should display different properties from bulk (or micrometric and larger) materials as a result of their size. These differences include physical strength, chemical reactivity, electrical conductance, magnetism, and optical effects. There are two main approaches used in nanotechnology, bottom up approaches and top down approaches. The bottom up technique built or grows larger structure atom by atom or molecule by molecule. These techniques includes to chemical synthesis, self assembly and positional assembly. Top down approaches which means reducing the size of the bulk material structure to the nanoscale without atomic level control *eg*. Atomic layered depositions

*** Author for correspondence**
Vaishali, Department of Biotechnology, Sardar Vallabh Bhai Patel University of Agriculture and Technology, Modipuram, MEERUT (U.P.) INDIA
Tanu Priya Sharma , S.S.V. (P.G.) College, HAPUR (U.P.) INDIA