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Perspective

Sustainable and precise agriculture facilitated by nanotechnology and artificial intelligence

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DESCRIPTION

The creation of smart and active packaging, nanosensors, nanopesticides, and nanofertilizers are just a few examples of how the conventional food and agricultural industries have been transformed into the rapid growth of nanotechnology. For the enhancing food quality and safety, agricultural development, and environmental monitoring, several new nanomaterials have been produced. The most current developments in nanotechnology are reviewed in this overview, along with the most difficult problems and exciting prospects in the food and agricultural industries, as shown by a few recent researches. These novel foods and agricultural products contain nanomaterials, and the basic principles of toxicology and risk assessment are also covered. It emphasised how bio-synthesized and bio-inspired nanomaterial may be used for sustainable development. To encourage the active research and implementation of nanotechnology, basic concerns about high performance, low hazardous nanomaterials must be answered. Regulation and inspection are essential for controlling the production, processing, use, and disposal of nanomaterials. To increase public acceptability of the revolutionary nano-enabled food and agriculture products, further work has to be done. It can be concluded that nanotechnology presents a wide range of potential by offering a fresh and sustainable alternative in the food and agricultural industries.

The widespread use of nanotechnology in daily life is revolutionising civilization. Since the US Department of Agriculture issued the first roadmap on September 9, 2003, it has been marching into the agricultural and food industries. During the last ten years, study on this subject has increased dramatically. Agriculture, irrigation/water filtration, food processing and packaging, animal feed, and aquiculture are just a few of the areas that it completely covers in the food and agricultural sector. The food and beverage business is a multi-trillion dollar one worldwide. According to a recent projection, nanotechnology will have a $3 trillion global economic effect by 2020, which might result in the employment of 6 million people in the expanding nanotechnology industry throughout the world. This is incredibly alluring, which is what has motivated many food businesses to create and commercialise revolutionary nanomaterial-based goods while also enhancing manufacturing effectiveness, food features, flavour, and safety. Amazingly, during the previous ten years, hundreds of items have already been commercialised and used in the food industry. The majority of these items, or food-contacting materials, are created “outside” of food yet “within” the food business. Apart for titanium dioxide and iron oxide, which have already been utilised as food pigment and colourants, no innovative nanomaterials-containing products have yet been directly incorporated into human food. The primary problem is that there is very little regulation and law pertaining to nanofood, particularly because nanomaterials are complicated and case-by-case legislative processes are used. Several research focus on the *in vitro* toxicity of nanomaterials but there is a dearth of information on their *in vivo* toxicity, not to mention their chronic effects. This lack of understanding about toxicity and danger, which innovative nanomaterials potentially bring, is a deeper reason of the restricted regulation. At least a few gaps need to be filled, including those related to the toxicity of nanomaterials to mammal cells, tissues, and organs and their long-term effects on human health, the migration of nanomaterials into food, their degradation or environmental fate, and their bioaccumulation and effects on ecosystems. Public approval is another crucial factor that is frequently disregarded by authorities, producers, and academics. In the end, it decides whether nanotechnology can be used and/or approved by consumers. Every area of the food business, from food production to food processing to food storage to food transportation to our plates, can and has extensively used nanomaterials. The trash will ultimately be disposed of into the environment and have a specific influence

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on flora, fauna, and ecosystems regardless of the population of people who adopt these unique nanofoods. Sadly, there is not much information here. Even worse, no researcher, food industry, or government body has yet to discuss the appropriate disposal strategy. Moreover, the evidence on the *in vivo* toxicity of nanomaterials is quite inadequate, particularly the possible long-term impact on human organs.