**Impact of genetically modified crops on environment and human health Indra Jeet Chaudhary1, Bhavna Nigam2 and Mangesh vedpathak3**

1Department of Environmental Science, Savitribai Phule Pune University, (University of Pune), Ganeshkhind Road Pune, Maharashtra- 411 007, India

2School of Environment & Sustainable Development, Central University of Gujarat, Gandhinagar Sector-30, Gujarat -382030

3Shriram Institute of Information Technology, Paniv, Tal-Malshiras, District Solapur, Maharashtra, India

Corresponding author:mvedpathak512@gmail.com

**Abstract**

The remarkable increasing population in the world turned in to food hunting and global food crises. Population control is a very daunting task. A fixed amount of land is available for farming. Therefore Millions of people suffer from hunger and malnutrition. Biotic and abiotic stresses are also declined the crop yield. Biotechnology advancements have been shown to increase food production both quantitatively and qualitatively. The enhancement of food quality and nutrition observed by changing its composition was also seen in in certain specific cases. However, the use of biotechnology has also given rise to concerns about environmental and human health risks. Genetic Engineering gives funds to host genes into plants via mechanisms, different in some respects from classical breeding. Numerous genetically modified food kinds have been developed, which are now essential nutraceuticals; Most recently, modern technology was used for developing canola, cotton, maize, and soybean crops, and at present, the traits introduced are herbicide or pest tolerance. Plant production increases because of gene technology, which also increases the plant's resistance to pests, viruses, frost, etc. Gene transfer technology is utilized to change the physical and chemical composition with nutraceutical worth. The current chapter compiles the information on the effects of genetically modified foods on the environment and human health.

**Keywords:** Ecological concerns, Genetic Engineering, Genetically modified foods

**1. Introduction**

The genetically modified organisms (GMOs) are demarcate as organisms (except humans), whose genetic material has been altered in a specific way through mating and/or normal replication. Microorganism’s *viz.* yeast and bacteria, plants, insects, mammals and fish are examples of GMOs (Lee and Gelvin, 2008). Since genetically modified organisms are the main ingredient in GM foods, they are typically employed in scientific research and the manufacturing of products other than food. (Lee and Gelvin, 2008; Park, 2007). The technical legal phrase "living modified organism" and the word "GMO" are closely connected, as the definition of the cartagena on Biosafty, which reflects to regulate global trade in living GMOs, specially, "Any living thing that results from the inventive merging of genetic material obtained through the application of modern biotechnology" (Nielsen, 2003; Melo et al., 2007). It has been noted that GMOs have several uses in biological and medical research, the manufacturing of pharmaceutical medications, agriculture, and experimental medicine (Shipitalo et al., 2008; Hutchison et al., 2010). Due to increased food demand and improved food quality, the application of gene technology in food production has become incredibly interesting (Izquierdo, 2000).

Nature frequently concerns itself with geology and wildlife in its different applications in recent times. The term "nature" may be used to describe a variety of living things, including plants and animals, and in certain cases to the processes connected to inanimate objects, such as the weather and Earth's geology, as well as the matter and energy that make up everything. Wild animals, rocks, woods, beaches, and other natural features that have not largely been altered by human activity are usually thought to represent the "natural environment" or wilderness, or that endure despite human interference. Factory-made items and human interaction, for instance, are not often seen as elements of nature, even if they are referred to as "human nature" or "the entirety of nature." This more traditional concept of a natural things, that can still be found recently, implies a distinct difference between the natural and the artificial, with the artificial being defined as anything created by a human consciousness or mind Based on the context, the concept "natural" may be differentiated from the unnatural, supernatural, or synthetic. It is important to distinguish between modern, synthetically created foods and naturally produced foods from farms that are popular in today's era. The effective application of gene technology to plants and animals can achieve goals more quickly than conventional selection. As a result, ethical quandaries regarding the long-term negative effects of genetically modified foods are raised. It appears that intake with nutraceuticals and wild foods, as well as a wild lifestyle, may be more protective, while a western diet and lifestyle may increase the expression of genes linked to various chronic diseases. MicroRNA is most likely regulating human genes or physiological/biochemical mechanisms (Wong et al., 2000; Mishra et al., 2009). Because they contain recognisable Mendelian subsets, the presence and mortality due to multi - factorial polygenic diseases such as diabetes, hypertension, coronary artery disease (CAD), and cancer have a varied contingent with genetic susceptibility and environmental forebears. Rapid changes in diet and lifestyle may have an influence on the heritability of variable phenotypes that rely on nutraceutical or functional food supplementation for their specific expression.

It is likely that the interaction between particular nutraceuticals and the genetic code that all nucleated cells possess will be recognized. Research data suggests that South Asians are more susceptible to developing CAD, diabetes, central obesity, and insulin tolerance at a younger age, It could be the outcome of a gene-environment interaction (Mishra et al., 2009). The negative effects could be detrimental to one's health, the environment, aetiology, society, and, eventually, ethical concerns (Mishra et al., 2009). The investigations that have been done so far along various theories and goals about the physiological and biochemical characteristics of genetically modified organisms and the resulting foods are summarized here.

**2. Development of genetically modified organisms**

Different innovative methods for creating GMOs are acknowledged in a systematic manner. An alien gene that is likely to be incorporated into microbial, plant, or animal cells is known as a transgenic. It is recognised as transgenic when It gets incorporated into the recipients' genomes. There are several methods for incorporating a transgene into a cell: I Bacteriophage-mediated transduction (Lujan et al., 2007; Petrescu-Mag and Bourne, 2008) (ii) Transgene injection using pronuclear microinjection (Mishra et al., 2009); (iii) Transfer using modified viruses and plasmids (Haase et al., 2010; Garcia et al., 2010); (d) Electroporation technique that achieves higher cell membrane permeability (Garcia et al., 2010; Miklavcic et al., 2010; Thomson et al., 2011). Non-natural chromosomes or chromosome fragments can also be used to transfer alien genes. Transgenes can be transmitted into egg cells by spermatozoa made up of chromosome fragments (Singh and Niaz, 1999). It has been observed that developed nations with material and intellectual resources point to research on transgenic technology for increased production and enhanced quality of food. In fact, there is not only plenty, but also too much food in the developed world.

Additionally, developing countries that require this technology to overcome the food scarcity cannot afford it (Smolin and Grosvenor, 2000 and Andrew and Daniel, 2011), thus leading towards the mandatory development of GMO, most likely getting proposed as 'nutraceuticals'.

**3. Benefits of Genetically Modified foods**

**3.1 Pest Resistance**

 Frequently, it has been noted that genetically modified crops (GM crops or biotech crops) are plants whose DNA has been altered through techniques of genetic engineering to resist pests and specific agents that cause damage to plants and to keep improving the growth of these plants to aid farmers' adequacy. The techniques of genetic engineering are far more accurate (Bock, 2010) as compare with mutagenesis, which involves exposing an organism to chemicals or radiation in order to create non-specific but reliable modifications. Selective breeding, animal, plant, and somaclonal variety are some other techniques utilized by humans to modify food organisms. The main goal in most cases is to introduce a new characteristic to the plant which normally does not occur naturally in this species. The production of a particular nutrient or pharmacological agent is another example, as is resistance to specific pests, diseases, or environmental conditions. Methods of growing GM foods *viz,* BT corn could indeed help in eliminating utilization of chemical pesticides while also reduction the cost of bringing a harvest to commercialise (Moellenbeck et al., 2001).

**3.2 Herbicide Tolerance and Disease Resistance**

Crop plants that have been genetically modified to resist a single powerful herbicide which reduce the need for herbicides and assist in protecting the environment (Gassmann et al., 2011; Federoff et al., 2010), lowering production costs while reducing the risk of agricultural residues run-off. Plant diseases are caused by bacteria, fungi, and viruses. Plant scientists, supported by the result of modern comprehensive profiling of crop composition, the results of modern comprehensive comprehensive crop composition profiling suggest that crops modified GM techniques are less than likely to have unexpected variation than conventionally bred crops (Catchpole, 2005). As technology develops, plant biotechnologists are striving to develop plants with genetically modified resistance to certain particular plant diseases. (Fairbairn et al., 2007).

**3.3 Cold, Drought and Salinity Tolerance**

Potato and tobacco plants have recently implemented an antifreeze gene from cold-water fish, allowing them to withstand cold temperatures that would normally kill unmodified seedlings (Fairbairn et al., 2007). As the world population increases and more land is used for housing instead of food production, farmers will need to produce crops in previously unsuitable regions. Plants that can withstand prolonged time of drought, cold, or high salt concentration in groundwater or soil will help populations in growing crops in unfavourable conditions (Kenward et al., 1999; Zhang and Blumwald, 2001).

**3.4 Nutrition**

Third-world nations have a high rate of undernourishment because the population is largely dependent on a single crop, example rice, as the mainstay of their diet. Moreover, all essential elements for preventing malnutrition are insufficiently present in rice. If rice could be genetically modified to also include other vitamins and minerals with sufficient nutraceutical (physiological and biochemical) value, Nutrient reduction could be alleviated. The Swiss Federal Institute of Technology's Institute for Plant Sciences conducted successful research that led to the creation of "golden" rice with unusually high beta-carotene (vitamin A) content (Tang, 2000; Ye et al., 2000). In order to enhance the high iron content of golden rice, more study is being done on this particular idea and purpose.

**3.5 Pharmaceuticals**

It is well known that producing medicines and vaccines can be expensive and that they occasionally require special storage conditions. Work on these specific initiatives to create targeted edible vaccinations for potatoes and tomatoes (Perr, 2001; Mishra et al., 2008; Karaman et al., 2006), probably easier to transport, store and administer as compared to conventional injectable vaccines (Mishra et al., 2008).

**3.6 Phytoremediation**

Plants like safflower (Madan et al., 2001; Mudgal et al., 2010) and poplars (Ahmed and Focht, 2001) have been genetically modified to improve physiological and biochemical traits important for the elimination of heavy metal contamination from nearby contaminated soils. A biotechnological application known as phytoremediation is used for removal of pollutants in plants and it is also a modern technology utilized for cleaning the environment. Because of their unique physiological, biochemical, and genetic characteristics, plants can identify the best treatments for soil and water restoration. As a result, safflower mature leaves, roots, and seeds accumulate Hg and Se. (Carthamus tinctorius L), evaluated after being cultivated hydroponically in 10.4 M solutions of phenylmercuric acetate and selenium dioxide for eight days. Tolerance was quantified and then categorized as tolerant, partially tolerant and intolerant using the response coefficient parameter. The accumulation of different pollutants in roots, in mature leaves and seeds, in five of tolerant, partially tolerant and intolerant plants was evaluated. Data from studies (Ahmed and Focht, 2001; Madan et al., 2001; Mudgal et al., 2010) provide new insights into the products that can be extracted with low levels of mercury and selenium in the aerial parts of certain economically and nutritionally important angiosperms.

**4. Disadvantages of Genetically Modified foods**

The disadvantages of genetically modified foods can be broadly classified as follows:

**4.1 Environmental Hazards**

Diminished pesticide effectiveness comes as mosquito populations created protection from DDT, a now-banned as pesticides; many individuals are concerned that insects will build up resistance to Bt. or other crops that have been genetically modified to produce their own pesticides. Nonetheless, gene transfer to non-target species is a worry since crop plants engineered for herbicide resistance and weeds will cross-breed, tends to result in the transfer of herbicide tolerance genes from crops into weeds, which will most likely be tolerant herbicide (Kenward et al., 1999; Zhang and Blumwald, 2001).

**4.2 Human Health Hazards**

The possibility that GM foods could harm a person's body poses the greatest hazard from them. It is believed that consuming these genetically engineered foods will lead to the development of antibiotic-resistant diseases. According to reports, a number of children in the United States and Europe have developed dangerous allergies to peanuts and other foods. (Nordlee et al., 1996). Furthermore, due to these foods are new one, little is known about their long-term effects on humans. Many people avoid these foods because the health effects are unknown. Incorporating a gene into a plant may result in the development of a new allergen or the induction of an allergic reaction in susceptible individuals. A proposal to insert a gene into soybeans from Brazil nuts was dropped due to concerns about causing unexpected allergic reactions (Nordlee et al., 1996). Furthermore, a current Lancet document (Hartmann et al., 1999). Investigated the effects of GM potatoes in rats digestive tract. Besides that, the gene introduced from a snowdrop flower lectin into the potatoes was a substance known to be toxic to mammalian systems. It is true that animal lectin yields are typically low when compared to plant lectin yields such as legume lectins. Lectins exhibit immunomodulatory, antitumor, HIV-1 reverse transcriptase inhibitor, antifungal, and antiinsect actions that may have practical applications. Only a few lectins have antinematode and antibacterial properties (Lam and Ng, 2011).

**5. Genetically modified crops**

**5.1 Bt Cotton**

India's principal fiber crop is cotton, having around 9.5 million hectares (mha) of land under cultivation, accounting for roughly about one-fourth of the global area of 35 million hectares under cultivation. The majority of this accomplishment can be attributed to the incorporation of Bt cotton in the previous few years, prior to which due to its susceptibility to insects and pests, cotton output continued to suffer significant losses. Every year, India uses insecticides on all of its crops, costing about US$660 million, with cotton accounting for roughly half of the total (Manjunath, 2004; Rai et al., 2009). Japanese researcher Ishiwata discovered the widespread soil bacteria Bacillus thuringiensis (Bt) in 1901 (James, 2008). Later research revealed that select Bt strains (Cry+) were incredibly poisonous to the larvae of particular insect species that are plant pests. Successive studies have revealed that Bt contains proteinaceous crystals that end up causing mortality in insects that have receptor proteins in their gut membranes that associate to Bt proteins. Other organisms that lack Bt protein receptors are not affected by the contaminant molecules. The development of genetic transformation technology has facilitated the insertion of cry genes and, eventually, the capacity for plant cells to create Bt proteins, which finally kill the target insect larvae damaging plant crops. It is also known that GM technology might affect the environment, as well as animal and human health, unintentionally. These risks include the creation of new viruses, the appearance of new weeds, the deterioration of crop diversity, allergenicity and toxicity, the development of antibiotic tolerance in microorganisms, and harmful effects on non-target creature (Gupta et al., 2008). In many ways, Bt cotton is an ideal choice for incorporation as a transgenic cash crop. It is typically grown as a fibre crop, and the cotton seed oil used for consumption is free of proteins, along with Bt protein. In terms of allergenicity and toxicity to mammals or other non-target animals, the safety of Bt toxins has been well-documented (Glare and Callaghan, 2000; Betz et al., 2000). The lack of receptors that bind to Bt toxins, as well as their rapid degradation in digestive system of humans, renders them harmless to humans. Community exposure to Bt spray mixture has not had any detrimental effects during the past 60 years. Bt toxins are non-allergenic due to their lack of homology to any allergenic protein/epitope sequences. Additionally, a lot of research has been done on Bt crop protection (OECD, 2007; Lemaux, 2008). Recent research has examined and confirmed the effects of Bt growing crops on non-target creatures such insect predators, diseases, and parasitoids (Babendreier et al., 2008). The efficiency of Bt crops against significant pest species between 1996 and 2006 was associated with a worldwide drop in the use of insecticide active ingredients of about 137 million kg (nearly 30% reduction). Advantages vary by region and country, but are weighted heavily toward production of cotton, that has in the past been one of the world's biggest insecticides users (Naranjo, 2009).

**5.2** Golden Rice

Carrots get their bright orange colour from beta-carotene, which is converted into vitamin A in the human body. However, vitamin A deficiency affects approximately 250 million people. As a result, approximately 500,000 children become blind each year as a result of vitamin A deficiency, with more than half of these children dying within months. Idyllically, everyone would eat a diverse diet full of fruits and vegetables rich in vitamin A and other nutrients. Every year, better nutrition could prevent up to two million deaths in children under the age of four. But that requires much wealth for the world, which is a long way off. Nearly half of the current population subsists on white rice, which did not contains vitamin A. Making rice more nutritious might significantly benefited people's lives (Magana-Gomez and de la Barca, 2009). Furthermore, the bioavailability of carotene has been confirmed from golden rice, and it has been observed an appropriate source of Vitamin A (Datta et al., 2007; Tang et al., 2009). Golden Rice was possibly the first genetically engineered crop particularly designed to come over from malnutrition. A biofortified crop, mainly Golden Rice, has the distinct advantage of being easily accessible to remote rural populations that do not have access to nutritional programmes (Moghissi et al., 2015; Van Loo-Bouwman et al., 2014)

**5.3 Potatoes**

A number of impoverished nations have been noted to be unable to avail vaccines. Clinics are frequently unable to sterilise needles or refrigerate vaccines. These problems make it extremely difficult to protect millions of children. Furthermore, most vaccines are used to make the pathogenic organism that causes the particular disease. The World Health Organization challenged scientists in 1991 to develop a safer, simpler, and less expensive method of vaccinating children. Some scientists initiated a brainstorming session centred on plants. Because plants evidently produce a wide range of compounds, it is unclear whether they can be reprogrammed to generate edible vaccines (Naranjo, 2009) The greater part the food in the supermarket contains GM subsidiaries, world hunger is at an untouched high, and there is a laundry list of disease connected to consuming GM foods, which including but not limited to autism and infertility.

**5.4 BT Brinjal**

Toward the finish of first ten years of twentieth hundred years, The GEAC (Genetic Engineering Approval Committee) of the Ministry of Environment, India's regulatory agency for authorising GM crops, granted commercial permission to Bt brinjal, the first GM crop of India, (Menon, 2009). The approval was granted as a result of reports submitted by the Mahyco (Maharashtra Hybrid Seeds Company Limited), which uses biotechnology to produce pest-resistant crops in large quantities. Bt Brinjal is a genetically modified plant that contains a gene associated to soil bacterium *Bacillus thuringiensis* is integrated into the brinjal's genome and can then be expressed as Cry1Ac, a protein, is produced. Against the shoot and fruit borer (SFB), this protein functions as a toxin, a pest that primarily affects brinjal. The gene change also includes the addition of two antibiotic conflict indicator genes (Menon, 2009). As a result, the obtained results could raise few concerns about the acceptability and safety of GMO food, as well as provide some credibility to the numerous consumers who are still hesitant to accept food produced using gene engineering technology.

**6. Relevance of Genetically Modified plants to human nutrition**

Currently, about 842 million people worldwide are malnourished, which means they do not have enough food to eat (FAO 2013). Furthermore, malnutrition, which affects approximately 2 billion people globally, is not caused by a shortage of calories but rather by a lack of essential micronutrients in daily eating habits (Von Grebmer et al., 2014). Individuals who experience the malnutrition frequently consume feasts which base on a staple crop, which results in a lack of access to the other wide variety of vegetables and fruits necessary for a healthy diet. As a result, poor nutrition is responsible for nearly one-third of all deaths of children’s under 5 year age globally, and one in every four children is stunted due to lack of nutrition (Maternal and Child Nutrition, 2015).

By adding a suitable mineral or inorganic substance into fertilizer, crops can be genetically modified, by traditional plant breeding, or by using biotechnology. Even though the implementation of nutritional micronutrient fertiliser is the simplest of these methods, its success is highly variable due to variation in mineral transport and accumulation between many plant species and various soil contents in the particular regions of each crop. It is likewise important to use the micronutrient routinely to the soil, accordingly expanding both expense and work.

Another important factor is the specific type of micronutrient that is consumed. For instance, the natural forms of a specific micronutrient can be integrated into tissue proteins, such as red blood cells and skeletal muscle, even more efficiently (Rayman et al., 2008) Natural types of micronutrients can likewise be put away more actually by the body and micronutrient status held for longer timeframes than inorganic micronutrients (Rayman, 2012). Genetically modified food crops with minerals *viz.* selenium, zinc and iodine have been accomplished utilizing this methodology (Dai et al., 2004; Hartikainen, 2005; White and Broadley, 2005). Nutritionally upgraded foods increase nutrient intake, thereby preventing and treating major causes of death *viz.* cancer, cardiovascular disease, hypertension and diabetes. Enhancing the content of nutrients in daily food intake has immediate effects, but the long‐term impact that reach out for a really long time throughout the span of an individual's lifetime.

In several developing nations, plant based daily nutrient accounts for 100% of an individual's supplement diet, recognizing the significance of nutritionally improved crop derived food sources. The benefits of nutritionally improved genetically modified crops and food sources may not be noticed for many decades as the later-life advantages of enhanced childhood nutrition are clearly understood.

**7. Conclusion**

Genetically modified foods can possibly tackle a considerable lot of the widespread starvation's and unhealthyiness issues, while also helping to conserve and protect the environment through increased yield. The most recent developments in biotechnology, especially in genetic engineering, molecular biology, and transgenic technology, provides a wide range of potential applications in food production. which include microorganisms, plants, and animals. Genetically modified foods have both benefits and drawbacks. There are numerous advantages to GM foods, including high yield, cold, salinity and drought tolerance, herbicide disease resistance and insect resistance, improvement in nutrients, phytoremediation and pharmaceutical functions. However, genetically modified foods are harmful to living things. The disadvantages include health risks, environmental hazards, economic concerns, and legal issues. Toxicology, allergenicity, and genetic hazards are the main health risks that are associated with GM foods. These can result from inserted genes and their articulated protein sperse, optional or pleiotropic impacts of gene expression products, and possible disturbance of natural genes in the manipulated organism. Several nations have presently developed a biosafety regulatory management to control the trans boundary movement of GM organisms in order to avoid potential risks to human health, biodiversity, and the environment.

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