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Are Genetically Engineered Crops Safe or Dangerous?

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Abstract

Genetically modified crops have the potential to solve many of the World's hunger and malnutrition problems. They also protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet, there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the hope of the future. The current uses of GE focus on increasing production by addressing such issues as insect and weed control, but additional applications are being explored. It is believed that GE methods will allow for more rapid adaptation to climate change and plants with increased drought and salt tolerance are in development. The number of acres planted in GE crops has increased dramatically since their introduction in 1996. Opponents to GE crops have pointed out that highly publicized efforts to help farmers in developing countries and the world's poor have not come into production. Every technology comes with potential risks and these risks must be evaluated. Genetic engineering of food and fiber products is inherently unpredictable and dangerous for humans, for animals, the environment and for the future of sustainable and organic agriculture. The hazards of GE crops falls mainly into two categories : human health hazards and environmental hazards . A brief look at the already proven and likely hazards of GE products provides a convincing arguments for why we need a global moratorium on all GE foods and crops. This article shows the work for deep debate on benefits and risks of Biotech-crops for human health, ecosystems and biodiversity.

Key words: Biotechnology; genetically modified crops (GM); Benefits regulation; risk assessment.

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1- Introduction

One of the greatest challenges before mankind today is to ensure adequate food security for the ever- increasing world population, currently around six billion people [1]. The global human population has increased six folds from one billion to six billion peoples since the year 1850. By the year 2050, estimates are that the population will be almost nine billion people [2]. At the same time food availability per capita has increased and the amount of land area used for farming has tripled but farming captures a smaller share for the global workforce [2]. Gradual agricultural production intensification through increased reliance on the use of synthetic materials like fertilizers, pesticide and the increased use of irrigation have led to these trends**,** [3].Yet despite abundance produced by modern agriculture, large percentage of the global population remains vulnerable to food shortages[4]. Unfortunately, cropland and population are not uniformly distributed. For example, China has only 1.4% of the world's productive land but 20-25% of the world's population [5]. China urges further protection of arable land. This situation is further aggravated by diminishing crop land due to erosion, fewer renewable resources, less water, and a reduced population working the land.

The destruction of wilderness, forests and continued use of coal and oil have led to a steady increase in carbon dioxide levels, resulting in global warming. It is expected that the average global temperature will rise by 2˚ F to 11.5˚F by 2100 depending on the level of future greenhouse gas emissions and the outcomes from various climate models[6].Climate change can radically alter rainfall patterns and therefore require the migration of people and shifts in agricultural practices. Further, an increasing in human population is responsible for wilderness destruction, water quality problems, and diversion of water. The loss of habitat has resulted in many species being displaced. Thus, to conserve forests, habitats, and biodiversity, it is necessary to ensure that future food requirements come only from cropland currently in use.

Human health is not achievable unless adequate quantity and quality of nutritious and safe foods are available and accessible during all life stages. An estimated one-third of the world's population, largely in the developing world, is currently food and nutrition in secure [7,8]. The biologic imperatives for achieving nutrient and food security, as well as humanitarian concern, are the driving forces behind efforts to achieve equitable food distribution among today's global population [9, 10]. Food systems, therefore, are challenged to meet current global needs and those of the future in the light of mounting population pressures and rising quality-of-life expectations, while recognizing increasingly limited arable farm resources. A principle assumption is that the resolution of food and nutrition problems and challenges of today and tomorrow have technological dimensions. Transgenic modification (GM), traditional and modern, applied to plant and animal food sources hold potential for improving human nutrition and health provided that the capabilities for using GM crops are available in the developing as well as the developed world [11]. Coexisting with potential benefits of genetic modifications of plants and animals are known and unknown risks, as is common to all technologies [12]. Under it, three agencies –the United States Department of Agriculture (USDA), The Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) were given the task of adopting existing status to govern the new technology. Beginning in 1987 and continuing to the present the agencies have announced officially a number of new rules and regulations. Opponents are concerned that negative impacts will not be evident until long into the future when changes are difficult to control. The objective of this review is to provide an outlook of some of the benefits utilizing GM crops, saving lands and reducing pesticide use. Also, the concerns associated with agricultural biotechnology are taken in consideration. Implicit in the latter assumption is that absolute safety is not an achievable standard.

1.1. What are Genetically Modified Organisms (GMO)

The introduction of foreign germ plasm into crops has been achieved by traditional crop breeders by artificially overcoming fertility barriers. A hybrid cereal was created in 1875 by crossing wheat and rye [13]. Since then important traits have been introduced into wheat including rust resistance [14]. Traditional breeding techniques, which genetically modify plants and animals for thousands of years through selective breeding, genetic organism's, has now applied refers to the introduction of specific foreign genes into an organism's genome through the techniques of molecular biology. The first GM crops became commercially available in the mid-1990s since then, GM crop adoption has increased rapidly. In 2008, GM crops were being grown on 9% of the global arable land [15], more than 148 million hectares of farmland are under cultivation for biotech crops throughout the world [16]. There has been a 60-fold rise in the application of Agri-biotechnology since 1996, when the first biotech-crop was commercially produced [17]. Major producers of GM crops include technology on USA, Argentina, Canada, and China [18]. In the US, about 80% of maize, cotton and soybean biotech varieties [18,19]. In Canada genetically engineered ingredients are used in more than 70% of the processed food products [20]. The current rate of biotech crop adoption is remarkably higher in developing compared to industrialized countries (21% vs. 9%) [17]. Developing countries are rapidly accepting the technology with the hope of overcoming hunger and poverty. These countries account for 40% of the global farmlands used for GM crop cultivation [17]. A record of 181.5 million hectares of biotech crops were grown globally in 2014 at an annual growth rate between 3 and 4 % up to 6.3 million hectares from 175.2 million hectares in 2013. The year, 2014 was the 19th year of commercialization, 1996 – 2014 when growth continued after a remarkable 18 consecutive years of increases every single year. (Global Status of Commercialized Biotech/ GM Crops [21]. It is expected that, by the end of year 2015, more than 200 million hectares will be planted by biotech crops in about 4 countries [17].

The majority of the Biotech-crops available on the global market have been genetically manipulated to express one of these basic traits: resistance to certain pests, diseases as for example viruses, tolerance to certain herbicides and nutritionally enhanced quality. Genetically modified (GM) crops have been discussed as one of the possible ways forward with the aim of combining higher yields, improved food and feed quality with environmentally friendly agronomic practices [22].

Examples in non-food crops include production of pharmaceutical agents, bio-fuels, and other industrially useful goods, as well as for bioremediation [23].

Transgenically modified crop plants are projected to give rise to benefits and risks in two broad areas: health and the environment. Four items of health benefits are recognized: enhancement of food security; enhancement of nutrient security; more targeted health benefits, such as, adult-onset chronic diseases through the manipulation of specific food components, e.g. manipulation of fat composition. Health risks associated with the approaches that are reviewed generally as allergies, toxicities, nutrient imbalances, and decreasing diet diversity.

1.2. History of Genetic Engineering (Related to history)

Genetic engineering of organisms began early in the 1970^{s} with the ability of scientists to clone genes and insert them in bacteria, such transgenic organisms could be made to produce the gene products of the inserted gene allowing scientists to produce drugs and biochemical products._The first GMOs were bacteria generated in 1973 and GM mice in 1974. Insulin-producing bacteria were commercialized in 1982 and genetically modified food has been sold since 1994. Glofish, the first GMO designed as a pet, was first sold in the United States December in 2003 [23].

Fraley and his colleagues [24] recorded that the first genetically modified plant was produced in 1982, using an antibiotic – resistant tobacco plant. However, James [25] stated that the first field trials of genetically engineered plants occurred in France and the USA in 1986 when tobacco plants were engineered to be resistant to herbicides. In 1986, the Reagen administration formally published a description of the biotechnology regulatory frame work. Under it, three agencies – the United States Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) were given the task of adapting existing status to govern the new technology. Beginning in 1987 and continuing to the present, the agencies have announced a number of new rules and regulations. Vaeck and his colleagues [26] reported that Genetic engineering, founded by Marc Van Montagu and Jeff Schell (Ghent, Belgium), was the first company to develop genetically engineered tobacco plants with insect tolerance by expressing genes encoding for insecticidal proteins from *Bacillus thuringiensis* (Bt). James [27] added that the People's Republic of China was the first country to allow commercialized transgenic plants, introducing a virus resistant tobacco in 1992. The first genetically modified crop approved for sale in the U.S., in 1994 was the *Flavr Savr* tomato which had a longer shelf life [28]. In 1994 the European Union approved tobacco engineered to be resistant to the herbicide bromoxynil, making it the first commercially genetically engineered crop marketed in Europe [29]. In 1995, Bt potato was approved safe by the Environmental Protection Agency (EPA), making it the first pesticide producing crop to be approved in the USA (Genetically altered potato for crops. The following transgenic crops also received marketing approval in the US in 1995. Canola with modified oil composition (Calgene). Bt corn/ maize (Ciba- Geigy), Bt cotton (Monsanto), soybean resistant to herbicide glyphosate (Monsanto), virus resistant squash (Asgrow) and additional delayed ripening tomatoes (DNAP, Zeneca/Peto, and Monsanto [25] . In 2000, with the production of golden rice scientists genetically modified food to increase its nutrient value for the first time. Also, Catchpole [30], pointed out that crops modified using GM techniques are less likely to have unintended changes than are conventionally bred crops. In 2012, Roundup Ready (glyphosate herbicide resistance) Roundup Ready, phytase-phosphorus availability, " Ignite" herbicide resistance, oxynil herbicide resistance, modified oil/ fatty acid are produced [31].

To date, several crops have been genetically modified. A few of which now account for the vast majority of those crops now cultivated in the United States. In the United States, nearly all corn, soybean and cotton crops are genetically modified. In Canada, nearly all rapeseed (canola)is significantly modified [31]. According to ISAAA [21], a record of 181.5 million hectares of biotech crops were grown globally in 2014 at an annual growth rate of between 3 and 4 %, up 6.3 million hectares from175.2 million hectares in 2013, 2014 was the 19th year of commercialization , 1996 – 2014 when growth continued after a remarkable 18 consecutive years of increases every single year, notably 12 of 18 years were double digit growth rates.

As referred to George Sadek [32]; Egypt takes a permissive approach to genetically modified organisms (GMOs), and its public policy does not oppose growing, importing, and exporting genetically modified crops. Egypt planted Bt maize for the first time in 2008 thereby becoming the first country in the Arab World to commercialize biotech crops [33]. Also, he said that genetically modified crops now referred to as biotech crops. According to recent news reports, Egypt ranks third in Africa in planting and importing genetically modified crops [34], Since December 2010, genetically modified crops have been planted without restrictions in ten different Egyptian provinces,[35]including one thousand hectares of genetically modified maize in 2012. In 2008, Egypt became the first North African country to grow genetically modified crops [36], and it is now one of the five countries worldwide to introduce biotech crops to other countries [15].

Egypt not only engages in growing and trading genetically modified crops, but also provides training to other countries to develop their capacity to produce such crops, one example being Tanzania, to which Egypt agreed to provide technical assistance in 2004[37].

In Burkina Faso GM cotton was cultivated on 115,000 hectares in 2009. Thus, in the second year of cultivation, GM varieties already covered almost 30 percent of the national cotton area. In the same year farmers in Egypt grew GM maize on 1,000 hectares. There were not enough seeds to plant a bigger acreage: because of problems with import licenses, farmers could only use locally produced seeds. (According to Plant genetic engineering in Africa (4 Nov. 2010) [38]

Disease-resistant bananas, drought-tolerant maize)

1.3. Benefits and Risks of GM Crops

A review of the existing literature reveals that key experiments on both the benefits and the environmental risks are scanty. The existing studies show that they can differ spatially, temporally and according to the trait adequate food production and cultivar modified [39]. Despite producing large quantities of commercially important industrial or pharmaceutical products in plants, there is a multitude of concerns about the impact of genetically modified crops on the environment [40]. According to Mansour, [41] genetic modification techniques allow novel traits to be introduced into animals, crops and microorganisms. He added that crops can be genetically engineered to improve appearance, taste, nutritional quality, drought tolerance and insect and disease resistance Thus GM crops are often held up as a solution to yield deficiency. Food security is having sufficient physical, social and economic access to safe nutritious and culturally acceptable food. This demands either adequate food production or food imports. Genetic engineering may be the solution of these aspects. However, the potential of such technologies is controversial. There is a considerable uncertainty about the impact on human health and the environment.

1.3.1.What are the environmental benefits of GM crops?

a) Pest resistance

Genetically engineered crops or foods have the potential to solve many of the world's hunger and malnutrition problems, increase the productivity of poor farmers and to help, protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides [42,43]. Adoption and uptake pathways of GM Biotech crops by small scale resource poor farmers in China, India and the Philippines shows how modern biotechnology has transformed farming into a profession that harvests agronomic and socio-cultural benefits beyond promise. It embodies the stories of how biotech crops particularly Bt cotton in China and India and biotech corn in the Philippines are changing the lives and state of small farmers, their families, communities and even nations.

On farm field trials carried out with Bt cotton in different states of India show that the technology substantially reduces pest damage and increases yields. The yield gains are much higher than what has been reported for other countries where genetically modified crops were used [44].

Every year a large amount of crops are lost due to pest infestation, resulting in financial losses for farmers. To prevent such losses, governments and farmers use huge quantities of pesticides, which only add to the health problems of consumers. By genetically modifying crops and increasing their pest resistance abilities naturally all the problems can be solved. On farm field trials carried out with (Bt) cotton in different states of India show that the technology substantially reduces pest damage and increases yields. Using comprehensive data from India show that applications in fields resulting in savings of up to 30 US dollars ha^{-1} and an 80 – 87 % increase in cotton yield [44]. The yield gains are much higher than what has been reported in other countries where genetically modified crops were used mostly to replace and enhance chemical pest control [44]. In transgenic plants, the cry protein is produced continuously inside the cells, the toxin is protected from UV inactivation and is highly effective against chewing insects that eat plants. Expression of the 3d-Cry toxins in transgenic crops has contributed to efficient control of insect pests and a reduction in the use of chemical insecticides. The mode of action of 3d-Cry toxins involves sequential interactions with several insect mid gut proteins that facilitate the formation of an oligomeric structure and induce its insertion into the membrane forming a pore that kills mid gut cells [45,33]. In particular, the cry 1 a toxin affecting Lepidoptera has proven an effective means of controlling several stem boring insect larvae especially in maize where the corn borer *(Ostrinia nubilalis*) is among the most serious pests. Park, [46] indicated that the growth of genetically modified crops of maize, rice and cotton by small holder farmers in developing countries can be beneficial for their earnings, their health and also for the ecosystem. It is just over ten years since the first GM crops were introduced, yet they are very popular with farmers. Also, he added that rats fed with high doses of Bt – proteins showed no detectable toxic effect.

The majority of genetically modified crops in agriculture consist of commodity crops, such as soybean, maize, cotton and rapeseed [47]. Yet, there are many challenges ahead for governments, especially in the fields of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, it is very important to proceed with caution to avoid causing unintended harm to human health and the environment.

One of the significant environmental benefits of GM crops is the dramatic reduction in pesticide use, with the size of the reduction varying between crops and introduced trait [45,33]. The most important benefits were documented in Bt – cotton such as a 70 % reduction in insecticide applications in fields in India, resulting in 80 – 87 % increase in cotton yield, [44]

Jikun Huang and his colleagues [48] indicated that in a survey of randomly selected farm households that are cultivating the insect-resistant GM rice varieties, when compared with households cultivating non-GM rice, small and poor farm households benefit from adopting GM rice by both higher crop yields and reduced use of pesticides, which also contribute to improved health. In general, benefits of GM farming are higher in developing countries compared with developed countries. Overall, it was estimated that GM crops benefit farmers by $ 7 billion per year worldwide [49].

In 2010, transgenic corn and cotton producing Bt toxins were planted on more than 58 million hectars worldwide [33). Several studies have shown that Bt cotton adoption is associated with significant benefits to farmers in various countries [14, 24, 25]. In addition to productivity gains [26, 27, 28, 29]. Bt adoption results in reduced incidence of acute pesticide poisoning among farmers [50].

Tobacco, corn, rice and many other crops have been engineered to express genes encoding for insecticidal proteins from *Bacillus thuringiensis* (Bt) [51, 26]. Papaya, potatoes, and squash have been engineered to resist viral pathogens such as which, despite its name, infects a wide variety of plants [52].

A study assessing the global economic and environmental impacts of biotech crops for the first seventeen years (1996-2012) of adoption showed that the technology has reduced pesticide spraying by 503 million kg and has reduced environmental footprint associated with pesticide use by 18.7%. The technology has also significantly reduced the release of greenhouse gas emissions from agriculture equivalent to removing 11.9 million cars from the roads [53].

Sankula and Blumenthal[54] in the USA stated that adoption of GM crops resulted in pesticide use reduction of 46.4 million pounds in 2003. Impacts on US agriculture of biotechnology-derived crops planted in 2003 – an update of eleven case studies. National Center for Food and Agriculture Policy, Washington, DC, October.

The use of Bt cotton in China resulted in pesticide use reduction of 78,000 tons of formulated pesticides in 2001. This corresponds to about a quarter of all the pesticides sprayed in China in the mid-1990s. Additionally, the use of Bt cotton can substantially reduce the risk and incidence of pesticide poisonings to farmers [55]. Hossain and his colleagues [56] recorded that the benefits of cultivating Bt cotton in China continue for five years.

The quantity of insecticides used to control bollworm reduced by 96% from 5748 metric tons of active ingredients in 2001 to as low as 222 metric tons of active ingredients in 2011. , the impact of free DNA of transgenic origin is likely to be negligible compared with the large amount of total free DNA. No compelling scientific arguments to demonstrate that GM crops are innately different from non-GM crops. The kinds of potential impacts of GM crops fall into classes familiar from the cultivation of non-GM crops (e.g., invasiveness, weediness, toxicity, or biodiversity). It is likely, however, that the novelty of some of the products of GM crop improvement will present new challenges and perhaps opportunities to manage particular crops in creative ways. According to (Philip J. Dale and his colleagues [57].

b) Tolerance to herbicides

Cultivation of many crops requires the removal of weeds that grow along with it. Weeding is a time-consuming and costly process, therefore farmers resort to the use of herbicides. Often they use multiple herbicides, increasing costs, causing harm to crops and environment, and having harmful after-effects for consumers. Genetic engineering ensures that a crop is made tolerant to one particular herbicide. By using this herbicide, crops can be protected from the need to use several herbicides resulting in reduced costs and reduced health risks. While there is evidence to indicate that the introduction of HT soybean will reduce herbicide use by up to 10 %, it should be noted that some authors (Gianessi and Carpenter [58] have concluded that their use had little effect on total herbicide used

Herbicide tolerant crops have facilitated the continued expansion of conservation tillage, especially no-till cultivation system, in the USA. The adoption of conservation and no-till cultivation practices saved nearly 1 billion tons of soil per year [59].

The HT and Bt crops have proved to be very popular with US farmers and have been widely adopted. Soybean growers appear to have been won over by the convenience of using glyphosate instead of older herbicides [60]. Bt corn is favorite because its use improve yield performance in their fields with less damaging levels of European corn borers [60].

Thus, developing crops that could withstand spraying with glyphosate would both reduce environmental and health risks, and give an agricultural edge to the farmer [61]. A 2014 review covering 12 states from 1996 to 2006, found that a 1% increase in herbicide-tolerant (HT) soybean adoption leads to a 0.21% increase in conservation tillage and a 0.3% decrease in quality-adjusted herbicide use [62].

Genetically engineered cotton has been documented to have a positive effect on the number and diversity of beneficial insects in the US and Australian cotton fields [63]. Yorobe and his colleagues [64]found that adoption of Bt corn in the Philippines did not show an indication that Bt corn had negative effect on insect abundance and diversity.

c) Resistance to diseases and cold

The organisms causing disease are taxonomically highly diverse. The major group include cellular pathogens e.g, bacteria, fungi and viruses. They are physiologically different from each other and therefore no single gene can be effective.

There are several fungal and bacterial infections that affect crops. Further unexpected frost and cold can result in destruction of seedlings or crops. By making plants genetically resistant to diseases and cold, these crops can be protected from such unexpected but fatal risks. Papaya, potatoes and squash have been engineered to resist viral pathogens, such as cucumber mosaic virus infects a wide variety of plants) [51, 26]. National Academy of Sciences [65] indicated that Papaya, potatoes, and squash have been engineered to resist viral pathogens such as cucumber mosaic virus which, despite its name, infects a wide variety of plants.

According to James [53] who stated that diseases and insect pests decrease potato yield by nearly 30% and 18%, respectively, the potato crop represents a unique opportunity for recovering significant losses through the development and deployment of biotech crops. Some of these technologies for viruses, and for the insect pest Colorado beetle, have already been developed and deployed and others are under development in EU institutions, for example, potato cyst nematode resistance at Leeds University, UK. Thus, member country, a unique opportunity exists to rapidly enhance the benefits by building on a successful late blight initiative by pyramiding genes that code for other beneficial biotech traits in the potato such as virus resistance and insect resistance that have already been developed. Late blight resistant potatoes was specifically identified by an EU Denmark, as an “appropriate crop for biotechnology application” that would be an early candidate for deregulation and deployment due to the significant productivity and environmental (less fungicide) benefits it offers. Other EU countries which support active R&D programs in the public and private sector in biotech potatoes include the Netherlands, United Kingdom, and Germany.

d) Enhancing nutritional value of the crop

This is considered one of the greatest advantages of genetically engineered crops. By enhancing the nutritional value of a crop, we can ensure that even in countries where lesser crops are available for consumption, the people would still obtain the required nutrition preventing malnourishment. The most promising is synthesis of vitamin A which improve nutrition of people who depend mainly on rice [66]. About Golden rice, developed by the International Rice Research Institute (IRRI), provides greater amounts of Vitamin A targeted at reducing Vitamin A deficiency [67, 68].

Researcher with vitamin-enriched corn derived from South African white corn variety M37W, producing a 169-fold increase in Vitamin A, 6-fold increase in Vitamin C and doubled concentrations of folate (Transgenic multivitamin) [69]. Modified Cavendish bananas express 10-fold the amount of Vitamin A as unmodified varieties [70, 71].

The GM oilseed crops on the market offer improved oil profiles for processing or healthier edible oils [67].

e) Pharmaceutical remedies

Vaccines and some medicines are expensive in several nations especially in the developing countries. By modifying certain commonly available fruits and vegetables into edible vaccines, scientists are seeking a solution to this problem Tobacco plants have been developed but are not in production, it can produce therapeutic antibodies [74].

f) Remedy for environmental pollution

Genetically modified plants have also been used for bioremediation of contaminated soils, mercury, selenium and organic pollutants such as TNT, RDX explosive contaminants and polychlorinated biphenyls (PCBs) have been removed from soils by transgenic plants containing genes for bacterial enzymes [72, 73].

g) ***Tolerance to drought and salinity***

It is important to use uncultivable lands in order to overcome the problem of growing population and lack of agricultural lands. By creating drought-resistant crops and plants that can tolerate and grow in grounds with high salinity, we can overcome the problem of waste lands and convert them into cultivation [75, 76]. Plants engineered to tolerate non-biological stressors such as drought, frost, [77,78] high soil salinity and nitrogen starvation were in development. In 2011, Monsanto's Drought Gard maize became the first drought-resistant GM crop to receive US marketing approval.

1.3.2. What are the potential risks?

Engineered crops may have specific harmful effects by virtue of the novel gene combinations they possess. This means that the risks of genetically engineered organisms may vary widely and therefore must be assessed on a case by a case basis. Much of the current debates on agricultural biotechnology have focused on the potential risks of GM crops for human health.

In fact GE crops could also adversely affect the environment. Once the risks are identified and can be detected by regulators, the next step is risk assessments.

The potential impact of genetically modified GM crops on poverty, income and nutrition in the 3rd world countries continue to be the subject of public controversy. There are concerns about the safety of GM crops. The most important concerns are that they may contain allergenic substances due to introduction of new genes into crops, nutritional changes and the formation of toxin. Another concern is that genetic engineering often involves the use of antibiotic-resistant bacterial strains that are resistant to available antibiotic. Bakshi and Pusztai [79, 80] recorded that this would create a serious public health problem. So far, scientists know of no inherent, genetic harms associated with the use of genetically engineered (GE) organisms. For example, it is not true that all GE foods are toxic or that all organisms are likely to proliferate and to increase rapidly in numbers if released into the environment. But specific engineered organisms may have specific harmful effects by virtue of the novel combinations they possess. Also, the absence of animal testing data as e.g on Golden rice is especially worrying as Golden Rice is engineered to overproduce beta carotene and studies show that some retinoid derived from beta carotene are toxic and cause birth defects [79,80,81, 82]in particular high concentrations of the retinoid called retinol are toxic[83]. This means that the risks of genetically engineered organisms may vary widely.

So far, scientists have identified a number of ways in which GE organisms could adversely affect both human health and the environment

A- Human Health Risks

A-1- New allergens in the food supply.

One of the major health concerns with GM food is its potent6ial to increase allergies in humans eating protein unlabeled GM food stuffs. When the gene is from a crop of known allergenicity, it is easy to establish whether the GM food is allergenic using in vitro tests, such as RAST or immunoblotting , with sera from individuals sensitized to the original crop. This was demonstrated in GM soybeans expressing the brasil nut 2 S (84) or in GM potatoes expressing cod protein genes [85].

Hye-Yung Yum and his colleagues [86] found that a skin prick allergy test shows that some people react to GM soy negatively. They added that cooked GM soy contains as much as 7-times the amount of a known soy allergin. Green and his colleagues [87] stated that hundreds of people exposed to Bt spray had allergic symptoms and mice fed Bt had powerful immune responses [88].

In India, the farmers suffered from allergic reactions from handling Bt cotton as those who are in contact with Bt spray [16].

A-2- Health Risks Associated with GM Food Consumption

Several authors indicate that animals fed by GM crops have been harmed or even died. Rats exposed to transgenic potatoes or soya had abnormal young sperm like cows, buffalo and other livestock grazing on Bt-maize, GM cottonseed and certain biotech corn showed complications including early deliveries, abortions, infertility and also many died [89- 93]. On the the contrary, a company producing GM crops did not show any negative effects on mice [94].

Although Agri-biotech companies do not accept the direct link between the GMFs consumption and human health problems, there are some examples given by the opponents. For example: The food borne dieases such as soya allergies have increased over the past 10 years in USA and UK [95] and an epidemic of Morgellons disease in the US [96] appeared. There are also reports on hundreds of villagers and cotton handlers who developed skin allergy in India [97]. Recent studies have revealed that Bacillus thuringiensis corn expresses an allergenic protein which alters overall immunological reactions in the body [90]. Many children in the US and Europe have developed life -threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions [98] .Extensive testing of GM foods may be required to avoid the possibility of harm to consumers with food allergies

A-3- Production of toxin

Most plants produce substances that are toxic to humans. The majority of the plants that human being consumed produce toxins at levels low enough that they do not produce any adverse health effects. It is liable that inserting an exotic gene into a plant could cause it to produce toxins at higher levels that could be dangerous to humans. This could happen through the process of inserting the gene into the plant. If other genes in the plant become damaged during the insertion process it could cause the plant to alter its production of toxins. Alternatively, the new gene could interfere with a metabolic pathway causing a stressed plant to produce more toxins in response. Although these effects have not been observed in GM plants, they have been observed through conventional breeding methods creating a safety concern for GM plants. For example, potatoes conventionally bred for increased diseased resistance have produced higher levels of glycoalkaloids. Viruses produce proteins that attack and disable the plant cells' defenses, increasing the chances that the virus will thrive. Previous studies have shown, however, that the proteins created by one virus can promote infections by other related and unrelated viruses.

In addition to attacking viral defenses, viral proteins can also be toxic. They attack fundamental processes, such as the cycle by which a cell divides and the mechanism for creating proteins from RNA. (98). If these were damaged in human beings, it could have serious health consequences. (Disrupting the cell cycle, for example, can lead to cancer).

Dona [99] found that animal studies with certain GM foods have shown that they may toxically affect several organs and systems. They may cause some common toxic effects such as hepatic, pancreatic, renal or reproductive effects and may alter the hematological biochemical and immunological parameters. He added that the use of recombinant GH or its expression in animals should be re-examined since it has been shown that it increases IGF-1 which may promote cancer.

B-Environmental Risk

B- 1- Evolution of some weed species

A very important risk of the biotech crops is the hybridization of some crops like wheat, rice, soybean, sorghum, millet, beans and sunflower seeds with wild relatives has contributed to the evolution of some weed species [100].

Out crossing is the unintentional breeding of a domestic crop with a related plant. A major environmental concern associated with GM crops is their potential to create new weeds throughout crossing with wild relatives, or simply by persisting in the wild themselves.

The potential for the above to happen can and is assessed prior to introduction and is monitored after the crop is planted as well. A ten-year study initiated in 1990 demonstrated that there is no increased risk of invasiveness or persistence in wild habitats for GM crops (oilseed rape, potatoes, corn, and sugar beet) and traits (herbicide tolerance, insect protection) tested when compared to their unmodified counterparts. The researchers stated, however, that these results “do not mean that genetic modifications could not increase weediness or invasiveness of crop plants, but they do indicate that productive crops are unlikely to survive for long outside cultivation [100]. It is therefore important, however, as regulations require, to evaluate individual GM crops on a case-by-case basis, both prior to release and after commercialization.

B- 2-Direct effects on non-target organisms (beneficial)

Plants engineered to produce proteins with pesticidal properties, such as *Bacillus thuringiensis* (Bt) toxin, may have both direct and indirect effects on populations of non-target species. One group of toxins from Bt primarily targets Lepidoptera (butterflies and moths), such as the European corn borers and others mostly affect beetles [101].

In May 1999, it was reported that pollen from *Bacillus thuringiensis* (Bt)-insect resistant corn had a negative impact on Monarch butterfly larvae. This report raised concerns and questions about potential risks to Monarchs and perhaps other non-target organisms [102, 103]. However, urged caution over the interpretation of the study because it reflects a different situation than that in the environment. The authors stated that this study was conducted in the lab and suggested that adverse effects may occur when monarch butterfly larvae ingest Bt corn pollen on host plants in the field while it raises an important issue, it would be inappropriate to draw any conclusions about the risk to Monarch populations in the field solely on these initial results.” In 2001, a study published in PNAS concluded that the impact of Bt corn pollen on Monarch butterfly populations is negligible.

A report from the US Environmental Protection Agency (EPA) indicated that the “data provide a weight of evidence indicating no unreasonable adverse effects of Bt proteins expressed in plants to non-target wildlife.” Furthermore, a collaborative research effort by North American scientists has concluded that in most commercial hybrids, Bt expression in pollen is low, and laboratory and field studies show no acute toxic effects at any pollen density that would be encountered in the field [102]. A *Nature* publication of Losey [103]; and lab experiments on force-fed predators [104] and extensive field work demonstrated no significant impact on Monarch Butterfly populations [105,106,102,107]. One group of toxins from Bt primarily targets Lepidoptera butterflies and moths such as the European corn borer and another mostly affects beetles [101].

No one knows how broadly these results apply to natural population because neither study addressed the rate at which larvae consume toxin.

Laboratory experiments done by [102, 103] suggested that the adverse effects may occur when monarch butterfly larvae ingest Bt corn pollen on host plants. Riddick and his colleagues [19] pointed out that effective control of the colorado potato beetle in transgenic fields may explain the decrease in a predator of this pest. In contrast other studies done by [108, 109, 110] show no direct effect of transgenic Bt crops on non-target organisms for particular reproductive traits measured.

B- 3- Development of insect resistance

Another concern over the use of Bt crops is that it will lead to the development of insect resistance to Bt. Many insects have developed resistance to different chemical pesticides resulting in inefficient insect control programs (111). IT has been shown that insects can develop resistance to Bt toxins in the laboratory and to the Bt sprays in the field Ferre & Van Rie [112]. Insect resistance management plans have been developed by government, industry, and scientists to address this issue. These plans include a requirement that every field of insect-resistant crops must have an associated refuge of non-GM crops in order for the insects to develop without selection to the insect resistant varieties.

Additional resistance management practices are also being developed by scientists all over the world. These must be performed in line with post-approval monitoring, where GM crops, as well as their immediate environment, will be constantly evaluated for changes even after the crop has been released.

B-4- Outbreak of non-target pests

Wolfenbarger and Phiffer [37] stated that a review of the existing scientific papers reveals that key experiments on both the environmental risks and benefits are lacking. Collectively existing studies emphasize that these can vary spatially, temporally and according to the trait and cultivar modified. Yanhui and his colleagues [113] reported that wide scale adoption of Bt cotton in china resulted in mired bug outbreaks. They stated that in field trials conducted over 10 years in Northern China show that mired bugs have progressively increased population sizes and acquired pest status in cotton and multiple other crops in association with a regional increase in Bt cotton adoption. More specifically they added that Bt cotton has become a source of mired bugs and that their population increase are related to decease in insecticide use in this crop Hence, alternation regime in pest management in Bt cotton could be responsible for the appearance and subsequent spread of non-target pests at an agro-landscape level.

2. Conclusion

The gene technology can help in fighting hunger and poor especially for people in the developing countries to find proper food and to prevent them from slow death. Technology is developing fast and to deliver the benefits to the society properly institutional set up needs to be gathered and communicated together. Sound monitoring system for a case by- case assessment of potential benefits and risks from genetic engineered crops is of great importance. Appropriate measures need to be taken to safeguard the interests of small scale farmers especially in developing countries. The benefits of gene technology need to be properly communicated to the media, public and policy makers.

Also, the environmental and ecological concerns potentially associated with GM crops are evaluated prior to their release. In addition, post-approval monitoring and good agricultural systems need to be in place to detect and minimize potential risks, as well as to ensure that GM crops continue to be safe after their release. Comparisons among GM, conventional, and other agricultural practices, such as organic farming, will bring to light the relative risks and benefits of adopting GM crops.

3. Recommendations

1. The rapid growth of the world population requires the development of new technologies to feed people adequately; even now, an eighth of the world's people go to bed hungry. The genetic modification of food plants can help meet part of this challenge.
2. Agriculture as it is currently practiced is unsustainable, as is indicated by the massive losses of topsoil and agricultural land that have occurred over the past few decades, as well as by the unacceptable consequences of massive applications of pesticides and herbicides throughout most of the world. Techniques to genetically modify crop plants have the potential to solve many of the world’s hunger and malnutrition

problems and to help, protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides, yet, there are many challenges ahead for governments, especially in the areas of safety testing regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, it is important to proceed with caution to avoid causing unintended harm to human health and the environment. Also, it is important to add novel methods and concepts to probe into the compositional**,** nutritional, toxicological and metabolic differences between GM and conventional crops and into the safety of the genetic techniques used developing GM crops if we want to put this technology on a proper scientific foundation and allay the fears of the general public (114) introduction of vaccines, new forms of therapy, new types of foodstuffs or new pesticides. Risk cannot be avoided, but it can be minimized. The long-term aim is to develop plants that can produce larger yields of healthier food under sustainable conditions with an acceptable level of risk. The latter can be determined by scientific studies, with the results made freely available to the public

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