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NOTICE

A CRITICAL STATEMENT TO GENETICALLY MODIFIED CROPS (GMC)

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ABSTRACT

It is estimated that the world's population will be 8 billion in 2020 and 11 billion in 2050 with an increase ratio of 1.5%. Cultivated areas cover 3% of the total world surface. However, these areas are getting narrowed down rapidly due to erosion, salinity, acidity, intensive agriculture and extreme grazing. With the effects of all these factors and increasing population, it is estimated that the per capita cultivated area will decrease from 0.26 to 0.15 hectare in 2050. Additionally, finding the required water resources for modern agriculture will be more difficult because of increasing water consumption and water pollution. On the other hand, food production will be negatively affected by the changes in the world's climate caused by global warming. Environmental conditions are being changed under the pressure of the rapidly increasing world population, and cultivated areas have reached their limits. This is why new varieties should be improved for continuous yield increase. Conventional plant breeding has some disadvantages due to the fact that hybridization is possible only among a limited number of genera, transition of undesired properties along with desired characters to the progeny cannot be prevented, and elimination of undesired properties by means of back-crossing takes too much time. This is why, in order to provide yield increase, biotechnological methods which are complementary of conventional plant breeding programs have been widely used. The sowing area of genetically modified crops, which firstly started to be cultivated in 2.8 million hectares in 1996, reached to over 200 million hectares nowadays. Recently, significant success was achieved in increasing crop quality and obtaining varieties resistant against herbicides, diseases and pests by using genes based on bacteria and viruses. Despite all benefits of genetically modified crops, due to carrying genes that do not belong to their own genus and negative results reported by scientific studies, their possible risks have come into question.

KEYWORDS:
Genetically Modified Crops (GMC), Benefit, Adverse Effect

INTRODUCTION

The world's shortage of foodstuffs longstanding until the mid-20th century has led to significant increases in food production especially in Asia and Latin America, with the use of high-yield wheat and paddy varieties called "Green Revolution" in the mid-1960s which played an important role in this revolution [1]. During this period, China and India, the two most populous countries in the world, became exporters of foodstuff. However, as time has passed, product growth has gradually declined. Moreover, economic developments in these countries have increased the need for higher-quality and diverse foodstuffs. Today, China and India both have become the world's largest food importing countries.

Today, agricultural areas account for 3% of the earth's surface. However, processed areas are rapidly shrinking due to erosion, salinization, acidification, intensive engagement in agriculture and overgrazing. It is thought that the area processed per capita will drop from 0.26 hectares to 0.15 hectares by 2050, with the impact of all these factors and the growing population [1]. In addition to this, due to increased water consumption and increasing pollution of water resources, it will be difficult to find the necessary water resources for modern agriculture. Another alarming problem is that foodstuff production will be negatively affected by changes in the world's climate due to global warming.

The need for foodstuffs in the world's most densely populated regions is expected to be doubled by 2025 [1]. Currently, it does not seem possible to meet this need by the increase in food production through classical reclamation or increase in processed areas.

Environmental conditions that are changing and the rapidly growing world population have further increased the significance of developing new varieties of plant production, and therefore, plant breeding studies. The beginning of plant breeding is as old as human history. With mankind's transition from collecting and nomadic order to settled life, humans have unwittingly bred plants by selecting those with high yields from among the crops they planted in order to meet the food needs of themselves and their families. Moreover, paralleling the growing population in the world, ways of obtaining higher yields from plants have been scientifically investigated. As a matter of fact, the increase in agricultural yield achieved in the last 50 years has been achieved as a result of the use of modern breeding methods in conjunction with appropriate breeding techniques. Nevertheless, considering that the world's population is increasing day by day, as well as that the final limit of areas used in agriculture has been reached, it is apparent that increases in yield must continue in the future. As a matter of fact, research shows that today's yield levels are well below the potential yield. Therefore, the genetic structure of plants should be improved to reach the potential level of yield [2].

The scarcity of species in which interspecies hybridization can be made, the inability to prevent the passage of undesirable characteristics together with the desired characteristics in hybridization processes and the too long time it takes to eliminate unwanted characteristics through introgressive hybridization processes are some of the major disadvantages of classical plant breeding [3]. Therefore, in order to increase productivity, it has become necessary to use environmentally friendly biotechnological techniques that complement and support classical plant breeding programs. Since the direct transfer of an isolated gene through the use of these methods is the case, first of all, the necessity of hybridization in the transfer of genes between different species and genera will be eliminated, and natural isolation — in other words, the problem of infertility and mismatch, which is the most important obstacle to benefiting from wild gene resources in classical breeding, will be solved. With the use of modern biotechnological methods, the transfer of unwanted genes to hybrids in addition to desired genes due to linkage, which is the second major obstacle in the transfer of genes between different genera in classical breeding, is no longer a problem [3].

The success desired to be achieved in classical breeding depends on selection, which depends on creation of a broad genetic variation. In order for the characteristics of a gene transmitted by hybridization to be observed phenotypically in plants, a hybrid population consisting of a large number of plants determined by the Mendel Laws is needed. Sufficient variation may be achieved by hybridization between compatible species using classical methods. However, hybridization with wild species requires a large population for sufficient variation. Such a population can be achieved through many years of introgressive hybridizations to correct infertility and deteriorating characteristics. The increase in the size of a population also leads to significant increases in space, time and financing [4]. Variation and selection, which form the basis of classical plant breeding, manifest themselves as transformation and *in vitro* selection in the new technology. *In vitro* selections allow selection of cells instead of the whole plant, which means working on the cellular level in petri dishes instead of thousands of plants in the field. Since selection under *in vitro* conditions can be performed at any time, not having to adhere to the development periods of plants also provides an important advantage [5].

In recent years, significant improvements in techniques such as gene cloning, transformation, plant regeneration, vector systems, creation of new gene structures and direct gene transfer methods in biotechnology and genetic engineering have enabled the transfer of genes between different biological systems. Varieties resistant to herbicides [6], diseases and pests have been developed especially by transferring genes of bacteria and viruses. In some important plants such as maize, potato and cotton, transgenic proprietary varieties have been broadly planted in some countries, especially in the United States, by using new techniques.

DEFINITION AND SCOPE OF GMOS

Biotechnology, which has found application areas in many different forms, from biologic treatment of waste to food production requiring fermentation, has also made it possible to make changes in the structure of living things that cannot be achieved through traditional breeding methods and natural reproduction processes, via the use of modern biotechnology techniques developed since the early 1970s. These modern biotechnology techniques, which enable acquisition of new genetic traits by transferring genes from one species to another species or by interfering with its existing genetic structure, are called gene technology, and the organisms that are given new characteristics which cannot be acquired by natural processes are called "*Genetically Modified Organisms (GMOs)*" [6].

The phases of modern biotechnological studies are (i) identification, (ii) characterization, (iii) isolation and (iv) transfer to the target species of desired genes in the order given. The basis of techniques used in transfer of genes to plants is formed by implantation of a piece of DNA carrying the desired gene into the chromosomes of cells within the tissue, and then, using tissue culture techniques to obtain transgenic plants from these cells. The most well-known of these techniques is rapid launch of the gene into the target cell or tissue using a gene gun. The basic principle of this method is to give a very high speed to 1–2 μm diameter gold or tungsten particles that carry DNA and thus allow them to enter plant cells. Once the particles enter the cell, DNA fragments merge with the plant genome [7.8]. Another tool used extensively in gene transfer is a bacterium called *Agrobacterium tumefaciens* [9].

Agrobacterium is a gram (-) bacterium in the family *Rhizobiaceae* that lives in soil, infecting most dicotyledons from wounds at the junction between the root and the shoot, causing crown-gall tumors. Whichever of these methods is used, the foreign gene eventually settles randomly into one or more of the chromosomes in the receiving cell. It is necessary to determine to which cells the gene in question is transferred. This is achieved by a process where the gene-transmitted tissues are cultured in a series of selective environments at the first stage and then in environments that encourage creation of shoots. These plants are subjected to various tests, determining whether the foreign gene is present and whether it functions as expected. After a foreign gene has been successfully transferred to another plant, it becomes much easier to transfer it to other plants by using traditional plant breeding techniques. For example, after obtaining a single pest-resistant maize plant using genetic engineering techniques, it is possible to transfer this feature to other maize plants by hybridizing transgenic plants with other maize plants.

POTENTIAL BENEFITS OF GMOS

Although genes can be successfully transferred to the majority of culture plants today, a significant portion of commercially used transgenic plants are field crops. Soybeans, maize, cotton and canola are the main ones. Some of the new features transferred to plants are quality and resistance to herbicides and pesticides.

In efforts to improve product quality, significant progress has been made in recent years. Sunflower, soybean and peanut varieties with high oleic acid or low linolenic acid content, and a canola variety with high lauric acid content providing cheaper raw materials for soap and detergents have been added to production. The paddy (Golden Paddy) variety with high vitamin A and iron content obtained through biotechnological studies conducted for the purpose of food production of high nutritional value is expected to play an important role in elimination of disorders caused by rice-dependent nutrition. Studies conducted in this direction are expected to produce sweet potato and paddy with high protein content, canola with high vitamin A content and fruits and vegetables with high antioxidant content in the near future.

It is observed that resistance to herbicides has reached 40%, resistance to pesticides has reached 8% and resistance to both has reached 4% in all transgenic planting areas. One of the most significant achievements in this respect is production of transgenic plants resistant to “sulfonylurea” herbicide as a result of transfer of the “acetolactate synthase (ALS)” gene to plants [10,11]. Transgenic plants provide an increase in productivity by reducing drug and pesticide costs as a result of effective pest and weed control. In 2001, it was reported that 1.6 thousand tons of more maize was obtained from transgenic maize production areas in the U.S. than in conventional maize production areas, and 183.4 million dollars of income was gained as a result of 3.8 thousand tons of reduction in pesticide use. It was stated that cotton production increased by 84 thousand tons with the use of transgenic varieties, and 235.6 million dollars of income was obtained as a result of 3.6 thousand tons of less pesticide use [12,13].

Very successful results have been obtained in studies on resistance to insects. *Bacillus thuringiensis*, a bacterium species, produces a protein (Bt) that damages the digestive systems of insects, especially in the family *Lepidoptera* [14]. As a result of isolation of the Bt gene, which causes production of this protein, from *B. thuringiensis*, and transfer of it to tomato, tobacco, cotton and maize plants, excellent resistance to insects has been achieved [15,16]. Assessing the results of field trials in the U.S., Koziel et al. [16] reported an increase in yield of up to 8% in maize with Bt. It has been reported that the amount of insecticides administered to potatoes decreased by up to 40% with introduction of Bt varieties. Reductions in pesticide use translate into increases in profitability for many farmers, which corresponds to 7–36 dollars per hectare for maize grown in the United States. Likewise, tobacco crops, which incorporate the “trypsin inhibitor (CpTi)” gene isolated from cowpeas, have shown resistance to attacks by the larvae of *Heliothis Virescens*, which is a type of tobacco shoot worm [17].

Another example of genes that increase productivity by reducing input is the gene that gives the ability to resist to glyphosate herbicide in cultivated plants. This gene was used by Monsanto to breed cotton, soybean and maize varieties that are resistant to glyphosate. It is known that these varieties, which are sold with names starting with “Roundup Ready,” are respected by farmers. It has been reported that planting of these varieties, which are resistant to herbicides, increased to 15 million ha in soybeans, 2 million ha in canola and 2 million ha in maize in 1998. The herbicide Roundup, which is usually administered in a single dose, reduces the need for use of multiple herbicides, and in most cases, it is sufficient to effectively take control of broad-leaved weeds. Although the cost reductions caused by resistance to weed herbicides vary, preliminary data in the U.S. show that Roundup Ready-resistant soybeans yield a profit of approximately $14 per hectare for farmers [18].

Studies on virus resistance are very few. Today, “CP” genes that encode envelope proteins isolated from viruses to give culture plants resistance to viruses are transferred to plants. This way, tobacco plants implanted with the tobacco mosaic virus (TMV) envelope protein gene have shown resistance to TMV infections [19].

Adherence to traditional methods in the fight against weeds has been reduced with cultivation of transgenic varieties, and soil structure and moisture have been preserved due to less soil processing. By using transgenic varieties that reduce agricultural pesticides, soil and groundwater contamination is reduced [20], thereby providing suitable facilities for more sustainable resource use and sustainable agriculture and allowing agriculture in broader areas (salty and barren areas) which are considered to be the most important environmental benefits of such varieties [20].

Delaying maturation by blocking ethylene synthesis in vegetables and fruits, and thus extending shelf life, has been achieved in tomatoes. Similar studies in this area are still conducted in raspberries, strawberries, cherries, bananas and pineapples. In another implementation to achieve high-quality tomato varieties with high dry matter content were obtained to increase the aroma, and similar varieties of peppers, bananas, melons and watermelons will be produced in the near future [21].

In the field of stock farming, a recombinant form (rBST) of a natural hormone (bovine somatotropin) which improves milk production in cows by 10–15% has been developed. Approved by the Food and Drug Administration (FDA) in 1993, rBST is now used by producers in 30% of cows in the United States. On the other hand, genes resistant to different diseases have been transferred in different fish species.

Another application of agricultural biotechnology is production of food enzymes. Attempts are made to obtain rennet that will allow producing cheese that is 60% harder. Nutrient-enriched GMOs will benefit not only humans but also animals.

Through genetic engineering, efforts are underway to obtain high nutritional value feed crops. According to researchers, if the composition of amino acids in animal feed is harmonized with the amino acids needed by animals, the need for total feed used in nutrition, and therefore the pollution caused by animal feces, will be possibly reduced. In fact, animal health experts are assessing the possibility of breeding feed crops that will have a vaccine effect on animals against some common diseases by using genetic engineering methods [18].

Additionally, some studies have shown that genetically modified rhizobia can increase the nodulation or nitrogen fixation of legumes. It was reported that such applications contribute positively to plant growth and yield by improving the plant root system [23].

The impact of GM crops on soil organisms is one of the other important issues. The interactions between GM crops and soil organisms were affected by a variety of environmental and non-environmental factors [24]. Yang et al. [24] noted that herbicide-tolerant soybean GTS 40-3-2 had no significant effects on soil nematode abundances. In addition, Yang et al. [24] reported that nematode ecological indices and nematode community structure analysis provide useful information for assessing the impact of GM crops on soil quality

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Finally, the possible benefits of genetically modified plants against environmental pollution is another issue that needs to be questioned. Ozcan et al. [26] reported that using GM plants in environmental protection the generation of transgenic plants for environmental protection involves the two quite separate fields of pollution prevention and pollution removal, with specifically tailored plants already existing for both purposes. Pollution preventing GM plants can significantly reduce the amount of agrochemicals needed for crops, thus reducing environmental pollution.

POTENTIAL RISKS OF GMOS

Unlike other products grown in nature, transgenic crops carry genes that do not belong to their species, and the negative results of scientific research especially in recent years have brought to the agenda the potential risks of products. Health risks carried by transgenic plants may be listed as allergy, toxicity, cancer, deterioration in nutritional quality, horizontal gene transition and reestablishment of non-working genes [22]. It is possible to list the environmental risks of these plants as follows: the transfer of gene-based toxins to soil and water, increased use of chemicals, accumulation of antibiotics, deterioration of the variation balance in the fauna, death of other creatures fed by dying insects, extinction of related beneficial species, formation of new pathogens and harmful types, loss or change of plant gene sources in the flora [23].

The majority of genes transferred to herbal products through the use of biotechnological techniques today are of bacterial and virus origin. Antibiotic resistance genes are used as marker genes to select transgenic plants after gene transfer. In other words, plants that can live in special selective environments where these antibiotics are present have been confirmed to be transgenic. However, there are big risks to human and animal health due to the emergence of this antibiotic resistance in the phenotype by passing into human or animal body, horizontal transfer of these genes to bacteria within the human body and transport of the virus-induced resistance gene to other viruses. In such a case, for example, it will be impossible to heal the slightest throat infection since antibiotics would not be functional because of the resistance of bacteria.

Examples are given below about the negative effects of transgenic products on human health determined by research.

As reported by the FDA's own experts, rBGH increases spleen mass by 46% as a symptom of leukemia development. Scientists of the company Monsanto have reported that 19% of the hormone can be neutralized by boiling for 30 minutes. However, normal pasteurization takes only 30 seconds. Canada, the European Union, Australia and New Zealand have banned the use of rBGH. Similarly, certain other chemicals found to be carcinogenic are used in other GMOs. Bromoxynil used in transgenic cotton and glufonsinate used in soybeans, maize and canola are just two of these chemicals [22].

Because dairy cattle that are given rBGH get sick more frequently, they require high levels of antibiotics. Studies have shown an unacceptable amount of antibiotic residue in the milk of such cattle. Scientists warn us of antibiotic resistance that may develop.

With the discovery of antibiotics, the twentieth century witnessed a decrease in infectious diseases. Nevertheless, there is an increase in systemic diseases that destroy the body's defense system such as cancer. Formation of cancer depends on all environmental effects, i.e. air, water and nutrients. There are over 100,000 chemical combinations in the environment in which living things maintain their lives. The harmful effects of such chemicals (especially of pesticides) that do not look very harmful when tested alone increase nearly 1,000 times based on the data obtained by scientists in the last few years. It is also possible that such chemicals get rearranged through genetic mutations and bring out a carcinogenic effect. Cancer affected one in every 11 individuals in the United States in 1990, whereas today, one in every two men and one in every three women have cancer at some stage of their lives [22].

As in the case of the HIV virus, virus genes can mix with other virus or retro virus genes. This makes viruses more lethal. The cauliflower mosaic virus (CaMV), which is heavily used in genetic engineering studies, belongs to the "pararetrovirus" group, which includes the Hepatitis B and HIV viruses. Plants were infected with cucumber mosaic virus in a study in Canada, and in less than two weeks, new genes were found in neighboring plants. This is the best evidence of a gene mixture.

According to a 1998 report by the Microbial Ecology in Health and Disease, gene technology may cause an increase in infectious diseases. This increase may occur through the emergence of new viruses unknown due to antibiotic resistance or horizontal gene transfer of transgenic DNA from bacteria to other bacteria. Moreover, transgenic DNA may be passed on to animals through animal feed and from animals to humans.

Another risk that GMOs can pose is the danger of allergy. If such transgenic nutrients are consumed, proteins produced by foreign genetic materials found in such nutrients may possibly cause discomfort in people who have allergic problems. In 1996, the company Pioneer Hi-Bred transferred genes from Brazilian chestnuts to soybeans. A number of individuals allergic to this chestnut type were observed to have apoplectic shock (similar to reactions to bee sting) which can lead to death. As a result of animal experiments, the product was withdrawn from the markets [22].

Transgenic plants may cause serious harm to biodiversity in Turkey, which is the center of genes of many plants. New features given to plants may lead to deterioration of the surrounding flora in which such plants live, loss of genetic diversity in natural species and extinction of wild species that form genetic resources by destabilization of distribution and destruction of balance of species in the ecosystem. A gene outbreak from transgenic products may cause wild species to have the same characteristics. Such gene sources are going to face irreversible destruction. If the gene for resistance to transferred weeds passes to the wild relatives of the transgenic plant, it is apparent that it will be difficult to fight such species. In such a case, there is even the possibility of a complete loss of the existing gene source. For biodiversity to be protected, extreme caution should be observed in cultivation of transgenic plants whose gene sources are found in Turkey. Additionally, plants that grow by themselves and can develop in the next year in areas where transgenic plants — that are transformed to be resistant to herbicides — are produced may act as weeds for another crop sown, and their fight against herbicides may be difficult [4].

There are significant doubts about the effects on soil fauna, of microorganisms that are carriers in the technology used or those whose genetic structure is altered and those that are left to the environment.

Another event that may damage the environment and biodiversity is development of a uniform flora and fauna due to application of uniform chemicals. This will disturb the balance of the environment. Additionally, if genes obtained from viruses transfer their resistance characteristics to other viruses, it will also pose a risk to the environment as resistance will occur in virus populations even though such resistance is unwanted. On the other hand, it is possible that transgenic varieties that are resistant to pests have adverse effects on other living things that are not targeted in nature.

Bioengineering experts are trying to attract the public's attention by claiming that GMOs will benefit the environment by causing a reduction in the use of toxic herbicides and pesticides. In reality, the situation is a little different. The majority of genetically modified agricultural products have been developed to resist to toxins. The aim of many products planned for future production is to ensure toxin resistance. According to a number of researchers, three times more herbicides will be used as a result of GMO production. It was revealed in a study conducted at the University of California that glyphosate (the active ingredient of Roundup) causes a type of disease called “Farmer’s Disease.” Scientists working in Oregon found that *klebsiella planticola*, which is a genetically modified bacterium, is able to sterilize soil and kill nitrogen-capturing fungi. In 1997, Guenther Stoctzky at the University of New York reported that genetically modified *rhizobium meliloti* is lethal for Monarch Butterflies.

Plant species several meters away will be affected as a result of transportation of genetically modified plant pollens by winds, birds, bees, insects, fungi and bacteria, resulting in genetic pollution. For this reason, field trials that were conducted in Berlin were stopped. The government in Thailand stopped field trials after it determined that there was gene transition in surrounding farms during field trials that were conducted with the Bt gene on cotton. Finally, it was revealed in a study conducted in the UK that production of genetically modified agricultural products caused gene transition in honeybees, although the production process was only for scientific purposes and extremely small [22].

Dependency on plant production based on transgenic varieties will lead to reductions in the use of local varieties in traditional agriculture, and it will also lead to the problem of foreign-source dependency in agriculture. This is because transgenic products are produced in developed countries and by the private sector. These products are mostly hybrid species that are pollinated in the open. Therefore, seeds must be renewed every year. The seeds of transgenic products are 25 to 100% more expensive than non-transgenic seeds. Small farmers who will not be able to continue purchasing seeds for a long time due to the high price will suffer from this condition [22].

There may also be changes in agricultural production systems with production of transgenic plants. Producers will have to cultivate non-transgenic varieties without chemical struggle in a certain part (1/3) of their fields to ensure continued resistance by companies owning transgenic varieties, especially in varieties resistant to pests (with Bt). Thus, a reduction in the yield of transgenic varieties will be observed at a rate of 1/3 [22].

Another issue closely concerning Turkey is the way European Union countries, which are an important market in agricultural product exports, approach this topic. Consumers in EU countries do not currently approve consumption of genetically modified products. The choice of transgenic products by consumers and the acceptance of the public are some other socio-economic dimensions of the issue. These products must be labeled so that consumers know what they are eating and can make their choice accordingly. In other words, increasing the production of transgenic varieties across the country will reduce agricultural product exports to EU countries, and therefore, the return on exports. In this case, new countries that have accepted consumption of transgenic products will have to be found.

RESULTS

Throughout history, people have unwittingly caused a sort of breeding by selecting the high-yield products from among the products they grew. Moreover, paralleling the growing human population in the world, ways of obtaining higher yields from plants have been scientifically investigated. As a matter of fact, the increase in agricultural yield achieved in the last 50 years has been achieved as a result of the use of modern breeding methods in conjunction with appropriate breeding techniques. Nevertheless, considering that the world’s population is increasing day by day, as well as that the final limit of areas used in agriculture has been reached, it is apparent that increases in yield must continue in the future. However, serious problems emerge in development of new species due to the infertility, lack of the number of species that can be hybridized and the inability to prevent the passage of unwanted genes with the desired gene, which are inherent in classical breeding methods. As known, breeding success is directly proportional to the extent of the variation in the population. In other words, as a gene pool to be used in breeding studies becomes larger, we have a better chance of obtaining individuals with the characteristics we want. Modern biotechnology that comes into play at this point has added a new dimension to breeding. As a matter of fact, limits on gene transfer between living organisms have been removed through the use of modern biotechnological methods.

The main goal in breeding is to improve the yield per unit area in plant production. To do this, efforts are underway to increase plant productivity and develop new varieties that are resistant to diseases and harmful and adverse environmental conditions that cause product losses. Some of the new features added to plants by biotechnological methods are quality and resistance to herbicides and pesticides. It is aimed to reduce the use of chemical drugs by giving plants resistance to insects. The paddy (Golden Paddy) variety with high vitamin A and iron content obtained through biotechnological studies conducted for the purpose of food production of high nutritional value is expected to play an important role in elimination of disorders caused by rice-dependent nutrition. By blocking ethylene synthesis in vegetables and fruits, it has been achieved to delay maturation, and thus, prolong shelf life.

In contrast to all these benefits of transgenic products mentioned above, unlike other products grown in nature, transgenic products carry genes that do not belong to their species, and the negative results of scientific research especially in recent years have brought to the agenda the potential risks of such products. Health risks carried by transgenic plants may be listed as allergy, toxicity, cancer, deterioration in nutritional quality, horizontal gene transition and reestablishment of non-working genes. It is possible to list the environmental risks of these plants as follows: transfer of gene-based toxins to soil and water, increased use of chemicals, accumulation of antibiotics, deterioration of the variation balance in the fauna, death of other creatures fed by dying insects, extinction of related beneficial species, formation of new pathogens and harmful types and loss or change of plant gene sources in the flora. We may summarize the agronomic risks under the headings of uniform use of varieties and drugs, problems in the fight against weeds, ineffective transgenic characteristics and the emergence of new undesirable characteristics. The necessity to renew seed stocks every year, expensiveness of seed stocks and drugs and the risk of becoming a country solely producing transgenic plants may be listed as economic risks.

As a matter of fact, all characteristics acquired by transferring genes of bacteria and virus origin to plants are also present in plants. However, since isolation and transfer of plant genes is extremely difficult with today's techniques, genes of bacteria and virus origin are preferred, which determine the same characteristics and are easier to isolate and transfer. What needs to be done at this stage is that biotechnological studies should be focused on isolation of plant-derived genes, and the trade of transgenic products carrying genes of bacteria and viruses should be stopped for a period of time. Thus, time should be gained, non-absolute resistant tolerant genes should be used, and the problems of marker, promoter and terminator genes should be eliminated. When these are done, the adverse effects of transgenic products on living organisms and the environment will be eliminated.

This study involved examination of the possible benefits and risks of transgenic products and their years of improvements in planting areas. An attempt was made to examine the rules and agreements for the trade and trade regulation of these products on a global and national scale. The contributions of GMOs to producers, consumers and community welfare were evaluated in general through examination of domestic and foreign sources related to the topic and especially through production and trade data obtained from statistics. To this end, developments related to GMO trade were analyzed using ratios and percentages, and production and consumption projections were made to be used in creation of scenarios for the future. Moreover, the risks and uncertainties that developing countries might face depending on developments in production and trade of GMOs were discussed, and solutions for them were evaluated overall.

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