

GENETICALLY MODIFIED ORGANISMS: PRESENT AND FUTURE IMPLICATIONS ON ENVIRONMENT, HEALTH AND ECONOMY

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Abstract: The improvement and prudent utilisation of crop biotechnology offer important contributions to food security and sustainability. The arrival of GMOs into the environment and the promoting of GM foods have brought about a public debate and discussion in many parts of the world. This open deliberation is probably going to proceed, most likely in the more broader context. While theoretical discussions have covered a broad range of aspects, some main aspects which need to be debated are weed resistance, pesticides, soil, water, environment, gene flow, biofuels, effects on non-target species, effects on human health, phytoremediation, economic impacts and Government regulations. We in this paper try to get to the bottom of this and explore the facts, fears and the future of GMOs.

Keywords: Genetically engineered crops, biotechnology.

1. Introduction

Humans have been changing genes for millennia by breeding the plants and animals that had traits beneficial to us. As traits suggest an expression of genes so with each generation those genes got more pronounced. This is called selective breeding which is basically hoping for lucky hits but Genetic engineering eliminates this factor. Genetic Engineering is a technique of controlled manipulation of genes to change the genetic makeup of cells and move genes across species boundaries to produce novel organisms. Genetic engineering is used in many fields but even though medical applications like GM insulin is widely accepted the debate heats up when it comes to food and agriculture. Why is that? Why is the same thing treated so differently? The GMO breakthrough came in 1973, with the creation of the first genetically engineered organism. GMO controversies exist in large numbers with the majority relating to GE food. Genetically modified foods were first endorsed for human utilisation in the United States in 1994, and by 2014 around 85 percent of the corn, cotton, and soybeans planted in the United

States were GM (Wikipedia). Before the finish of 2010, GM crops secured more than 10 million square kilometres (3.86 million square miles) of land in 29 nations around the world one-tenth of the world's farmland (World health organisation). GM foods are created and advertised on the grounds that there is some perceived advantage either to the producer or consumer of these foods. This is meant to translate into a product with a lower cost, greater benefit (in terms of durability or nutritional value) or both. Still, GMOs today are one of the most controversial areas of science. Due to their hypothesised impact on environment, economy and human health. Since dramatic advances in food production, distribution, and access will be required if we are to meet future needs (National Academies 2000, National Research Council 2015) the debate and discussion about the facts, fears and future of genetically modified crops are just too valuable to ignore.

A. Weed Resistance

Researchers say that the genetically modified crops were developed to provide resistance to the weed that grows by their side and compete with them for nutrients. The tolerance is provided by adding Glyphosate to the seeds. Such tolerance, introduced into corn, soybeans, and canola, allows farmers to control weed easily[1]. How was this done? To provide this tolerance, the GM crops have used Glyphosate. Glyphosate is the herbicide tolerant substance. It is used to kill weeds, especially annual weeds and grasses that compete with crops. Effects of glyphosate on contamination of soil, water, and air are minimal, compared to some of the herbicides that they replace.[2]. However, this glyphosate herbicide is also considered to be a carcinogenic i.e. cancer causing. Moreover, new weed varieties are now developing resistance to the GMOs. At least 10 species of weeds have evolved resistance to glyphosate in herbicide[3]. This has now raised new doubts and theories and scientists are now looking into this.

B. Pesticides

The use of pesticide was never appreciated. Farmers did not have a choice but to use them for protecting their crops from animals and pests. With the introduction of GMO, the farmers have reduced pesticide usage. Since 1996, the use of pesticides was reduced by 224 million kg of active ingredient (a 6.9 percent reduction)[4]. This not only makes farmers work easier but also provides food security to the consumers. But this has also led to the development of a new species called Secondary Pests. These grow in large numbers and thus destroy the crop. Development of secondary pests has recently increased in GMC fields where pesticide applications kill natural enemies of such species and disturb the biological control [5]. Development of such species is now a huge concern in the field of GMO.

C. Soil

GM crops interact with the soil similarly to other non-GM crops. They have the same life cycle just like any other crop. These plants also take in nutrients and minerals required for their growth from the soil. Also, they assist farmers in adopting conservation tillage or no-till practices. Reduced tillage helps preserve organic matter in the soil, which has numerous environmental benefits[6]. This reduction in tilling of soil has led to the increase in the carbon content of the soil. The use of no-till and reduced-till farming systems that utilise less ploughing increase the amount of organic carbon (in the form of crop residue) that is stored or sequestered in the soil. There were different experiments conducted to check how the growth of GM crops affected the soil organisms. Whether they deprived the soil of its nutrients or had no major effects.? The answers are yet to be discovered and lots of research is still going on as this data collection is difficult.

D. Water

Water is a necessity required by all living things for their survival- be it plants, animals, humans etc. With the rapid increase in population and degrading environmental factors, the scientist has always shown concern about the scarcity of water that we will face in the future. Thus it is now an important task to produce crops which utilise very less water. This feature was fulfilled by GM crops. GM Technology allows farmers to produce more food, using less land and few chemicals, while conserving soil, water, and on-farm energy.

E. Environment

We are aware of what Greenhouse gasses are doing to the environment we live in. The GM crops have an adverse and a positive impact on controlling the Greenhouse Gas emissions. But how? GM crops contribute to a reduction in fuel use due to less frequent herbicide or insecticide applications and a reduction in the energy use in soil cultivation. The decrease in fuel consumption led to decrease in CO₂ emission which is an important Greenhouse gas.

F. Biofuels

These are fuels developed using crops. These are cleaner and produce less emission. GM crops like soya are grown to produce agro-fuels. However, there is little evidence to prove this. Instead, the rapid expansion of agro-fuel cultivation can lead to loss of land primarily used for food production, increased chemical usage, displacement of farmers and indige-nous people and loss of biodiversity[5].

G. Effects on Non-Target Species

These are the friendly species that grow in the environment along with the GM crops. Herbivores, bees, soil organisms, pollinators etc are all non-target organism. We are a part of a food web which consists of many different food chains. Every level of food chain determines the amount of nutrition gained by the consumer. The introduction of GMO has brought changes in the plants compounds. Variation in the quality and quantity of plant secondary compounds may indirectly affect the natural enemies by reducing the nutritional suitability and palatability of their prey.(Price et al. 1980, 1997) This disturbance will lead to the disturbance in the food chains and the food web. Many factors are thus to be evaluated to get a better understanding

H. Effects on Human Health

The one thing that we humans care about a lot is our physical health. It is always said that health is wealth. Therefore the food we consume should be healthy. Thus GMOs caught the attention towards health security of consumers. The different concerns were-1.what if it induced different allergic reactions? 2.what if the body becomes resistant to antibiotics on consuming these? 3.what if these induced cancer-causing cells? Thus different surveys were done and then finally the result was by the UN Food and Agriculture Organisation is GM foods and crops currently on the market have

brought no documented new risks either to human health or to the environment[7]. The food safety organisations also did not find any inherently unsafe gene. This was thus a green signal for the production of more consumable GMOs.

I. Phytoremediation

Phytoremediation (phyto means plant) is a generic term for the group of technologies that use plants for remediating soils, sludges, sediments and water contaminated with organic and inorganic contaminants. In this process, the plants detoxify the contaminants using natural activities. The GM crops developed to provide this effect and thus carry out the self-cleaning process. Phytoremediation efficiency of plants can be sub-stantially improved using genetic engineering technologies[8]. Recent research results have opened up new possibilities in phytoremediation. Thus this ensures that the use of GM crops will lead to self-remediation in nature. In the coming decades, this will prove to be one of the major reasons to opt out for GMOs.

J. Impacts on Economy

One of the main reasons to produce GM crops was to increase the yield. As expected there was a tremendous increase in the yields. There has been a 100-fold production increase since the dawn of the genetically modified crops production.[9]. The increase percentage differs from place to place, landscape to landscape and crop to crop. Over the decades, beginning with the introduction, these crops production has been increasing at a very rapid rate. With the increased production came the increase in incomes of the farmers and all people related to its production. The farmers could now pay off their debts. The nations now could be self-dependant. Their profitability increased by exporting the surplus crops to deprived nations. Thus this led to an increased economy of these nations. There have been very significant net economic benefits at the farm level amounting to USD 18.8 billion in 2012 and USD 116.6 billion for the 17-year period[10].

Most of the GMO development is done the public sector of a country i.e. by the government funding. Thus a proper testing of the crops in the labs is carried out and only then it is distributed among farmers. For this purpose, the developed as well as the developing countries, have set a few regulations that need to be followed and kept in mind as rules. This is to ensure bio-safety and risk assessment.

K. Gene flow

Gene flow means GM crops could mix with traditional crops and introduce unwanted new characteristics into them. There is a method that might guarantee complete prevention but is a big anti GMO argument by itself: Terminator seeds, the idea is that they can produce sterile plants requiring farmers to buy new seeds every year. The very concept of this however caused a public outcry stopping the technology being put to use. This brings us back to the unintentional spreading of the engineered DNA, there have been cases of GMOs growing where they were not planted and traces of modified genes found in foreign crops. But there are some facts to consider 1.) Many GM plants only pollinate themselves 2.) Buffer zones can keep unintentional crossing at a minimum. Which make us believe that gene flow is certainly preventable but GM seeds should be kept under watch when planted.

L. Future

GMO technologies were using today aren't particularly enhancing the state of agriculture, as they have the potential to, but there is reason to be optimistic about the future of GE. Scientists are working on GMOs that could improve our diet thus helping in making a healthy world. Plants that produce more and different nutrients like fruit with higher antioxidant level(purple tomato) that help to fight diseases or rice(golden rice) with additional vitamins which could help fight vitamin deficiency. On a larger scale we are trying to engineer plants that are more resilient to climate change, plants that can better adapt to harsh weather and adverse soil conditions making them resistant to droughts or floods and thus helping in disaster management. GMOs could not only reduce agriculture's impact on environment but could actively help to protect and enhance it. Scientists are working on crops that can draw nitrogen from the air like tiny microbes do. Nitrogen is a common fertiliser but its buildup pollutes the ground water and speeds up climate change. Plants that collect their own nitrogen can fix two problems at once the over use of fertilisers in the developed world as well as the shortage of it in developing countries. We could even modify plants to be super effective carbon collectors like the American chestnut tree to mitigate and actually reverse climate change. With the tools we have today our imagination is the limit.

2. Conclusion

We will need 70 percent more food by 2050 which could be done by extended farming that will result in cutting more and more trees and using much more pesticides or we can change agriculture to a more sustainable model by growing that food on the land we have by using more effective methods like intensified farming with GM crops, thus making GMO the new organic. Much of the criticism to this technology is actually the criticism to modern agriculture and the business practices of the huge corporations that control our food supply. GMOs as a technology are actually an ally and not an enemy, helping to save and protect nature and minimise our impact on the environment. To conclude we can say GMOs have the potential to drastically change agriculture and can also dampen the effects of our own irresponsible behaviour. GMOs can quite possibly become our weapon to save biosphere.

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