



Adverse effect of GMO on human health & life

Final Report

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Abstract

The discussion here outlines a term paper about the adversity of genetically modified organisms impacting human health and life. GMOs hold much promise on modern agriculture; they provide chances of high crop yields, pest resistant, better nourishment. Nevertheless, as discussed earlier, use of GMOs has created fears for their effects on human lives and lifestyles, environment, and larger ecosystem. The paper introduces GMOs in an explicit manner by defining them while at the same time discussing the significant concerns related to their utilisation, safety benefits, and the substantial implications of health, life, as well as sustainability.

Introduction

GMOs is normally a reference to organisms whose genes have been changed using genetic engineering to improve certain desirable traits. Genetically modified crops such as rice, corn, soybeans, and cotton, which are widely used in crop production, have become a common staple in many people's daily diet.

The modern-day farming system revolves around Genetically Modified Organisms, commonly known as "GMOs". Their main motives are for intensifying or establishment of traits in organisms that enable them to perform well and possess unique traits. For instance, in agriculture GMOs could be configured to repel pest, enable herbicides, or boost nutritional level. Firstly, it can increase the crop yield, reduce the chemical use, and enhance crop resilience. This will use gene manipulation to solve problems, increase productivity or reduce costs with respect to different operations. Surely, it cannot be argued that the possible risks outweigh the potential benefits. The major issue of concern in the contemporary society lies in the detrimental outcomes caused by GMOs on human health and life, where some significant shifts have been made.

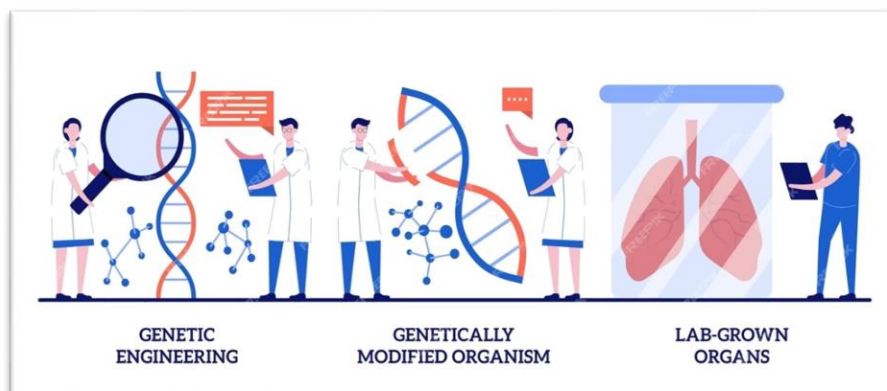


Figure 1: Overview of GMO

How are organisms genetically modified?

Genetic Engineering is a concept whereby altering the genotype or DNA of a specific organism leads to modifications in its phenotype. A restriction enzyme cuts bacteria's DNA, or more precisely their plasmids, to recombine, creating a new gene. This enzyme is specially shaped to look for the exact site on the DNA strand where to cut and join another one with "sticky ends." The new DNA addition is subsequently sealed with DNA ligase. It grows various genetically engineered organisms with incorporated genes. It can be used for studying plants, animals, among other living organisms.

The bacteria called *Agrobacterium tumefaciens* uses horizontal gene transfer technique and involves transportation of the DNA between different genomes. Bacterial HGT is achieved either via transformation, conjugations, or transductions. However, the process of HGT between eukaryotes and bacteria is unexplained. Bacteria and share genetic material via transformation (DNA uptake from an external source), conjugation (genetic transfer during cell-to-cell contact) or transduction (bacterial DNA spread by phage or viruses). The accompanying diagram shows that a bacterium called *Agrobacterium* is commonly used in genetic engineering as it could exchange its DNA with plants.

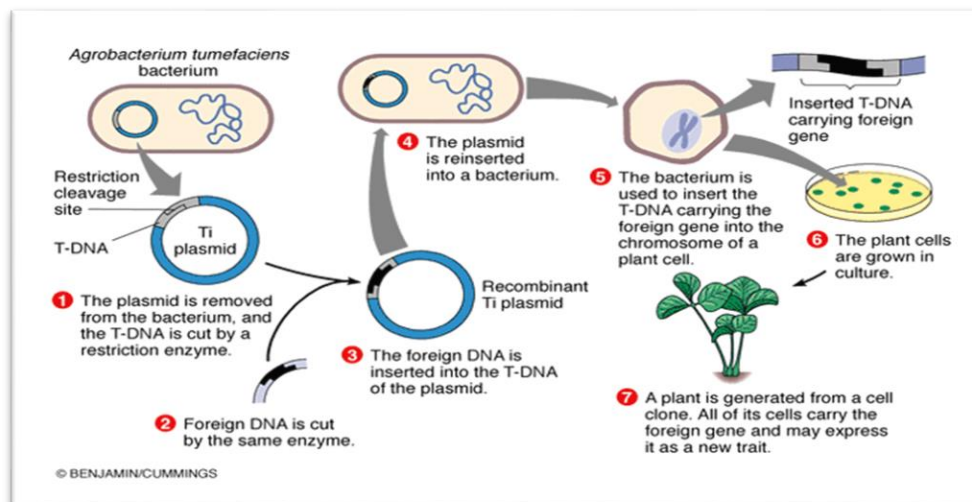


Figure 2: Process of Using *Agrobacterium* for Genetic Engineering

(Source https://sphweb.bumc.bu.edu/otlt/mph-modules/ph/gmos/gmos_print.html)

Brief History of Genetically Modified Food

For a very long-time humans have been seen using distinct types of traditional modification method like cross breeding to breed plants and animals. For example, farmers developed cross breeding methods to grow corn with a range of colours, sizes and uses. On the modern time strawberries are crossed between species native to North America with species native to South America. Nowadays foods that we see or eat are

mostly created through breeding methods. It is of course a very lengthy and time-consuming process and moreover exceedingly difficult to make specific changes excluding the health hazards. But after scientists discovered genetic engineering in the 1970s, they accomplished to make similar changes which were more specific and that was also within a short amount of time.

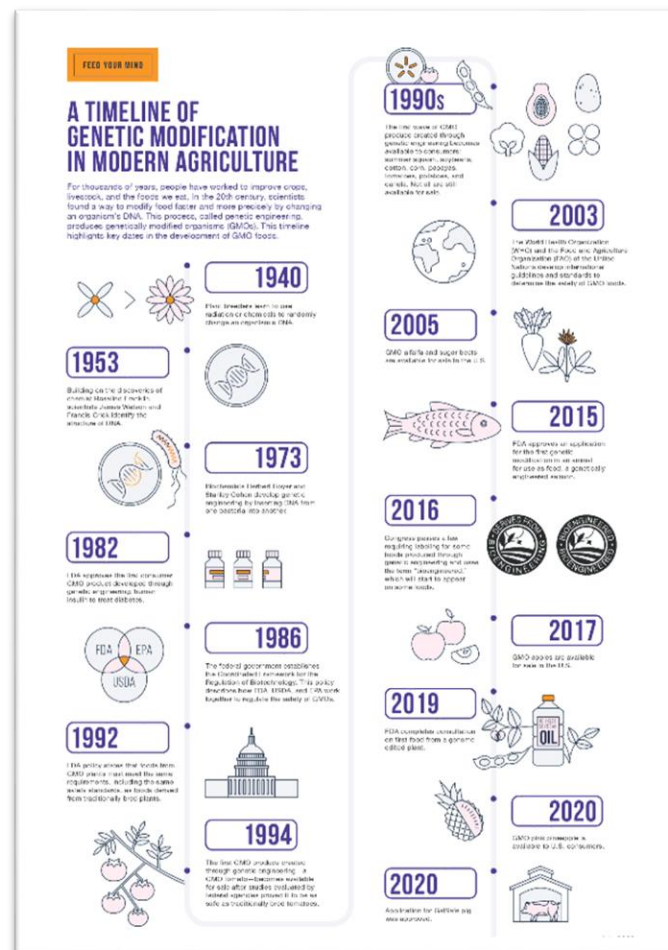


Figure 3: A

Timeline of Genetic

Modification in Modern Agriculture

(Source FDA) <https://www.fda.gov/food/agricultural-biotechnology/science-and-history-gmos-and-other-food-modification-processes>

Circa 8000 BCE: During this time, the traditional modification methods used by humans were selective breeding or cross breeding to breed plants and animals so that they get more desirable traits.

1866: An Austrian monk, Gregor Mendel, recognises the basic process of genetics by breeding two diverse types of peas.

1922: By using genetics, the first hybrid corn was produced and sold commercially.

1940: During this time to randomly change an Organism's DNA the agriculturists learn to use radiation or chemicals.

1953: Scientists James Watson and Francis Crick based on the discoveries of chemist Rosalind Franklin, identifies the structure of DNA.

1973: Development of genetic engineering by inserting DNA from one bacterium to another were done by Biochemists Herbert Boyer and Stanley Cohen.

1982: Approval from FDA, the first consumer GMO product that was developed through genetic engineering. Human insulin to treat diabetes.

1994: The production of the first GMO created through genetic engineering i.e. GMO tomato becomes available for sale after being evaluate by federal agencies proved it to be as safe as traditionally bred tomatoes.

1990's: Using genetic engineering the first wave of GMO was produced and made available to consumers. For example- Soybeans, cotton, corn, papayas, summer squash, potatoes etc, though not all are still available for sale.

2003: To determine the safety of GMO foods, The World Health Organisation (WHO) and the Food and Agriculture Organisation (FAO) of the United Nations develops international standards and guidelines.

2015: Approval from FDA was seen for an application to used genetic modification in an animal for use as food, a genetically modified salmon.

2016: Law requiring labelling for foods produced through genetic engineering and the usage of the term "bioengineered" was passed by Congress.

2017: Apples that were made through genetic modification was made available for sale in the U.S.

2020: GMO pink pineapple was made available for sale to US consumers. Also, application for Gal Safe pig was approved.

Research Question on GMO

1. In what ways do GMOs and genetically modified crops affect yields and agricultural productivity?
2. What dangers may accompany if the manufacture of GMOs increase?
3. What could be some chronic side effects associated with ingestion of GMOs?
4. Does biodiversity gets affected through GMOs in agricultural ecosystems?
5. What are the moral concerns with the use of genetically modified crops?
6. Are GMOs capable of solving global food problems?
7. Considering economics and society, what do farmers say about GMOs?
8. What effects does GMO leave globally, and how do you think its impacting on their development?
9. In what way the advancement of genetical engineering is happening to contribute safe GM foods?
10. Does the acceptance or rejection attitude of consumers on GMO products make an impact on the global market?

Research Objectives About GMO

1. Conduct field trials and data analysis on the effect of GMOs on crop yields and agricultural production.
2. Conduct research on the environmental impacts of GM crop production which includes the soil quality, water efficiency and non-insect pests.
3. Evaluate the impact on biodiversity in production system taking plants and animals into account.
4. Analyse how GMOs affect biodiversity in agroecological systems regarding plants and animals.
5. Examine the ethical dimension behind GMOs based on questions about informed consent, equal distribution, and hidden hazards.
6. Discuss the contribution of GMOs towards solving world crises on food productions, as well as their resistance properties against climates variations coupled with increased quality of nutrition.
7. Conduct surveys and interviews with regular people who has idea about GM foods as well as with farmers about their views on GM Seeds against the backdrop of economic, social, and cultural dimensions

Research Methods

There can be several types of methods through which research on GMOs can be done;

Field Trips: Controlled experiments can be conducted on agricultural fields so that we can see the impact of GMOs on crop yields and productivity.

Environmental Monitoring: To evaluate the consequences of GMO farming on soil health, water quality, and non-target weed or species implementation of environmental sampling and analysis can be done.

Long-term Health Studies: Long term studies involving human or animal subjects are to be undertaken so that potential health risks associated with the consumption of GMOs can be inspected.

Biodiversity Surveys: Ecological surveys are to be conducted to evaluate the impact of GMOs on the variety of plant and animal species in agricultural ecosystems.

Ethnographic Research: To know about the ethical dimensions of GMO use from the perspective of different stakeholders' engagement in different subjective research methods such as interviews and participant observation can be done.

Global Food Security Analysis: To evaluate the contribution of GMOs to the global food security, considering factors such as Climate flexibility and nutritional values, employment of data analysis and modelling techniques can be done.

Farmers Survey and Interviews: Gather as much as surveys and interviews of the opinions of farmers and adoption sequence of GM seeds, taking economic, social, and cultural factors on account.

Consumer Surveys and Focus Groups: Collection of as much as data through surveys and focus groups to understand the consumer opinion on GMO products, considering factors like their intellectual thoughts, belief, and most importantly the impacts of labelling

Literature Review

The literature on GMOs in relation to possible negative impacts they might have on human health, often, is highly controversial. However, there are some research regarding the issues linked to allergies, accidental gene transfer, and emergence of toxins with regards to GM foods. Nevertheless, there are differences in the research methods, sampling sizes, and experimental models among these studies.

On the other hand, many scientific reviews, and assessments, among them FDA and WHO affirmed the safety of approved GMOs for human consumption. These organisations have put stringent testing and evaluating methods to show no ill health implications in consuming GMOs.

Therefore, we need to critically review studies on adverse implications of GMO to properly examine methods, sample sizes, and funding sources. However, there are reviews that identified some potential challenges associated with GMOs such as the threat to human health and the environment and ethics.

Why do we need GMO for?

Before we start talking about the contributions of GM crops, it is essential we know why scientists or organisations are putting such significant effort on developing genetically modified crops/foods. So, if we look deeply, we face some major challenges which are discussed below.

A. Expansion of Population:

The present population of the world is about 7.35 billion. In the past decade, growth rate of the world population has reduced from 1.24% per year to 1.18% per year, although the global population rate has slowed in recent years. The projected world population for 2030 will be 8.5 billion and 9.7 billion for 2050. In 2016, the U.N FAO stated that there were 795 million undernourished people worldwide, 780 million being in developing countries. Therefore, it should be a priority of policymaking to eradicate hunger. The most viable means of matching the world's growing demands for

food crops are to increase the crop yields on cultivated land. The current crop-yield increase annual rate of 1.7% does not meet the demand of growing population, improved nutrition and decreasing ability. This is a difficult job, that cannot be accomplished expect by optimization of genetically modified crops and quantitative management of the agricultural system.

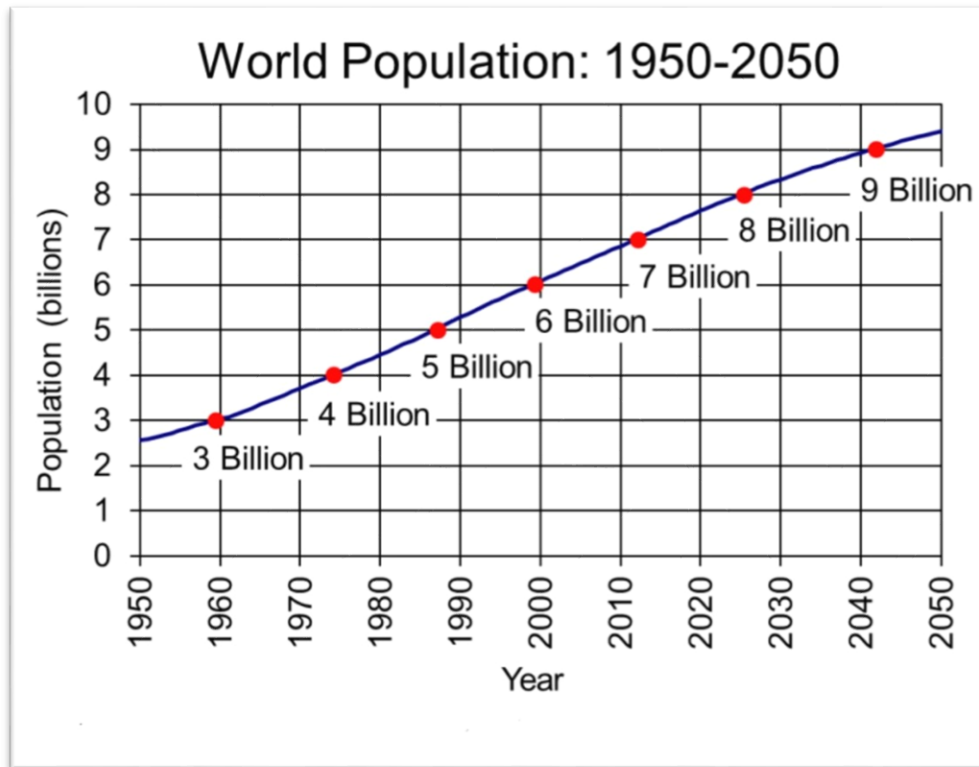


Figure 4: Predicted Global Population Growth From 1950-2050 (Source Us census Bureau, international database, 2016) <https://www.census.gov/library/visualizations/2011/demo/world-population--1950-2050.html>

B. Decrease in Arable Land:

Limited amount of arable land which are available for food production will decrease over time as predicted by FAO. As a result, the arousal of population and malnutrition will be seen. So, to overcome this problem there must be greater crop yields per acre, and to achieve this greater agricultural input must be implemented, such as fertiliser, water, pest and weed control. But the outcome is bended due to some complex reasons:

- 1) due to the skyrocketing demand for biofuel and raw-material production;
- 2) Urbanisation;
- 3) limited water resource;
- 4) land erosion, degradation etc.

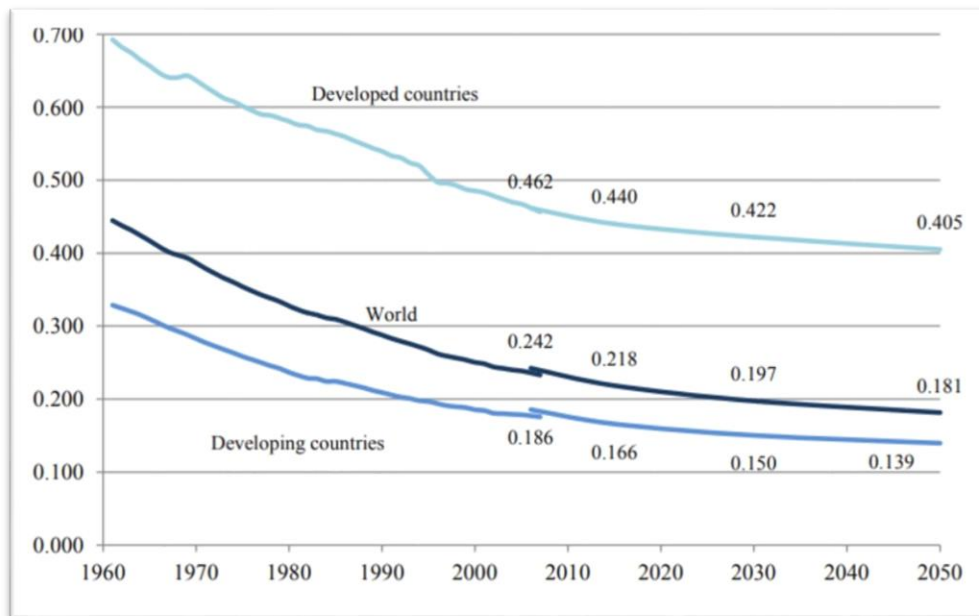


Figure 5: Arable Land Per capita (Source Nikos Alexandratos and Jelle Bruinsma, 2012)

<https://www.fao.org/3/ap106e/ap106e.pdf>

Contributions of GMO at various levels

Effect of GM Foods on Health

If we look at any advancing technology, we can see the agricultural biotechnology presents both advantages and disadvantages. Multiple economic, ecological, societal, moral, and political concerns need to be considered. Rising populations, particularly in

developing nations, generate demand for an increasingly abundant food supply. Many analysts have proposed that biotechnology has the potential to enhance global food production and reduce food insecurity by boosting crop yields and mitigating crop loss. As with any technological progress, farmers in developing nations must find the novel innovations financially viable. Consumers in developing nations will gain if biotech crops are more economical or more nourishing than traditional crops. Researchers seek genes that will be advantageous for the farmer, the food processor, or the consumer. All the proteins incorporated into foods through biotechnological methods are non-toxic, easily digestible, and lack the characteristics of proteins known to trigger allergies.

Positive Health Effects of GM Food

Rising populations, particularly in developing nations, generate the necessity for a continually expanding food provision. Numerous analysts have proposed that biotechnology holds the capability to enhance global food production and alleviate food insecurity by enhancing crop yields and minimising crop loss. Like any progression in technology, farmers in developing countries must discover the recent innovations that are economically viable. Consumers in developing countries will gain if biotech crops are more cost-effective or more nourishing than conventional crops.

To Improve the Nutritional Values

Human Diet necessitates a specific quantity of vitamins and minerals to uphold a healthy equilibrium for life. Not everyone adopts a diet, either by choice or necessity, that is comprehensive in all these essential nutrients. The genetic modification process for food items can integrate these required elements into foods that might not typically encompass them. By introducing these fundamental nutritional components into a broader range of foods, fewer health problems arising from malnutrition may develop over time. Genetic Engineering can currently generate plants enriched with nutrients (e.g., "Golden Rice," which contains more vitamin A through the incorporation of genes from a microbe and daffodils), plants with an extended shelf life, and plants which reduced levels of naturally occurring toxic substances. The objective of combining blueberries with tomatoes was to enhance the quantity of anthocyanin, which is an antioxidant that may potentially combat cancer and offer other health advantages. The expense of this genetically modified GMO food is frequently lower than that of natural blueberries or tomatoes, enabling most individuals to access the improved nutritional profile of the food during regular consumption.

Means of Medication/Pharmaceuticals

It is widely recognised that the production of medicines and vaccines can be expensive, and often, specific storage conditions are required. Ongoing efforts in this field aim to develop edible vaccines in tomatoes and potatoes, which may prove to be more convenient for shipping, storing, and administering compared to conventional injectable vaccines.

Essential vaccines for protection against dangerous diseases, as well as certain medications for daily well-being, can be incorporated into the everyday foods we consume, thanks to modern GMO practices. This could reduce the cost for individuals to access the medication they need and might revolutionise how doctor visits are approached in the future. Imagine receiving your flu shot while enjoying a peanut butter and jelly sandwich.

To Reduce Pesticide and Herbicide Use

To remove pests from harming crops, farmers use pesticides on their farming lands. These pesticides are mostly synthetic which can cause harm to the soil. As a result, many farms are bound to move their fields because pesticides add salt to the soil which harms the crop and needs to be removed over time.

On the other hand, when farmers harvest diverse types of weeds becomes a major problem for the croplands. So as a result, if herbicides are also sprayed too much it could damage the essential nutrients from the soil. In this case genetic modifications help to prevent weeds from interfering naturally and helps to eradicate the usage of chemicals used in the croplands. This results in more compatible yields on croplands instead of rotating fields every now and then.

Negative Health Effects of GM Food

The discussions surrounding genetically modified (GM) foods primarily revolve around uncertainties related to the potential negative impacts on human health and environmental safety. Consumer apprehension stems from four sources: challenges faced by the scientific community in succinctly explaining the biological techniques to the public; worries about the inappropriate dissemination of GM foods; ethical considerations embedded in traditional food processing practices; and reservations regarding the adequacy of the evaluation of GM foods. Genetically modified foods pose potential hazards to human health. Moreover, GM organism/foods impact environmental, economic, and legal issues, which also carry indirect consequences for human health.

Human Health Hazards

If we look at GM foods, three primary health concerns could be potentially linked to foods that are genetically modified, they include toxicity, allergenicity, and genetic hazards. These risks can be originated from three sources: the inserted gene and the proteins they produce, secondary or pleiotropic effects resulting from gene expression products, and the potential disruption of natural genes in the manipulated organism.

Allergenicity

Genetically modified GM foods have a comparable potential to induce allergic reactions as traditionally grown foods. However, the proteins generated by newly introduced genes carry an additional risk of triggering allergic reactions. To mitigate allergenicity, the transfer of genes from commonly allergenic foods are discouraged unless there is evidence that the protein produced by the introduced genes is not allergenic. Tests are conducted to assess the heat and digestive stability of these proteins, as well as their similarity to known allergenic proteins. It is crucial to acknowledge that the traits

introduced into a specific plant may be novel to the plant but are frequently naturally occurring in other plants.

Increase Antibiotic Resistance

Overuse of antibiotics in medicine as well as agriculture has led to significant challenges with antimicrobial resistance, which is a known problem in medical science. Antibiotics are widely used in the genetic modification process as selection marker for finding appropriate bacterial cells. It also involves the danger of transmitting antibiotic resistance genes into bacteria present in the microflora of human and animal guts as well pathogenic bacteria taken in during consumption of GM foods. As such, useful bacteria can send to genes they contain, including those living anti-bodies, among their bacteria species. Although it may be beneficial to create medicated food products, this will create latest problems as well. Nature adapts through observed resistance now being present for some strains of bacteria and specific antibiotics. Constant consumption of medicinal foods can even cancel the effect of the medicine in every person at the same time and accelerate the growth of resistance. This will, after some time, because some ought health problems which no solution will be provided easily.

Main Description

Scientists have debated extensively about the possible harmfulness of GMOs with respect to human health. However, it should be noted that not all studies have been concerned about harmful health effects and there is no general agreement on adverse health impacts.

The problem arises from an allergy likelihood. Addition of new proteins into common foods through genetic modifications can cause allergic reaction in some people who may be hypersensitive to certain types of proteins. While some regulatory agencies do demand intense on allergenicity of GMOs prior to the release into general food market.

Transfer of antibiotic resistant genes constitutes another worry. During some genetic engineering procedures, antibiotic resistant markers are employed as indicators for successful transformation. There are concerns that such markers might pass onto gut bacteria cause drug resistance. Despite this, current biotechnological practices attempt to reduce these health risks regulatory schemes call for alternative technics.

However, it is critical to point out that major scientific institutions like WTO and NASA have ascertained that most GMOs presently permitted for consumption are harmless. Strict testing protocols are in place to assess potential risk and studies show minimal adverse health effect on consumed approved GMOs.

In conclusion, even though there are certain valid worries about GM foods and continued research is needed at this moment, the overwhelming majority of credible scientist say that the known risks to human health of such foods do not make them dangerous or cause harm. Constant monitoring, open research method, surveys, and the development of advanced biotech would bring lighter on the effects of GM food.

GM Crops in Asia

If we look at all the continents of the world, the production of GM crops is less in Asia. According to a report based on ISAAA, 19.1 million GM crops were grown within five countries they are, India, China, Pakistan, the Philippines, and Myanmar. Insect resistant (Bt) cotton is the most grown crop among India, Pakistan and Myanmar, and the largest crop in China. Whereas maize only grows on the Philippines.

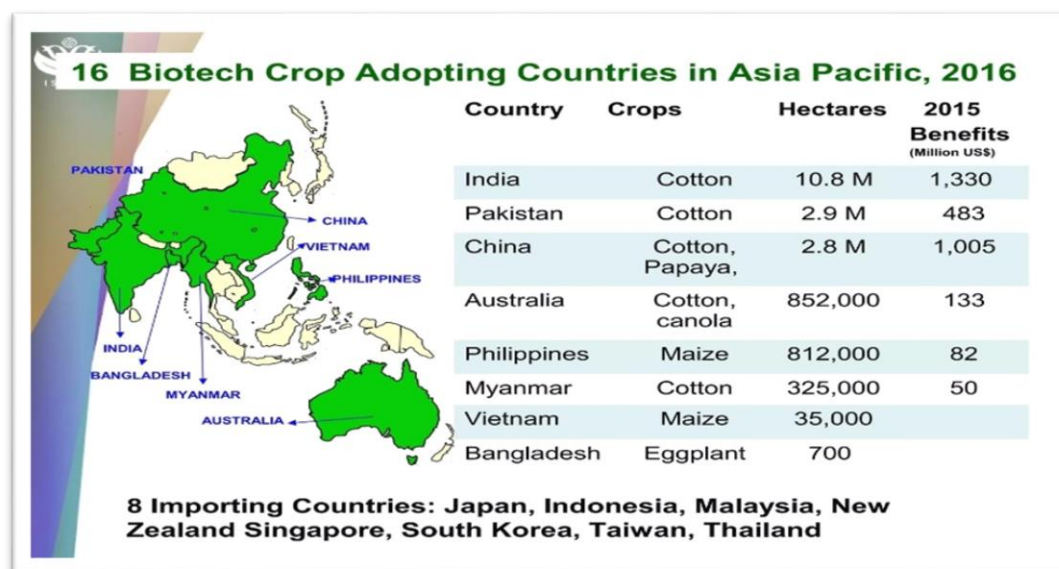


Figure 6: Overview of GM crops in ASIA (source ISAAA <https://image.slidesharecdn.com/02rhodoraaldemitaisaaa-80604080629/75/current-status-and-longterm-investments-in-agricultural-biotechnology-for-sustainable-development-in-asiapacific-10-2048.jpg?cb=1673722504>)

Socioeconomic Effects of GMO

Monetary Consequences

In terms of the economy, GMOs can boost farmers profits through higher crop yields and lower pesticide costs. For instance, research conducted by the National Academics of Sciences, Engineering, and Medicine discovered that US farmers who planted Bt

soybeans and corn were able to increase their yearly income by an average of \$22.5 billion compared to the farmers who did not plant these crops.

Consumers can be benefitted by bringing down their cost of food at a minimal range by using GMO labelled foods. Research conducted by the International Food Policy Research Institute shows that, consumers from developing countries have saved up to \$16 billion yearly.

Effects on society

If we look at a developing country poverty is a noticeably big issue here, as a result GMOs has the potential to lessen poverty and help in a lot of ways. For example, farmers in developing countries comes from an extremely poor range, if they start yielding genetically modified crops that are resistant to pests and sickness, they can eradicate their need.

On the other hand, if proper labelling and proper knowledge of GM foods are given to consumers, they will also be able to live an easier life.

Long Term Effects of GMO

We cannot surely say what will be the impact of GMO on people eventually as it has only been global for a few decades. However, organisations and experts have been working hard on finding the long-term effects of GMO and brought up few worries: -

Weeds Emergence of Pesticide Resistance

As a result of the extensive use of GMO crops resistant to herbicide we might see herbicide-resistant weeds on the near future GMO crops lands. And this may increase the costs related with managing weeds as well as the expenses of herbicides might increase.

Antibiotic Resistance in Bacteria

Genetically modified crops are modified in a way that they can tolerate certain antibiotics. As a result, antibiotic-resistant bacteria might emerge if too much antibiotic-resistant genes are used in genetically modified organisms (GMOs).

Data Presentation

According to the below given figures, we can see the global area of biotech crops and the biggest GMO lover countries. Also, this section includes data collected through an online survey completed 100 people. Through their given response, we can see about

their knowledge on GMOs and its effects on human health and life. Some of the responses from the survey are shown below:

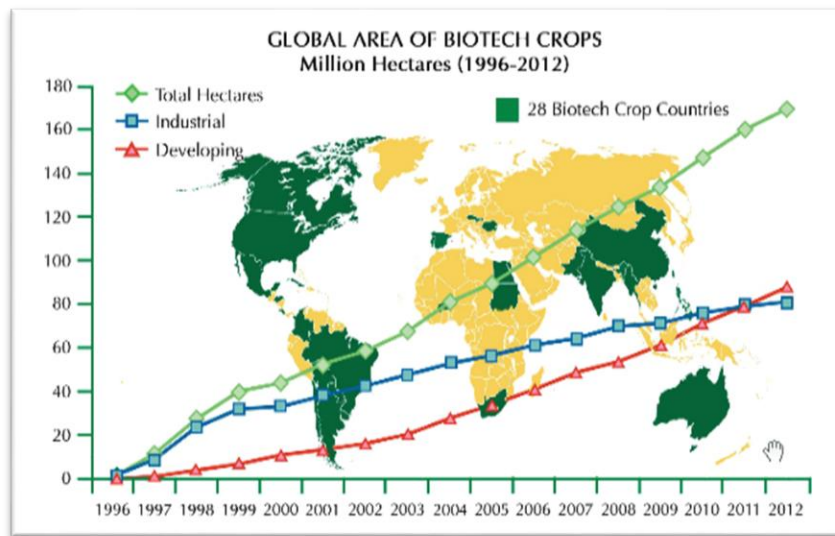


Figure 7: A record 17.3 million farmers, in 28 countries, planted 170.3 million hectares in 2012, a sustained increase of 6% or 10.3 million hectares over 2011, Source <https://www.isaaa.org/resources/publications/briefs/55/default.asp>)

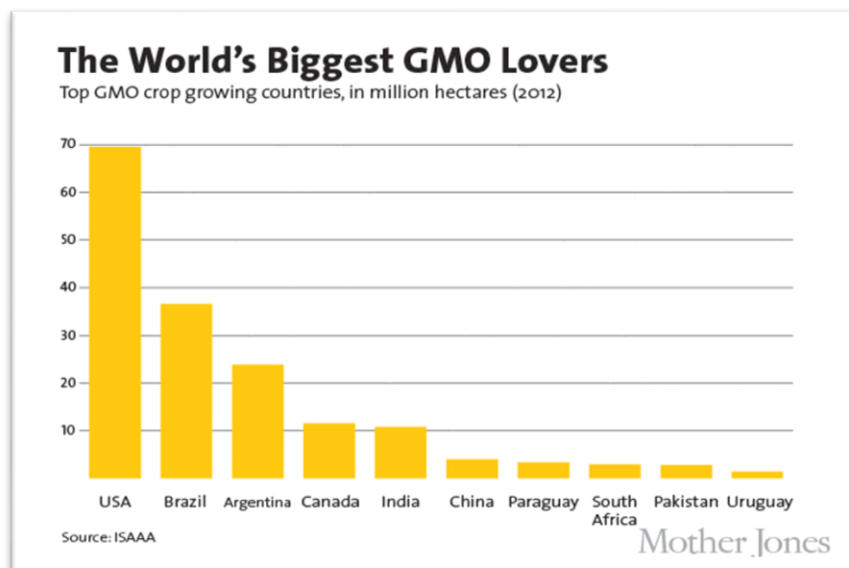


Figure 8: Top GMO crop growing countries, in million hectares (2012) (Source <https://www.greenamerica.org/show-ga-blog?nid=7156>)

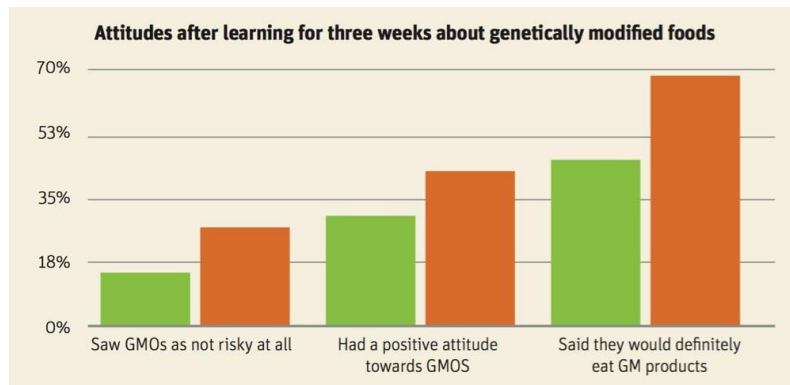
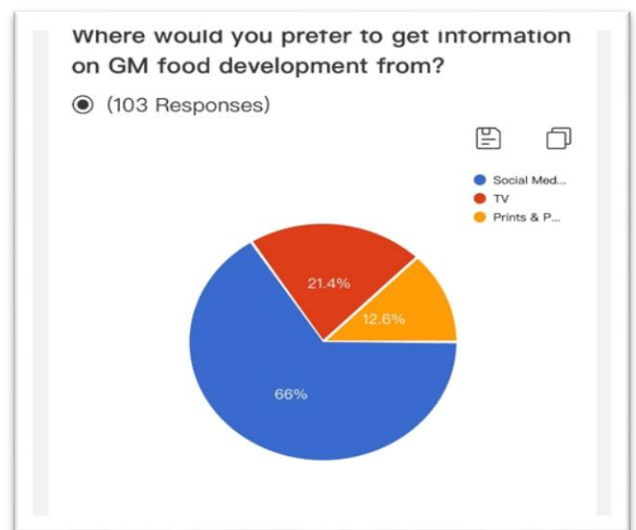
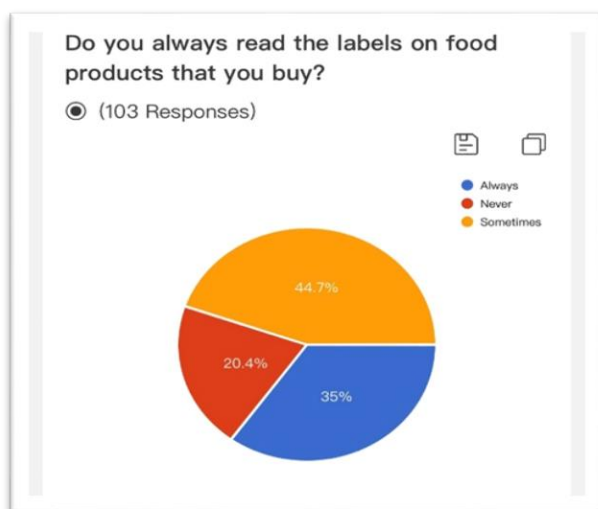
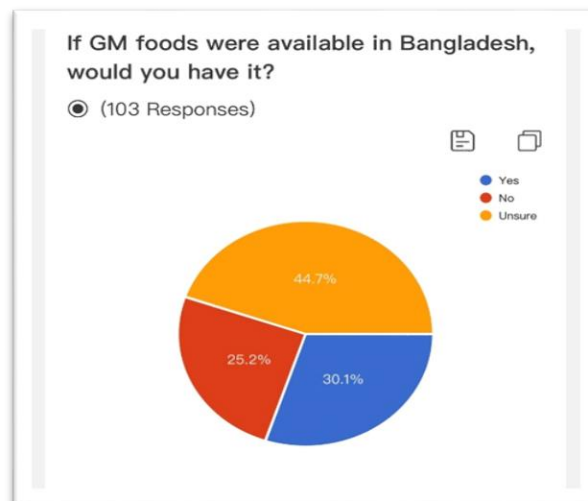


Figure 10: Bar Graph of Peoples responses on Learning about GMO (Source <https://farmtario.com/news/knowledge-helps-change-gmo-opinions/>)

Responses from Online Survey



Results Discussion

Throughout the whole report we can see, starting from the birth of Genetic Engineering to the evolution of Genetically Modified Organisms/Food scientists have been working on creating a revolutionary world through GMO. As we know this topic is a kind where a lot of argumentative topics can arise where some might support the concept of GMO while others might have different opinions. There might be both advantages and disadvantages to the usage of GM products where in some countries it is not yet used. But over 28 countries have been using GM labelled products and so far, no problem has arisen. GM foods have improved crop yields, herbicide resistance, insect resistance, drought frost, and many types of disease resistance. Furthermore, increased tolerance to salinity, floods, and low nutrients. Increased nutrients produced such as – Golden rice. We can say GMO has brought a huge change in the agricultural field, now farmers are earning millions using genetically modified crops. But if we pay heed to the critics we can see worries about potential environmental effects, as well as long-term health effects.

To summarize, GMOs represent a field of biotechnology in genetic engineering to modify organisms for some distinct purposes, with applications ranging from agriculture to medicine and shows the need for careful evaluation of their benefits and risks.

Learning Objectives

At the end of the report the learning outcomes are:

- Understood what genetic modification is.
- Application of GMO in agriculture
- How can we conduct research that includes GMO?
- Contribution of GMO
- Positive and Negative effects of GMO
- Socioeconomic effects of GMO
- Learned about the countries that are using GMO.

Conclusion

It is important to use GMOs in an ethical way. To create a proper suitable environment to produce GMOs we must follow and learn how to comprehend the possible hazards and advantages of these GM products.

References

- [1] FDA," A Timeline of Genetic Modification in Agriculture",<https://www.fda.gov/food/agricultural-biotechnology/science-and-history-gmos-and-other-food-modification-processes>
- [2] Boston University," Genetically Modified Organisms",
- [3] Chalachew Chekol," The Health Effects of Genetically Modified Foods: A Brief Review", <https://austinpublishinggroup.com/nutritional-sciences/fulltext/ijns-v6-id1047.php>
- [4] Shafia Mashiat," Genetically Modified Crops: Promises and Problems in Modern Agriculture" <https://bsmrau.edu.bd/seminar/wp-content/uploads/sites/318/2018/05/Shafia-Masihah.pdf>
- [5] Theresa Philips, PhD," Genetically Modified Organisms (GMOs): Transgenic Crops and Recombinant DNA Technology",

Online Survey Link

<https://docs.google.com/forms/d/e/1FAIpQLScfDVJAsYFobVoIAkG5anyKdVbCkKGwcVJDTUSPCPMfVTXg/viewform>