American Journal of Biology and Natural Sciences
https://biojournals.us/index.php/AJBNS
ISSN: 2997-7185

Evaluating the Benefits and Risks of Genetically Modified Organisms

Bayan Shakir Mahmood AL-Saeedi, Marwa Shaker Mahmood, Noor Waththab Ali
Department of biotechnology, college of science, university of Baghdad, Baghdad, Iraq

Received: 2025, 15, Jun
Accepted: 2025, 21, Jul
Published: 2025, 25, Aug

Annotation: This paper addresses many Fields on GMOs and its uses and risk. As a result, Genetically modified organisms (GMOs) have gained significant popularity in the fast lane of modern biotechnology and anticipated to make outstanding solutions to agricultural, medical as well as scientific problems. This review deliberates the benefits and potential risks of GMO use and production. Benefits include increased crop yields, enhanced nutritional quality, resistance to pests and diseases, reduced use of chemical pesticides, and access for smallholder farmers in developing countries to valuable crops.

Biomedical research, the production of bio-based industrial products and the development of medications such as vaccines all rely on GMOs. But questions persist about how they affect the environment and human health. The potential risks include unintentional gene transfer to non-target organisms, the creation of resistant weeds and pests, allergenicity, as well as undesired inhibition on natural ecosystems. There are also ethical and socio-economic concerns, such as IP issues and farmer dependence on biotech

companies that make the public reluctant to adopt. This review underscores the need for thorough risk assessment, transparent legislation and continued research for balancing innovation with safety. To a certain extent, that may be true, and balance is needed to both maximize the benefits of GMOs and minimize their potential negative impacts on the environment or human health.

Keywords: genetically modified organisms (GMOs), benefits, risks.

Introduction

Genetically Engineered Organisms (GEO) — modified plants and animals that are not created through natural breeding or recombination of genes Classic selection and hybridization include the some of the techniques by which GMOs are produced, but genetic modification, modern biotechnology, genetic engineering, gene technology, recombinant DNA technologies upon the genomicsactivation-tagged TT-DNA or activating tagging system ZFN Rodgers Pyramiding should be considered before transgenosis. By using these methods cellular DNA can be altered to either develop biological products or change heritable traits. (1) (2).

Lacoste GMOs are incorporated to be used in a variety of medical applications. Bacteria The medicinal products made by bacteria are: Antibiotics, antibodies, interferons, hormones, growth factors, probiotics and vitamins etc. Accordingly, this technology is making critical medications more available for disease control and infection control.

Industrial and agriculture are some of the sector that widely using GMOs due to it has more advantages from conventional way as well. Breeding processes are improved, increasing the likelihood of adequate production at reasonable prices while maintaining safe levels (quantity and quality) GMOs also allow for higher chemical selectivity, and a wider molecular diversity.

GMOs are also beneficial to the environment since they may be used to reduce the use of pesticides and dangerous chemicals, eradicate weeds, and clean up hazardous waste sites. Furthermore, through increased farm yields and profitability through lower costs and new product variations, GMOs promise to improve the quantity and quality of food available for consumption.

Through technological intervention, genetically modified organisms allow for the development of plants, animals, and microbes with desired traits, as well as the alteration of some of the current traits. For example, food can be vitamin-enriched, and plant kinds that are more resilient to pests and drought can be created. Most animals that have undergone genetic modification are created for use in lab tests. These animals are used as "models" to learn how a particular gene functions and how genes relate to health and illness. However, since genetically modified salmon have been created to grow faster and the U.S. Food and Drug Administration has declared that these fish are acceptable to eat, some GMO animals are intended for human consumption (Haspolat, 2012).

As the world's population continues to grow, the development of gene technology has increased to meet basic demands. Biotechnology made it possible to produce agricultural products more

efficiently in less time, enhance them by giving them more nutrients, and prevent the emergence of diseases. Examples of such scientific advancements include genetically modified microorganisms that effectively release insulin for diabetics, "golden" rice developed to address vitamin A deficiency, and boosted growth hormones for greater output of milk and meat. (Altuntaş and others, 2020)

Objectives of the Review

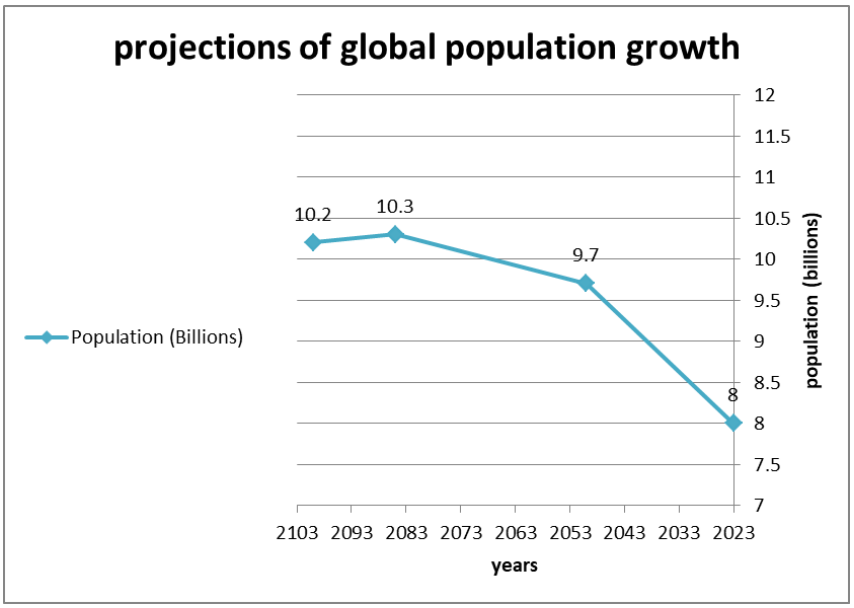
Examining the advantages, risks, and debates surrounding the use of genetically modified organisms is the goal of this review. With an emphasis on their role in sustainable agriculture, its economic ramifications, their impact on biodiversity and ecosystems, and their potential to contribute to global food security, the review will offer a fair assessment of the level of knowledge about genetically modified organisms and their effects.

Benefits of Genetically Modified Organisms

To improve these genetic traits, plants or animals with desired traits were historically bred together. We call this "selective breeding." Because of this sluggish process, plant and animal breeders have had to labour through several generations and wait years for changes that are evident (for example, bananas have been developed to have smaller seeds and be much sweeter). Many of our current crops, like corn, wheat, and fruit like apples, bananas, and carrots, are quite different from the wild types from which they were initially derived. (Bhutta and others, 2023)

"Green gene technology" refers to the use of genetically modified organisms, whereas "red gene technology" refers to its usage in medicine. It is evident that biotechnological approaches, particularly molecular techniques, which have made major strides in recent years, provide a number of benefits in the rapidly expanding agricultural sector. GMO food manufacturing is becoming more prominent due to the world's population expansion and the necessity to feed this population. Growing more highly productive GMO crops is necessary to meet the demand. (Mustafaeva and others, 2013)

The United Nations estimates that by 2050, there will be 9 billion people on the planet (figure 1), making it extremely difficult to produce enough wholesome, sustainable food. Traditional breeding is insufficient to keep up. Although their safety for the environment and human health is still up for debate, genetically modified (GM) crops help close this gap. Although GM technology holds great promise for meeting future food demands, sustainable agriculture requires its usage in conjunction with traditional and organic farming practices.



(figure 1) This chart shows projections of global population growth from 2023 to 2100 based on the UN reports (Tabashnik et. al, 2023)

The most noteworthy characteristics of genetically modified crops in comparison to conventional crops are herbicide and insect tolerance, improved nutrition, disease resistance, stress tolerance, improved storage, medicinal use, and industrial use. Assessing their advantages and possible risks becomes a scientific necessity and a social responsibility (Razzaq et al., 2021). Herbicide tolerance, pest resistance, and increased nutritional value are the most common traits of the main genetically modified crops grown worldwide: soybeans, corn, cotton, and canola (Bhutta et al., 2023)

Ethical Issues and Risk Assessments in Usage of GMOs

The main ethical issues surrounding the development and application of genetically modified organisms. The public generally believes that people shouldn't alter nature in the name of genetically modified organisms. Because of the possibility for genetic crossing and mutation, altering an organism's genetic makeup could have more negative effects on humans than positive ones (Tiedje et al. 1989).

When introduced into the ecosystem, genetically modified organisms (GMOs) may have more unintended environmental effects than their wild counterparts. In order to become a dominant and permanent strain and cause long-term effects on the living system, genetically modified microbes can occasionally multiply more quickly. The precise traits of a customised gene may be imparted by DNA alteration, but it is crucial to make sure that the environment and human health are not harmed by the released recombinant creature. (Stewart and others, 2000). therefore negating the impact of the changes that have been carried out. The negative consequences of genetically modified organisms affect not only human health but also the environment, biodiversity, and water sources. Such items have the potential to alter the ecosystem as a whole in certain situations. Therefore, research on the risk assessment of GMO release in the natural environment requires a cautious approach. Gökmen and Özel (2020).

The acceptability of genetically modified organisms is restricted for a number of reasons, including the possibility of food allergies, in addition to the environmental hazards. New proteins are synthesised as a result of genes being transferred from one organism's cells to another organism's cell nuclei. The primary allergens are believed to be alimentary proteins, which can cause severe health consequences such as skin reactions, changes in the respiratory and circulatory systems, and even the induction of anaphylactic shock. In 2011, Ladics et al.

The cultivation of maize under the utility name StarLink is a common illustration of adverse GMO impacts. An extra gene that was conditioned to naturally resist pesticides was present in the altered plant. The expression result of Cry9c protein, which exhibited potent allergenic qualities, was produced by transferring genetic material from Bacillus thuringiensis bacteria to the cell nuclei of maize. (JL. Domingo, 2007)

Since opponents of GMOs point to the possibility of antibiotic resistance genes being passed on to microorganisms, resistance to antibiotics is one of the negative effects of GMOs. In order to select for transformed cells during initial transgenesis, resistance genes of bacteria to therapeutic antibiotics are commonly employed as a marker. This would make viruses resistant to drugs by transferring resistance genes to the intestinal microbiota of humans or animals. (Craig and others, 2008)

Due to the possibility of anti-nutritional, toxic products or products synthesised in cells and tissues that increase the risk of neoplastic processes activating, toxic chemical synthesis is a dangerous issue that is related to the impact of GMOs on consumers' health. According to findings released in 2002, customers who eat genetically modified cow's milk had higher levels of the IGF-1 factor, which is positively correlated with the development of lung, breast, and colon cancers. Research is being done to find out if there are any relationships between cultivable plants that have been made resistant to pesticides and the occurrence of lymphoma in people and animals who consume the products of these plant transformations. In 2008, Craig et al.

Public Perception and Acceptance of GMOs

Globally, there are huge differences in how the public views and accepts GMOs. Cultural views, institutional trust, and knowledge of opposing viewpoints of the technology's benefits and drawbacks all contribute to this heterogeneity. GMO regulation is driven by public opinion, which also has the ability to affect the creation, uptake, and effects of GMOs (Hoban & Boudreau, 2019). Differences in GMO Acceptance Around the World The public's acceptance of GMOs varies greatly around the world. In general, countries with high levels of GMO crop production, like Brazil and the US, have higher levels of acceptability, whereas those with low levels of GMO agriculture, like the EU and the Arab world, have lower levels. These disparities in acceptability are a reflection of cultural orientations towards food and the environment, levels of faith in science and government regulators, and technological knowledge and comprehension. They also show how different interest groups—such as consumer advocacy groups, environmental organisations, and the biotech sector—have positioned themselves to influence public opinion on genetically modified organisms (Khalid ET. AL, 2024).

Public Participation in GMO Regulation and Research Public participation in GMO development and regulation is extremely important given the differing opinions on the subject. Participatory methods in GMO research and development or public consultations throughout the regulatory approval process could be the options. Involving the public can help guarantee that a wide range of viewpoints and values are taken into account when decisions regarding GMOs are being made. Moreover, public involvement in GMO research and development can lend legitimacy to this technology within its societal context. Here, farmers are participating in the selection and breeding of new crop varieties including genetically modified organisms using participatory plant breeding approaches. These methods can help to create GMOs which clear social and probiotic hurdles (Ithalso-ronot et al. (Huang and others, 2013).

Conclusion

Modern biotechnology, very focused on genetically modified organisms (GMOs) as a solution to various industrial, agriculture and medical problems. In this review, we evaluate the advantages and potential risks of using and producing GMOs. Other prominent advantages of these GM crops include high plant yields, improved nutritional qualities, and reduced susceptibility to pests or diseases making them less dependent on chemical pesticides leading towards Overall enhanced global food security. Vaccines, medicinal research and even bio-based industrial products all rely on GMO. However, they remain an environmental and public health concern. Possible risks include the unintentional transfer of a transgene to non-target organisms, the development of resistant weeds and pests, a potential increase in allergenicity and problems for natural ecosystems. Public acceptance is further hampered by socioeconomic and ethical concerns, such as intellectual property rights and farmers' reliance on biotechnology companies. In order to balance innovation and safety, this evaluation emphasises the need for comprehensive risk assessment procedures, open regulatory frameworks, and continuous research. To maximise the benefits of GMOs while minimising any potential harm to the environment and public health, a comprehensive approach is necessary.

Referance

1. *Chilton MD (2016). "Nature, The First Creator of GMOs". Forbes.*
2. Blakemore E. (2019). The First GMO Is 8000 Years old. smithsonian
3. G. Tagliabue , 2017, The central dogma, "GMO" and defective epistemology. Biotechnology in Agriculture and the Food Chain, Volume 8, Issue 4
4. Tiedje JM, Colwell RK, Grossman YL (1989) The planned introduction of genetically engineered organisms: ecological considerations and recommendations. Ecology 70:298–315.

5. Stewart CN Jr, Richards HA, Halfhill MD (2000) Transgenic plants and biosafety: science, misconceptions and public perceptions. Biotechniques 29:832–843.
6. Bhutta, M. A., Bibi, A., Ahmad, N. H., Kanwal, S., Amjad, Z., Farooq, U., Khalid, M. N., & Nayab, S. F. (2023). Molecular Mechanisms of Photoinhibition in Plants: A Review. Sarhad Journal of Agriculture, 39(230).
7. Razzaq, A., Ali, A., Zafar, M. M., Nawaz, A., Xiaoying, D., Pengtao, L., Qun, G., Ashraf, M., Ren, M., & Gong, W. (2021). Pyramiding of cry toxins and methanol producing genes to increase insect resistance in cotton. GM crops & food, 12(1), 382-395.
8. Domingo JL. Toxicity studies of genetically modified plants: A review of the published literature. Crit Rev Food Sci Nutr. 2007; 47: 721–733.
9. Ladics GS, Cressman RF, Herouet-Guicheney C, Herman RA, Privalle L, Song P, et al. Bioinformatics and the allergy assessment of agricultural biotechnology products: Industry practices and recommendations. Regul Toxicol Pharmacol. 2011; 60: 46–53.
10. Craig W, Tepfer M, Degrassi G, Ripandelli D. An overview of general features of risk assessment of genetically modified crops. Euphytica. 2008; 164: 853–880.
11. Craig W, Tepfer M, Degrassi G, Ripandelli D. An overview of general features of risk assessment of genetically modified crops. Euphytica. 2008; 164: 853–880
12. Özel, Į. A., & Gökmen, A. (2020). University students' views about genetically modified organisms: A case study. International Journal of Curriculum and Instruction, 12(1), 351-369.
13. Haspolat I. Genetically modified organisms and biosecurity // Ankara Üniversitesi Veteriner Fakültesi Dergisi. 2012. V. 59. №1. P. 75-80.
14. Altuntaş B., Beyaz R., Yıldız M. A critical statement to genetically modified crops (GMC). 2020.
15. B. E. Tabashnik, J. A. Fabrick, Y. Carriere, Global patterns of insect resistance to transgenic Bt ` crops: The first 25 years. Journal of Economic Entomology 116, 297–309 (2023).
16. Khalid R.M., Alexandra N. , Guy G. , Mercy O. , Carmen H.(2024) Societal perceptions and attitudes towards genetically modified (GM) crops, feed, and food products in the Middle East, North Africa, and Turkey (MENAT) region: A systematic literature review. Food Quality and Preference J. 117. https://eprints.ncl.ac.uk/file_store/production/297817/7C51CF55-EC41-4414-BD67-B4E678ECBB1B.pdf
17. Mustafaeva, A., Mamedov, V., Akhmedov, I., & Khalilov, R. (2013). Geneticheski modifitsirovannye pishchevye produkty. Baku. (in Azerbaijani).