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Recent Advancement in Genetically Modified Crops

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Abstract: ***Current agricultural practices alone will neither address the shortage of food nor abolish worldwide hungry and malnourished people. The major reason behind food shortage is crop loss and reduced crop yield. Continuous application of insecticides and controlling agents have raised more serious concern regarding soil fertility and bioaccumulation of toxic compounds. Genetically modified (GM) crops is one of the evoluting methods to tackle the food shortage. GM crops have higher resisitance towards pests, pathogens and abiotic factors alonwith higher crop yield. However, ethical concern related to foreign genes, evolution of resistant pest and possible toxic effect on end consumer. The current review paper discussed negative and positive effects, risk and contversies, public concerns and consumers attitude, ethical concerns for using GM crops and its future challenges.***

Keywords: Genetic engineering, ethical concern, gene transfer, insecticide resistance.

I. INTRODUCTION

Current agricultural practices alone will neither address the shortage of food nor abolish worldwide hungry and malnourished people. According to current research, around 17.2% of the world's individuals cannot obtain nutritional and adequate food (Bimal Kumar, Ghimire, 2023). Crop production is declining, and numerous living and non-living components play a role in this trend. With the world's population prediction to reach 9.2 billion by 2050, there is a tremendous need to boost crop output. Because the number of people worldwide is growing at a rapid pace, there's an urgency for quick and effective techniques to transfer characteristics of interest to target cultivars, and genetic alteration may resolve this issue. Genetic alterations, often known as genetic manipulation, is a technique for transferring an outside gene within the desired agricultural plant (Thomson, 2018b). Using this method not just gives desired characteristics but also enhances nutrient levels, changing dicot and monocot plants into rich and healthful food products. Genetically modified crops are developed by inserting genomes into the plant genomes by the transformation methods such as agrobacterium tumefaciens, gene gun is called genetically modified crops. The gene was introduced from living organisms like bacteria, viruses, Fungus also known as transgene (Kumar et al., 2020b). The first GM Crop was developed in 1982 as an antibiotic resistance tobacco plant and the first GM crop approved by the Food and Drug Administration (FDA) in 1994 with its characteristic feature of longer shelf life was Flavr Savr Tomato (Kumar et al., 2020b). Later on, different types of GM Crops came onto the market such as; Bt Cotton, Bt Brinjal, Golden rice, GM Mustard, Canola, and many more their different properties according to the people's need these crops were modified some are resistant to insects and pesticides, some are nutritious (James, 1997). Till now we have 525 transgenic events in 32 crops available. In which the maximum number of events is maize. For the past two decades, Gm Crops play a very important role in increasing world agriculture productivity. By using GM crops the world's agriculture productivity increased by 22% according to a global meta-analysis (Klümper & Qaim, 2014). Plants with new gene(s) are still a source of concern due to the possibility of gene transmission between genetically modified crops and their wild relatives, as well as the chance of lateral transmission of the antibiotic resistance-associated gene (s) through the different methodologies of genetic engineering used to generate improved crop plants. To address concerns about foreign gene insertion, two new procedures, cisgenesis, and intragenesis, were developed as alternatives to transgenesis. In the cisgenesis method, the genetic materials are transformed from closely related plants, and in the intergenesis method, in which the genetic material of bacteria, animals, and other plants are transformed into carrier organisms. The other methodologies such as CRISPR-Cas9 are also new editing methods. And through this method, we can edit cut and paste the genome with the help of cas9 protein. Despite biosafety and concerns regarding the environment, genetic engineering has been a preferred strategy for the quick production of better agricultural plants and the assembly of several beneficial features. There are many benefits and harmful effects on the environment, health, medicine, and agriculture. The major benefits include herbicide tolerance (HT), insect resistance (IR), disease resistance, abiotic stress tolerance, and nutritional enhancement. The other harmful effects such as allergenicity, toxicity, health, and environmental effects. The First Gm crop approved by GOI is Bt Cotton in 2002.

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II. MERITS OF GENETICALLY MODIFIED CROPS

1) *Improving Nutritional Quality:* Micronutrient deficiencies affect the world's population. By Genetic engineering technology, genetically modified plants produce very nutritious staple food crops. (Szenkovics et al., 2020) It is an effective tool in helping to fight against micronutrient malnutrition, which threatens billions of people globally. (Sundar et al., 2006) The biotechnology method is useful for producing extra nutritious plants like "Golden Rice" which contains Vitamin A which is highly beneficial for human beings. Normal rice "Oryza sativa", lacks beta-carotene in its endosperm, which is the starchy and largest component of the rice seed and is normally an off-white colour. Beta carotene is a member of the carotenoids class of chemicals, one of the hundreds that plants naturally make, and it has a yellow-orange colour. So, Vitamin A containing Golden rice is helpful and improves the health of human beings.
2) *Environmental Tolerance:* Due to regular changes in weather, climate, and other environmental factors cause destroying of animals, and plants. With the emergence of biotechnology, we have plants that are tolerable to environmental conditions. The GM plants are weather-resistant, and drought resistant, the plant can survive in cold-to-cold conditions and also in high temperatures. Changing or inserting new genes helps in survival in different environmental conditions. As we know nowadays the changes in climate conditions day by day many plants die due to high temperatures, drought, cold temperatures, and storms. So, we needed plants that can survive in all these conditions and it became possible through genetic engineering. Plants that can withstand high salt and lengthy periods of drought have been identified, which may enable humans to grow food in colder, less watered places. Plants like GM corn and GM rice are drought-tolerant and highly beneficial for humans.
3) *Insecticide Resistance:* With the growing use of chemical fertilizers and pesticides to kill the insects which harm the plants' production the insect became resistant to these chemicals. Bt cotton was also approved in India in 2002. GM crops have been successfully made in such a way that controls the insects. With the help of GM Crops like "roundup ready" crops which are herbicide tolerant. (Ayaz et al., 2021) The crop such as Bt cotton, produced a toxic protein known as Cry or d-endotoxins, when these toxins are used for developing GM crops. (Peng et al., 2018) It controls many insects and is species-specific harm only some kinds of pathogens, pests, and insects such as budworm, lepidopterans, and coleopterans but doesn't harm the other organisms.
4) *Medical Benefits:* Using genetic alterations, it is possible to create specific proteins and vaccines, as well as other pharmaceutical commodities, through a process known as "pharming." This practice provides less expensive techniques for enhancing personal health and may influence how certain pharmaceuticals are administered to patients in the future. (Rybicki, 2010) Various crop-based vaccination has been effectively formed in plant tissues as a consequence of gene expression, either steady or transitory. (Xu et al. 2011) Plant-based vaccinations are less expensive than cultured cell bioreactors, are easier to transport, have a lower risk of contamination and degradation, do not require medical personnel, high-tech machinery, or preservation, and are less expensive than cell culture bioreactors. (Sala, 2003) Antigens genes generating Rabies Capsid proteins such as HBsAg and HIVgag have been effectively produced in transgenic tomatoes by inventing the notion of an edible vaccination.

III. DEMERITS OF GENETICALLY MODIFIED CROPS

1) *Affects Human Health:* Despite the many advantages of GMOs, there are many negative effects on human body. These crops causes many undesirable changes and physiological, and biological effects on humans and other mammals. The transformed gene sometimes reacted with organisms DNA and it may causes allergenic reactions by the forming toxic proteins or allergens (Pelletier, 2005). Other many concerns with GMOs such as it causes incomplete digestion because it contains different genes (Kramkowska et al., 2013). it cause cancer, human DNA alters, harmonal imbalance. Others effect that gene transfer might induce infertility in animals and allergic responses.
2) *Resistance to Antibiotics:* It has increased Food, vaccinations, bacteria, or viruses can all introduce GM goods into the human body. Mnay GM crops containing genes which are resistance to antibiotics. Many bacterial resistance genes present in there genomes which also resistance to drugs and resistance to some specific type of antibiotics. If we take food on daily basis may causes resistance to all antibiotics no affects we got after taking any antiobiotics (Keese, 2008). These causes increasing in diseases in human body.
3) *Environmental Effects:* Many GM crops causes resistance to pesticides and causes superweeds increased. The releasing of such items and their potential environmental repercussions necessitate close monitoring of environmental biosecurity in order to mitigate or eliminate the danger posed by them (Hall et al., 2007). The use of genetically modified (GM) technologies has resulted in a shift away from a wide variety of selective herbicides and towards one or two broad-spectrum herbicides.

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According to researchers Bt cotton release a toxic substance which kills the larvae and insects which causes disturbance of food chain (Hilbeck et al., 1998). Also claimed by many farmers it causes negative influence on farmers and indigenous substances.

IV. ETHICAL CONCERN AND SAFETY ASSESSMENT

There are two kinds of people who support GM crops and the one who doesn't support it. The main concern is why they criticize GM crops and want to ban them. There are issues regarding such as ethical issues. The issues related to harm to human health, harmful to the environment, unnaturalness, corporate dominance, dependent on only some kinds of food, and loss of traditional farming. But on the other people who say GM foods can deal with poverty and starvation. This isn't correct, we have enough food if we distribute them equally no one dies from hunger, but there comes politics of distribution (Weale, 2010). The concern related to GM crops is: the first is if genetic material enters into an environment that is not native to it could lead to many unforeseen problems for the other organisms. GM crops are resistant to insecticide and pesticides and growing GM crops in the field lead to an increase in the use of chemicals and causes environmental pollution. The second concern is economic effects; if only GM crops are available then lead to a food crisis or the amount to be paid is maximum than normal crops (Ricroch et al., 2018). These crops are man-made so it's not easily available for all some categories of people can be made these crops and set prices according to them, which may cause not be affordable for all. Another concern is it affects human health there's no safety for consuming GM food. Many GM crops cause numerous health problems like sterility and infant mortality. The other concern loss of traditional farming, traditional farming known as organic farming with the use of natural fertilizers, without using any chemicals can grow plants known as organic farming. If we start using GM crops their productivity is maximum in small time, people only use these crops for production, for maximum benefit in small time.

V. PUBLIC CONCERN AND CONSUMER ATTITUDE

Even when GMOs were not on the market in the late 1980s, there was a big controversy around them. However, industrial uses of gene technology have been developed to the point of manufacturing and sale. The majority of study work has been spent to examining people's opinions regarding genetically modified foods as a technology (Bawa & Anilakumar, 2012). The public concerns regarding GM Crops people worry about that inserted DNA in food crops could spread to other plants and creating "superweeds". Public concern regarding GM crops generally revolves around safety, environmental impact, and ethical issues. There is also concern about the environmental impact of GM crops, particularly regarding their potential to disrupt ecosystems and natural food chains.

Consumer attitudes towards GM crops are mixed (Martinez-Poveda et al., 2009). Public have different opinions for using GM crops as food source; Some consumers are in favour of GM crops, believing they can help increase agricultural yield, reduce the use of pesticides, and address global food insecurity, Other consumers are sceptical of GM crops, questioning their safety, long-term effects on the environment, and potential health risks, Some consumers may not have strong feelings about GM crops and are willing to consume them if they are deemed safe and beneficial, Heightened concerns of being manipulated by powerful food and agricultural corporations, that are managing GM crops. Overall, public concern and consumer attitude towards GM crops are diverse, with people holding different perceptions and beliefs based on various factors such as education, cultural background, and personal values. Now a days people easily influenced by new discovery because we become dependent on only research and natural things aren't even in good condition, some reasons that influenced the individuals towards purchasing GM-free goods; (a) for saving traditional value and organic farming is best methods (b) For protection of the environment (c) Concern regarding marketing (d) Not easily available for all (Tsourgiannis et al., 2011). These types of crops puts pressure on the world for their legalization and globalisation. Many countries where food crises on next level they adopted the GM crops as their foods; In Africe total 47 countries adopted and cultivating GM crops to tackle the food crises (Ghimire et al., 2023b). It is controversial topic in worldwide there are many supporters who supports for their nutritional quality, environmental protection, non-toxic. But many independent studies found that presence of DNA fragments in some body parts which we cant detect in blood and tissues (Rizzi et al., 2012).

VI. RISK AND CONTROVERSY

GMOs have been a topic of debate since their inception. The risk associated with these are affecting human healths, various investigations found traces of GM DNA remains in the body part like gastrointestinal tracts. The risk associated with are many; environmwetal risk, health risk, herbicide resistance, GMO labelling and consumer choice, ethical concerns. Despite of all these the many countries accepted these crops as food sources oe income sources, countries like north and south America, China accepted many of the GM crops and its like a second green revolution in their countries. These crops shows that beneficial for the both small

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and large farm (Cohen & Paarlberg, 2004). We cant become dependent on only GM crops; sometimes people worry about the cross contamination of GM crops with any non-GM crops, which affects the organic farming and creating creating difficulties in maintaining a GMO-free market and also loss of native species (Beckwith et al., 2003). The main concern of GM crops croprate control. Many countries belevied that GM crops is private things manage by some people and not for all (Qaim, 2010). Many GM crops are banned from India, recently GM mustard from India by the GOI (Government of India) but approved by GEAC.

The reasons behind the banning were there's gene present in GM mustard which causes infertility in men. . There are many organizations which protest against GMO and giving many ethical and biological reasons why we should not eat/ use GM foods. If there's many benefits and in present era it also harms the human beings. We can't totally deny the use of GM crops because with the growing population it is really necessary for us to use as food so that people get maximum nutritious substance. In many countries GM campign was initiated to stopping the use of these, In this peotest the many participant are participated like organization, environmentalist, anti GM- groups; this protest emerged because people have lack knowledge and for biosafety regulation (Tironi et al., 2013).

VII. FUTURE CHALLENGES

Biotechnology is an emerging technology and briging a new potential for the nations where the food production is not sufficient and scarcity of foods. Biotechnology can also aid in the development of cellulose-rich plant species for the manufacture of biofuels, but it is fraught with difficulties. The increasing research and concern about GM crops effects on the health, environment, biodiversity (Shukla et al., 2018b). According to World Bank Group, global climate change poses a serious danger to agricultural output, potentially driving more than 100 million people back into poverty by 2030. To help contribute to global food security in the next years, there are now global initiatives underway to generate new crop varieties with drought resistance through traditional breeding as well as through the use of contemporary biotechnology technologies. In the future the genetic engineer method used for making more advanced crops and aid in the progress of plant species. But research and scientist should do more study for modifying crops so that we can tackle scarcity of foods. Despite of all these positive points of GM crops we should also concern about its negative impacts and should used at efficient amounts and government should put some rules for using GM crops.

Genetically engineering technology is vast methods of producing crops. We should use this method as per our requirrements only. We all cant be dependent on this technology for our foods. These crops helped farmers a lot for better crops production, for getting better price, and socially economically helps all the public. Furthermore, the general public may be opposed to the development of "super plants" as a credible solution to global famine.

VIII. CONCLUSION

In clusion, the Genetic engineering technology is an emerging technique for the production of foods where the food is insufficient. Greater advantages of GM food are it helps in future for we get maximum nutrients by eating minimum foods. The food crops like golden rice which contains vitamin A helps the human health, crops also helps in making money like Bt cotton. But on the other it's negative impacts on environment. These crops are man-made so it's not easily available for all some categories of people can be made these crops and set prices according to them, which may cause not be affordable for all. The risk associated with these are affecting human healths, various investigations found traces of GM DNA remains in the body part like gastrointestinal tracts. The risk associated with are many; environmwetal risk, health risk, herbicide resistance, GMO labelling and consumer choice, ethical concerns. Research and scientist should concern about the problem associated with GM crops. The growing global demand of these crops we should use thecrops as per only of our requirement.

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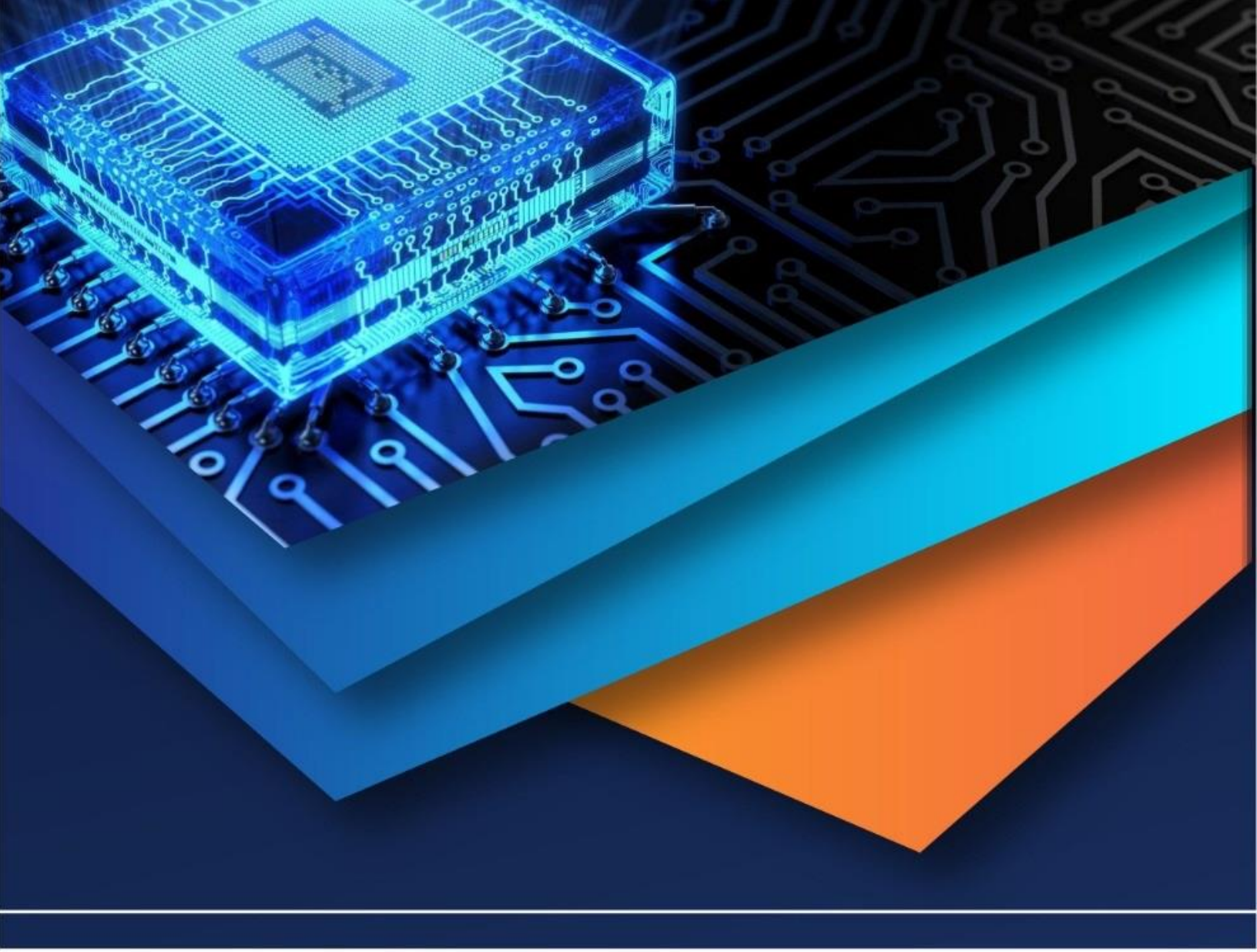

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