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GM Food in India: Are we ready for it?

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Abstract

India's approval of the first Genetically Modified Food Crop (GMFC), GM Mustard brought about this biotechnological product back in news. Issues pertaining to ecological impact, biosafety, economic benefits and labelling of these crops have been debated continuously at national and global level from past two decades. Yet there is no clarity on their efficacy, benefits or even harmful impacts. This paper is in direction to clear the controversies surrounding GM crops in context with the Indian agricultural set up. The readiness of the country to adopt and use these crops has been studied on 3 indices; Biosafety Readiness Level Regulatory Readiness Level and Social Readiness Level. The in-depth analysis highlighted the preparedness of the agricultural system legislative set up as well as consumer acceptance over these crops. Asymmetrical research database, regulatory lacunae and dubious perception of the society was reported at all the three levels of readiness. Therefore, the study recommends reforms in the agricultural system, in the regulatory policy and science communication policy of GMFCs so that this innovation of biotechnology can be used for the betterment of mankind.

Keywords: GMCs, GMFCs, GM Mustard, biosafety, regulation, ethics

Introduction

Recently, the Genetic Engineering Appraisal Committee (GEAC) under the Union Ministry of Environment, Forest and Climate Change of India approved Genetically Modified (GM) Mustard for commercial use. It is the first Genetically Modified Food Crop (GMFC) of the country to get the approval in two decades. As claimed by a section of scientific community and activists, growing GM Mustard commercially may hamper crop diversity and pose a threat to food security while on the other hand Government declares that this clearance is integral to its goal of attaining self-sufficiency in edible oils. Soon, a petition challenging this decision was filed and protests by activists, agricultural analysts and NGOs broke out in the country (Nitnaware, H. 2022) ^[14]. It is being claimed that Government agencies have flouted laws at various levels including understanding the effect of GM Mustard on honey bees and other pollinators and by-passed biosafety protocols.

History repeats itself; the green signal to GM Mustard met the same fate as was with Bt Brinjal a decade ago. It brought the issue back into controversy with a duel of claims and counter claims by the opponents and proponents. Sadly, the research data on biosafety, reported economic benefits and existing policy framework over GMFCs is highly varied. The scientific community stands divided on this issue. Thus, large asymmetrical database has been generated over the potential impacts of GMFCs (Dadgarnejad *et al.* 2017) ^[5]. And this data is being misrepresented by various stakeholders to fulfil their vested interests. Consequently, variegated opinion on their biosafety, profitability and possible impacts lacking long-term ecological studies and chronic biosafety analysis. Under such scenario, release of any such GMFC is bound to lead to an uproar and chaos in the society. It has jolted the Indian psyche where moral and ethical values have better place than any other issues (Kaur *et al.* 2013) ^[18]. This compels the scientific community to tear the fibres of the technology and analyse it scientifically as well as ethically.

Materials and Methods

This review attempts to establish a comprehensive understanding of the controversy on release of Genetically Modified Food Crops (GMFCs) in India. The study employs an interdisciplinary approach to examine the GMFCs readiness level of India based on three-tier research.

1. **Biosafety Readiness Level:** This index studies the existing biosafety network of biotechnological innovations in the country by reviewing the governmental guidelines as well as published data on biosafety of GMFCs
2. **Regulatory Readiness Level:** This index dwells on the legislative network of India on GMFCs. The study of guidelines governing research, development, testing, labelling, release as well as post release monitoring of GMFCs is studied here.
3. **Social Readiness Level:** This index studies the social acceptance of GMFCs in the country. It analyses the intricate ethical, moral, and social aspects governing GMFCs.

Results

Use of GMFCs has been an extremely contentious issue in India. From last two decades, these crops have been proposed and opposed with equal voyeurism by stakeholders with vested interests. Thus, urgent need is to study and comprehend the real efficacy and value of these crops in context with Indian Agroecosystem. This review attempts the same by analysing the GMFC Readiness of the country on aspects of Biosafety, Regulation and Social acceptance in the following sections.

Biosafety Readiness Level

Issue of biosafety of GMFCs has been debated world over by scientists. GMFCs if once released in environment are bound to enter our food chain one way or the other. Adverse health effects may occur due to the new Genetically Modified (GM) gene product or the GM transformation process or both (Ajami *et al.* 2016) [1]. In humans it may lead to emergence of new allergens in the food supply, antibiotic resistance, production of new toxins, and concentration of toxic metals. It can also lead to increased cancer risks as was reported by George *et al.* in case of glyphosate resistant crops. It leads to degradation of the nutritional food value, and many other unknown risks that may arise later (George *et al.* 2010) [7]. Such corroborating evidence, repeated patterns of illness, and health reactions have increased consistently in past few years and superimposed the known potential risks of GM foods.

Presence of GM residues in human body has been contested by many scientists.

pioneer study in this field was done to evaluate the correlation between maternal and fetal exposure, and to determine exposure levels of Glyphosate and its metabolite aminomethylphosphoric acid (AMPA), Glufosinate and its metabolite 3-methylphosphinicopropionic acid (3-MPPA) and Cry1Ab protein (a Bt toxin) in Eastern Townships of Quebec, Canada. It reported presence of Cry1Ab toxin in 93% and 80% of maternal and fetal blood samples, respectively and in 69% of tested blood samples from non-pregnant women (Aris and Leblanc, 2011) [2]. Hematotoxicity of four genetically modified Bt-spore crystals was evaluated on Swiss albino mice. The short term study reported selective hematotoxicity on erythroid lineage and significant reduction in bone marrow cells at all exposure times becoming more evident at 7 days suggesting need for further studies (Mezzomo *et al.* 2013) [11]. Recent study based on bio-informatic analysis was performed to assess the safety for human and animal health

of putative translation products of gene VI overlapping P35S. No relevant similarity was identified between the putative peptides and known allergens and toxins, using different databases (Podevin and Jardin, 2012) [15]. Another *in vitro* study of Cry 1Ab and Cry 1Ac alone or with Glyphosate based herbicide was done on human cells. The Cry1Ab caused cell death from 100 ppm concentration while Cry1Ac, showed no effects under same conditions. This study highlighted the fact that modified Bt toxins are not inert on non-target human cells, and that they can lead to combined side effects with other residues of pesticides specific to GM plants (Mesnage *et al.* 2013) [10]. *In vitro* studies also evaluated the toxicity of four glyphosate (G)-based herbicides in Roundup (R) formulations, from 105 times dilutions, on three different human cell types; umbilical, embryonic, and placental cells. It reported that all glyphosate formulations cause total cell death within 24 h, through an inhibition of the mitochondrial succinate dehydrogenase activity, and necrosis, by release of cytosolic adenylate kinase leading to membrane damage (Seralini *et al.* 2012) The current review study highlights lack of any chronic biosafety research on GMFCs which holds substantial importance as these organisms may persist in the system and may affect later in life. Moreover, there is no regulation in the country governing the biosafety evaluation of these food crops by independent or government bodies and relies completely on data submitted by the developer for its commercial release. Therefore, GMFCs completely fail to hold their ground on this index requiring rigorous and chronic biosafety studies of all crops under experimentation before approval.

Regulatory Readiness Level

Government of India is ceased of the compulsion and limitations, as also the potential dangers of GMFCs. For such reasons, the Ministry of Science and Technology (DBT), Ministry of Environment and Forests, and Ministry of Health and Family Welfare together exercise an elaborate policy framework over these. The premier government agency, Recombinant DNA Advisory Committee (RDAC); function under DBT. This agency advises any research organization interested in GE research in the country about the developments in biotechnology at the national and international level and help them prepare suitable guidelines for safety in research and applications of GMFCs (DBT, 1990) [6]. The institution interested in GMFC research is also required by law to constitute an Institutional Biosafety Committee (IBSC) at its organization level. This committee develops a manual of guidelines for the regulatory process on bio-engineered organisms in research, use and application in the agency to ensure environmental safety. Before commencing any form of research activity the research agency needs approval of Review Committee on Genetic Manipulation (RCGM) under Department of Biotechnology (DBT). It formulates Monitoring cum Evaluation Committee to monitor and review all ongoing GM research projects up to the multi-location restricted field trial stage by undertaking field visits to trial sites to ensure adequate security measures. It can also issue clearance for the import of raw materials needed in GM research projects. Large scale field trials require approval of Genetic Engineering Appraisal Committee (GEAC) under MoEF. It approve activities involving large-scale use of bio-engineered organisms and recombinants in research and

industrial production from an environmental safety angle as well as approve imports of bio-engineered food/feed or processed product derived thereof (MoEF, 1989) ^[13]. It has the power to take punitive actions on those found violating GM rules under EPA, 1986. Further State Biotechnology Coordination Committee (SBCC) and District Level Committee (DLC) function under the state government and District Administration respectively.

This policy on GMFCs has been under the scanner of public groups and scientists because of its weak implementation and lacunae. Implementation of the rules and guidelines is very weak, because of lack of skilled human resource and infrastructure. There are strict guidelines over biosafety evaluation of these crops before approval carried out by the developer but no independent evaluation or cross checking of data is done by the government. Moreover, these crops once released are bound to enter our food chain one way or the other. There is also possibility of GM food and food material entering the country during imports from GM crop growing countries like USA and Canada. But none of the legislations have provisions on labeling of these products produced, sold or imported in the country. The development of these crops has introduced a variety of novel legal questions, which our regulatory system fails to answer. The regulation policy of the country has strong bearing on their political, economic and social set up (Chauhan, 2012) ^[3]. There are number of stakeholders of this technology with varied interests and contrasting views. From government to scientists who promote this technology, to Biotech MNCs who want to earn money from it, the farmers who want to increase their yield to the common man who is unaware and wants healthy food at affordable price. As the numbers and interests of stakeholders increases, drawing a consensus on a stringent comprehensive policy becomes even more difficult.

Social readiness level

Whether GMFCs are morally acceptable or not, depends on the factual claims of the scientists and their acceptance by the society (Cheery, 2020) ^[4]. It is often argued whether GE in itself has any value or not. But more precedence is given to the applications of GE in life. Genetic engineering is a quantum leap in science and technology with the ability to modify life to a great extent. It has been successfully used in the pharmaceutical industry. It could be of great use in better and faster breeding of plants using recombinant DNA technique and marker assisted selection. But, how, where, to what extent, and for whose benefit it can be applied remains a big question. Such arguments are inescapable in today's interlinked global society. Any new technology always follows a fundamental purpose to protect and promote the welfare of mankind (Sutkovic, 2020) ^[17]. It demands careful dissection of its potential impacts on health environment, economic status, and the socio-cultural footing of the society.

In India, Vedas and epics, written thousands of years ago, ascribe prime importance to nature and all living beings. Any idea of tampering with organisms or modifying their genes can render them impure. For instance, the idea of substituting cow genes to pig to convert pig skin to cow hides is being considered. Such genetic modification if done can lead to a massive riot of beliefs and hurt religious sentiments of many (Kaur *et al.* 2012) ^[8]. However, genetic

modification between kingdoms, where genes of plants could be altered with animal genes, blurs the line between vegetarian and non-vegetarian food. Like a gene of fish found at bottom of the ocean at very low temperatures is being substituted into strawberry to make it frost resistance. Even worse is the scenario of substituting human genes in popular cereal crops like rice.

An ideal situation will be where individuals have the choice to determine their future. Such demand of choice makes labeling of GM products a necessity. These increased costs should be levied either on the consumer with increased price of food or with the producer as lesser returns. Thus, a balance must be struck between cost to producer for offering the choice and the cost to the consumer for forgoing it. Apparently, every technological innovation produces gains for some and losses to some, the same implies for GE. The need is to see if the gains can compensate for the losses incurred and in welfare of all. In preview of the existing understanding of general public and the ever-widening gap between science and society, GMFCs fail on the third Readiness Index too. A deeper analysis on the possible socio-cultural and ethical impacts of GE is called for.

Conclusion

The inherent power of Genetic Engineering (GE) cannot be doubted. However their sustainability in the current agricultural, biosafety and legal set-up of the country is highly questionable. The current synthesis dissected the nuances of implications of GMFC cultivation on the agricultural set up of the country in the wake of poor biosafety evaluation, weak policy framework and dubious public perception. With the background of these unsettled issues tagged with GMFCs, heralding them as a solution to fight food scarcity and malnutrition may prove disastrous. Time and again, GMFCs have questioned the ethics and morals of people, societies, and cultures world over. It is vulnerable to questions about its real usefulness and who are its beneficiaries.

It is important to note that this technology is not an isolated scientific technique instead it is deeply embedded in the society. Thus, its success depends on its acceptance by the society. Especially in country like India where agriculture accounts for 15.7% of GDP and employs 55% of workforce any such technological shift is going to have far reaching effect on different segments of the society (MoA, 2010) ^[12]. There is perhaps lack of basic understanding of science behind GMFC use and production as the ongoing controversies further increase doubt in people's mind. People are either not informed or misinformed as the gap between science and society widens. Concerns regarding GMFCs are not addressed properly and people who have the power to influence decision making process follow an escapist route.

"Science finds, industry applies, man conforms." In case of GMFCs this conformity of man is lacking. What is required is educating the society of the new advancement and use it in a way that benefits all equally. The real challenge is to make an ethical choice to employ scientific knowledge in the hope of improving human condition. We stand at no man's land. Any policy decision taken at this time without understanding the intricacies involved, is bound to bounce back. Therefore we need to be very cautious in our approach and should not let a scurry of GMFCs enter India.

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