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The Issue of Genetically Modified Organizim (GMO) And Assess to Food in Ethiopia

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Abstract

Genetically Modified Organisms, commonly called GMOs, refer to organisms whose genetic material has been altered using recombinant DNA technology, a method used to recombine the DNA of different organisms. The advancement of modern biotechnology and development of GMOs, though it comes up with solutions that ease human life, it occasionally has an overwhelming risk. There are different GMO-related environmental risks, inter alia, genetic contamination/interbreeding, ecosystem impacts, and increased selection pressure on target and non-target organisms. In the same pattern, it also affects human health, WHO, in listing health-related issues of GMO, included, direct health effects (toxicity), tendencies to provoke allergic reaction (allergenicity), specific components thought to have nutritional or toxic properties, and any unintended effects, which could result from the gene insertion. The main reasons for Ethiopia to take this stance on GMOs include the perceived damage to biodiversity, including crop landraces and wild relatives; the assumption that GMOs are incompatible with Ethiopian farming systems, particularly with poor smallholders; the perception that GMOs are a threat to the country's agricultural exports and concerns about farmers' dependence on multinational companies for patented seeds To ensure safe use of GMOs for the benefit of their people, countries have instituted biosafety systems as a mechanism for making informed decisions, taking into account their national interest and international obligations. Ethiopia has played a leading role in international biosafety negotiations, encouraging developing countries to adopt strict regulation of GMOs, firmly based on the precautionary principle. At a national level, the country explicitly stated in its environmental policy document that the importation and use of biological material, including those that were genetically engineered, should be under stringent regulations. On the contrary, much less attention was given to developing domestic capacity in terms of infrastructure and manpower to initiate genetic engineering activities aimed at safe use of the technology to address priority national problems. As a result of this imbalance in approach to GMOs, no genetic engineering research or development activity has yet been started in the country. Regarding GMO regulation, the prevailing opinion in Ethiopia, spearheaded by its Environmental Protection Authority (EPA), was that a standalone biosafety law is a prerequisite for initiating any genetic engineering activity, including research.

Key words: *Ethiopia; Food; Gmo; Issue*

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Introduction

Genetically Modified Organisms, commonly called GMOs, refer to organisms whose genetic material has been altered using recombinant DNA technology, a method used to recombine the DNA of different organisms. The advancement of modern biotechnology and development of GMOs, though it comes up with solutions that ease human life, it occasionally has an overwhelming risk. There are different GMO-related environmental risks, inter alia, genetic contamination/interbreeding, ecosystem impacts, and increased selection pressure on target and non-target organisms. In the same pattern, it also affects human health, WHO, in listing health-related issues of GMO, included, direct health effects (toxicity), tendencies to provoke allergic reaction (allergenicity), specific components thought to have nutritional or toxic properties, and any unintended effects, which could result from the gene insertion (Zattoni and Legname, 2021, Ekwealor, 2017). The use of genetically modified organisms (GMOs) in agriculture is rising, but not without debate. There are many scientists who argue that genetic engineering in agriculture is the best way to solve many issues of poverty, food security, environmental harm, and the need for increasing competitiveness in sales, but others raise ethical issues regarding the health of the people who consume the genetically modified products, the possible harm to the environment, the depredation of the welfare of the farmers and their food security, and the general introduction of engineering into mainstream use in society(Marx, 2007).

Applications of modern biotechnologies offer huge benefits in agricultural, medical, industrial and environmental sectors throughout the world. In agriculture in particular, crops developed through genetic engineering have a considerable positive impact in the area of crop pest management in many countries. Notwithstanding the great potential for benefits that this technology could bring to society, there is a common understanding within the international community that a balanced and comprehensive approach to biosafety is needed to evaluate the possible adverse effects of these products on the environment and human health. Although Ethiopia has made significant progress in the last decade by using more simple biotechnology applications (Abraham, 2013). its approach toward products of genetic engineering, commonly referred to as genetically modified organisms (GMOs), has been skeptical and highly cautious, focusing mostly on avoiding the perceived environmental and socioeconomic risks rather than harnessing the potential benefits. The main reasons for Ethiopia to take this stance on GMOs include the perceived damage to biodiversity, including crop landraces and wild relatives; the assumption that GMOs are incompatible with Ethiopian farming systems, particularly with poor smallholders; the perception that GMOs are a threat to the country's agricultural exports and concerns about farmers' dependence on multinational companies for patented seeds (Ayele, 2008).

To ensure safe use of GMOs for the benefit of their people, countries have instituted biosafety systems as a mechanism for making informed decisions, taking into account their national interest and international obligations. Ethiopia has played a leading role in international biosafety negotiations, encouraging developing countries to adopt strict regulation of GMOs, firmly based on the precautionary principle (Gebre Egziabher). At a national level, the country explicitly stated in its environmental policy document that the importation and use of biological material, including those that were genetically engineered, should be under stringent regulations(Authority and ABABA, 1997). On the contrary, much less attention was given to developing domestic capacity in terms of infrastructure and manpower to initiate genetic engineering activities aimed at safe use of the technology to address priority national problems (Ayele, 2008). As a result of this imbalance in approach to GMOs, no genetic engineering research or development activity has yet been started in the country. Regarding GMO regulation, the prevailing opinion in Ethiopia, spearheaded by its Environmental Protection Authority (EPA), was that a standalone biosafety law is a prerequisite for initiating any genetic engineering activity, including research. This position contrasts with that of many African countries with permissive GMO policies (e.g., Kenya, Uganda, South Africa and Egypt), which have been using interim biosafety regulations formulated using the existing laws or ministerial decrees to facilitate genetic engineering research long before their respective biosafety laws were in place (Abraham, 2013). After signing the Cartagena Protocol on Biosafety to the Convention on Biological Diversity6 (hereafter called the Protocol) on May 24, 2000 and ratifying it on September 22, 2003, Ethiopia started to formulate its national biosafety framework with the assistance of UNEP-GEF(Sbhatu, 2010). The main outcomes of these efforts were the entering into force of the Ethiopian Biosafety Law (Asfaw) on September 9, 2009, as Proclamation No. 655/2009 and its six accompanying directives (Directive Nos. 1–6/2009) issued pursuant to it as implementing guidelines. Various sectors of the society have debated the implications this law will have on national biotechnology development in different national fora and accepted the law with some level of optimism. Some stakeholders, including environmental groups, hailed the law as a mechanism to ensure the safety of the environment, human health and the quality of socio-economic and cultural conditions from the risks arising from GMOs (Abraham, 2013).

Ethiopia has been the leading advocate for anti-GMO movement in Africa (Mabaya et al., 2015). Moreover, the country has negotiated the CPB as a leading figure. After ratifying the protocol in May 2003, it has enacted a biosafety proclamation and six directives on i.e. AIA application procedure, risk assessment, risk management, transportation, storage, and accidental release of GMOs with stringent requirements in 2009(Segger et al., 2013). However, this didn't last for longer. In 2015, the parliament introduced an amendment proclamation that tries to give space for the development and adoption of GMOs in Ethiopia. Following the amendment, the EFCCC gave permission for the cultivation of BT- cotton and a field trial on GM maize (Yirga et al., 2020).

Background to the Law

The Proclamation has been a long time coming. It comes six years after the ratification of the Cartagena Protocol by the Ethiopian Parliament (Demissie and Muchie, 2014). The Protocol requires signatories to take necessary and appropriate legal, administrative and other measures to implement their obligations (Cartagena Protocol, Art2 (1)). The central objective of the Proclamation is to incorporate the Protocol into Ethiopian law. Under the equivocal Ethiopian law on the incorporation of international agreements, it is far from clear what status the Protocol had prior to the passage of the Proclamation by Parliament. A reading of Articles 9(4) of the Ethiopian Constitution gives the full impression that an international agreement becomes Ethiopian law without the need for an incorporating legislation (Mgbako et al., 2008). Other provisions of the Constitution set out the power of ratification and possibly of separate acts of incorporation (Strauss, 2000). Given the state of the law under Ethiopian Constitution, the Proclamation does not come as a surprise and can even be considered a mere formal procedure (Demissie and Muchie, 2014).

However, for the biotechnology community in Ethiopia, it did come as a surprise. Among the controversies surrounding the Proclamation is the charge that it was not preceded by sufficient deliberation as its passage was rushed through Parliament just before it went into recess. It was not referred to the relevant parliamentary select committee; nor was it duly deliberated elsewhere. What is more was that it was promulgated in the shadow of the more controversial antiterrorism proclamation that veered attention away from the less politically charged Biosafety Proclamation. In the call for a reopening of the debate, the biotechnology research community in Ethiopia invoked these same circumstances surrounding the passage of the Proclamation as grounds justifying an immediate review of the law. There are lessons to be drawn for the Ethiopian biotech debate from the history of EU GM regulation. The EU Commission is now in a much better position and is flexing its rule-making muscle to correct past mistakes. It has re-opened the GM agenda. It is encouraging member states to go their own way by removing the semblance of moratorium (Demissie and Muchie, 2014). The change being introduced by the EU Commission is being emulated by other bodies of the EU particularly.

the European Parliament. Labelling of GM food has been religiously pursued by the EU over the last decades. It was this very issue of labelling that was at the center of the transatlantic trade war. The labelling of GM products was seen as a protectionist measure and the litigations raged for decades. In a complete U-turn on labelling policy, Members of the European Parliament (MEP) declined calls for labelling of meat from cloned animals drawing lessons from the GM trade war (Demissie and Muchie, 2014). This is a stark example of how the GM debate impacted the debate on related emerging technologies.

It would be no surprise if there were no eyebrows raised at the Ethiopian bill on biosafety to come at such a time unheeding the lessons from the changes taking place at the hotspots of the GM debate. The call for the re-opening of the debate by the Ethiopian research community is justified given the developments in Europe and elsewhere. The Ethiopian Government has hinted at revising the law in its rather mixed reaction to the demands of the research community in Ethiopia (Fiseha, 2012).

The Issue of Genetically Modified Organism (GMO) And Access to Food in Ethiopia

A coalition of Ethiopian Civil Society Organizations and their global allies have launched a campaign against the cultivation of Genetically Modified Organisms in Ethiopia (Howard, 2000).The public outcry started when United States Department of Agriculture (USDA) Foreign Agricultural Service published a report that revealed that the government had approved commercial cultivation of genetically modified (GM) insect-resistant cotton (Bt-cotton) and confined trial of GM enset and maize in Ethiopia (Mulesa et al., 2021).In 2015, the Ethiopian parliament opened up the country to genetically modified organisms (GMOs) by loosening the safeguards built into a 2009 biosafety law. Three years later, the government approved commercial cultivation of a strain of cotton. Despite this, there has been limited public debate or media coverage. Yet, the moves broke with decades of Ethiopian public policy and have major implications for Africa as a whole. The Ethiopian approach was praised in the above-mentioned report published in February 2020: "approval of commercial cultivation of genetically modified (GM) insect-resistant cotton (Bt-cotton) and confined field trail on GM maize can be taken as an effort to improve agricultural productivity using modern agricultural tools."Pleased with the government's deeds, the report went on to state that the country's "adoption of Bt-cotton not only has high economic importance but is also expected to have a positive influence on the acceptance of this technology in the region." Criticizing the government for its past precautionary approach to GMOs, the report says Ethiopia is now on track "especially considering that a decade ago the country was at the forefront of the anti-GMO movement in Africa."(Schurman and Munro, 2013). The USDA's appreciation of Ethiopia's policy change may well be driven by a strategic interest for the U.S. and its multinationals to use Ethiopia as a springboard to expand GMO cultivation in Africa. Despite GMO establishment of various crops in South Africa since the late 1990s, expansion elsewhere on the continent has thus far been restricted to four out of the 47 countries, and with the exception of South Africa, limited to Bt cotton. However, there are indications that this may change. While recent droughts have led Zambia and Zimbabwe to lift bans on importation of GM maize for consumption, Ethiopia, Rwanda and Uganda seem to be the new target countries for expanding GM production. Uganda has allowed trials for genetically modified banana in last few years. Rwanda is considering opening up to genetically modified potato (Pua et al., 2019).

Status Of GM Crops Production in Ethiopia

The continued increase of biotech crops production reveals that agricultural biotechnology will play important impact on agricultural production as far as accepted by farmers everywhere in the world (Klümper and Qaim, 2014). A new wave of acceptance is evolving in the African continent. Countries such as Malawi, Kenya and Nigeria are on the way from field trial experiment to granting environmental release approvals, while six others: Burkina Faso, Ghana, Ethiopia, Nigeria, Uganda and Swaziland accomplished major progress in touching towards the completion of multi-location field for considering commercial approval of GM crops while Tanzania showed its interest on GM crops (Tsatsakis et al., 2017). South Africa and Sudan are the most GM crop producers in Africa. In addition to these two countries, Egypt has started producing GM crops (Pretty, 2013).

Ethiopia ratified a highly preventive biosafety law in 2009, as Proclamation No.655/2009 and its directives (Directives No.1 to 6/2009) (Gebretsadik and Kiflu, 2018). Whether Ethiopia wants or not, neighboring countries such as Sudan and Kenya have already started producing GM crops and hence GM seeds can be found in the country as far as there is illegal and noncertified exchange of seeds in the borders. However, Ethiopia needs to forward toward revising its biosafety regulations to facilitate active participation of foreign technology providers and local researchers in the biotechnology sector so that it can harness maximum benefits from developments in modern biotechnology (Abraham, 2013). In 2016, the Ethiopian Parliament Amended the GMO Law known as 'A Proclamation to Amend the Biosafety Proclamation, which somehow relaxes the previous, a bit strict GMO policy, by permitting the involvement of Ethiopian researchers initially on non-edible crops (Gebretsadik and Kiflu, 2018).

In 2016, at the Ministry of Agriculture's request, the Ministry of Environment, Forest & Climate (MEFC) approved the importation of Bt cotton seeds for field trials and research in Ethiopia (Directive, 2015). As a result, field trials on Bt cotton have been underway at several sites in the cotton-producing areas of Ethiopia (Directive, 2015). The Bt Cotton crop is on the concluding stage, which will permit the commercialization of the crop. The agricultural biotechnology sector at the Ethiopian Agricultural Research Institute, will probably release the biotech Bt cotton seed varieties to farmers in the coming one or two years (Gebretsadik and Kiflu, 2018). The success of this trial will play pivotal role in the development of other transgenic crops in the country.

Gm crops production may inspire foreign assets and domestic invention in Ethiopia to successfully advance its various interests and increasing competitiveness in agricultural and industrial sectors of the economy (Abraham, 2013) In an effort to improve agricultural productivity and safety, Ethiopia has approved the commercial cultivation of Genetically Modified (GM) cotton and field research on GM maize in 2018 (Gebretsadik and Kiflu, 2018). MEFC approved the environmental release of Bt cotton following two years of confined field trial research by the Ethiopian Institute of Agricultural Research (EIAR). The two cotton hybrids that will be released for commercial cultivation have been tested to ensure they are compatible with Ethiopia's growing conditions (Terefe, 2018). Therefore, assessment of the possible opportunities that can be earned from the application of biotechnology and the potential challenges that may be encountered by the production of GM crops is of utmost importance to Ethiopia if the country is to feed its alarmingly growing population.

The status of genetically modified crops in Ethiopia and regulatory mechanisms

Genetically modified crop development at global level is increasing (Qaim, 2009) and many GM crops are commercialized in developing countries to hasten agricultural productivity and nutritional status of important crops (Anthony and Ferroni, 2012). Starting to amendment of biosafety law toward workable in Ethiopia, the first GM crop approved for confined field trail in the country is Bt-cotton in 2016 cropping season which is resistance to boll worm. GM Bt-cotton adopted from Indian JK Seeds Company and from Sudan and now it is in second season of confined field trial in eight different ecological locations to evaluate the agronomic performance and to compare with high vigor local varieties. It is expected to be commercialized in 2018. This encourages to overlook in other GM crops to introduce and try in confined field trials of like, Bt (insect resistance) and DT (drought tolerance) GM maize of WEMA project works in water efficiency maize for Africa and to start GM crops product development in other crops at National Agricultural Biotechnology Research Laboratory found in Holeta 29 km far from Addis Ababa (Terefe, 2018). Different Ethiopian scientists are feeling to initiate genetic engineering projects starting to the amendment of the Biosafety law. But the major challenging in the country is the availability of limited evidences on the concerns/biosafety issues of GM technology. And few biosafety research papers are published and there is dilemma on the benefit and risk of GM technology, these results denying the technology and believe in propagandas of GM cons (Terefe, 2018).

The Cartagena protocol was first adopted 29th January in 2000 and entered in to force starting from September 11th 2003 with the objective of ensuring adequate level of protection in the field of safe handling, transfer and using of living modified organisms that may have adverse effects. Currently around 164 countries signed the protocol. Ethiopia also become a member in January 23, 2000. According to the Cartagena protocol regulatory framework, every member countries should have a minimum of policy statement by the government, regulatory regime designed to address safety of GMOs law proclamation, decree, directives, regulations, guidelines to govern the transboundary movement, system to handle notification or requests for authorizations import, export, transit, release, contained use placing in the market, a system for enforcement and monitoring for environmental effect, a mechanisms for public participation, awareness, education and also optional mechanism for testing, verification presence of GMOs (Alexandrova et al., 2005). There are also other international organization and regional regulations or treaties and convections involved in controlling a transboundary movement of GMOS (LMOS) and safe GM product development. Some of these are, international plant protection convection, Union for the protection of new varieties of plants, World Trade Organization, WHO, FAO, European Union, African Union, OECD, FDA, etc. Ethiopia enacted its own Biosafety law in 2009 as proclamation No 655/2009 and amended in to workable in 2015 as "Amended Ethiopian Biosafety Law proclamation No 896/2015". The country is developing national regulatory system. The ministry of environment forest and climate change is the responsible ministry for implementation of the protocol and biosafety laws. However, weak regulatory systems in developing countries are the drawbacks which allow international agribusinesses and industries to promote genetic engineering technologies without considering its impact (Terefe, 2018).

Potential GMO Applications

Many industries stand to benefit from additional GMO research. For instance, a number of microorganisms are being considered as future clean fuel producers and biodegraders. In addition, genetically modified plants may someday be used to produce recombinant vaccines. In fact, the concept of an oral vaccine expressed in plants (fruits and vegetables) for direct consumption by individuals is being examined as a possible solution to the spread of disease in underdeveloped countries, one that would greatly reduce the costs associated with conducting large-scale vaccination campaigns. Work is currently underway to develop plant-derived vaccine candidates in potatoes and lettuce for hepatitis B virus (HBV), enterotoxigenic Escherichia coli (ETEC), and Norwalk virus. Scientists are also looking into the production of other commercially valuable proteins in plants, such as spider silk protein and polymers that are used in surgery or tissue replacement (Ma et al., 2003). Genetically modified animals have even been used to grow transplant tissues and human transplant organs, a concept called xenotransplantation. The rich variety of uses for GMOs provides a number of valuable benefits to humans, but many people also worry about potential risks.

GMO Debate

Despite GMO establishment of various crops in South Africa since the late 1990s, expansion elsewhere on the continent has thus far been restricted to four out of the 47 countries, and with the exception of South Africa, limited to Bt cotton. However, there are indications that this may change (James, 1998). GMO establishment of various crops in South Africa since the late 1990s, expansion elsewhere on the continent has thus far been restricted to four out of the 47 countries, and with the exception of South Africa, limited to Bt cotton (Paarlberg, 2001).

Bio-strategic

As the home of the African Union diplomatic community, Ethiopia is a particularly strategic country to promote GMO expansion on the continent (Musila, 2019). or example, a 2016 field visit to a Bt-cotton field trial in Werer in Afar region of Ethiopia counted multilateral organizations such as New Partnership For Africa's Development (NEPAD) Agency and African Biosafety Network of Expertise (ABNE) among its attendants. Furthermore, Addis Ababa has hosted the African Union's African Seed and Biotechnology Programme since 2008. In this manner, Ethiopia may prove to be a more effective springboard than South Africa has been (Sisay et al., 2017).

Two scenarios are possible to envisage. On the one hand, given Ethiopia's role as a Pan-African leader, the opening up of Ethiopia to GMOs can lead to similar policy shifts elsewhere, as hoped for by the USDA. On the other hand, Ethiopia's Pan-African reputation and leadership can be questioned by those who are aware of the potential risks GMOs pose for the environment, as well as the negative implications of the control of agricultural inputs by a few multinationals (Kangmennaang et al., 2016).

Prior to 2015, Ethiopia resisted the use of GMOs for many years, taking a keen interest in global environmental negotiations and playing a key leadership role within the African Group. Among others, Ethiopia, through its former chief negotiator, Dr. Tewolde Berhan Gebre Egziabher, played a key role in the international negotiations that led to the Convention on Biological Diversity's Cartagena Protocol on Biosafety, which was adopted in 2000 and entered into force in 2003 (Sendashonga et al., 2005).

Laws and leadership

As a foundation for its GMO regulatory system, in 2009 Ethiopia enacted a highly restrictive biosafety law that prohibited the deliberate release of GMOs into the environment. By passing this law, Ethiopia proved to itself and to crop diversity enthusiasts and scientists like Dr Melaku Worede that it was protecting its uniquely high crop diversity from GMO contamination and genetic erosion (auf ein besseres Äthiopien). Furthermore, this was in harmony with a law (Proclamation No.123/1995) prohibiting patents on plants and animals and a law (Proclamation No. 481/2006, later amended to Proclamation No.1068/2017) establishing farmers' rights to save, re-use, exchange and sell seeds of all kinds from their produce. On the ground, Ethiopia has the biggest national GenBank in Africa, which was established in 1976. As of June 2019, the national gene bank in Addis Ababa has conserved about 86,599 samples of seeds of over 100 species of plants (mainly food crops) that have been collected from all over the country. In two field gene banks, the country has conserved 5,644 samples of coffee plants (Sida, 2021).

The restrictive laws in Ethiopia were developed to protect smallholder farmers from becoming indebted to and dependent on multinational corporations for seeds. The multinationals enjoy the privilege offered to them by the World Trade Organization (WTO)—of which Ethiopia is only an aspiring member to control the agricultural inputs including seeds through global markets and international rules, e.g., patents on GMO seeds (Morfi, 2020). The multinationals enjoy the privilege offered to them by the World Trade Organization (WTO)—of which Ethiopia is only an aspiring member to control the agricultural inputs including seeds through global markets and international rules, e.g., patents on GMO seeds. Farmers are not allowed to re-use patented GMO seeds saved from their harvest and must instead buy seeds from the companies every planting season. The multinationals can even sue farmers if they find genes from their patented GMO seeds (e.g. maize) in farmers' fields (Bernhardt, 2005). This is against the "'polluter pays principle", where companies whose GMOs contaminate farmers' fields are supposed to compensate farmers. This was what the government aimed to avert by passing the highly restrictive 2009 biosafety law on the process for approving genetically modified crop cultivation. The USDA report described Ethiopia as the "vanguard of [the] anti-GMO movement in Africa by working with [the] African Union and drafting the restrictive African Model law" for its actions (Sida, 2021).

Unfertile soil

Since the mid-2000s, as a precursor to the recent liberalization of Ethiopia's GMO regulations, there has been intensified promotion of commercial seed market development through private entry into the business, especially for hybrid maize seeds. This is supported by the government's Agricultural Transformation Agency (ATA) and the Alliance for a Green Revolution in Africa as well as their funders such as the Bill and Melinda Gates Foundation and the United States Agency for International Development (USAID). Extensive documentation has been made on how these actors' work and support the commercial cultivation of GMOs in Africa and Ethiopia (Sida, 2021). Ethiopia has a lot to thank these actors for. Through ATA, they supported capacity building of its public research and seed sector institutions. ATA managed to wake the Ministry of Agriculture's apparatus up from a decades-long deep sleep. They developed strategies and set clear objectives for the Ministry. Consequently, agricultural research and the formal seeds system have improved in many ways during the last 10 years (Spielman et al., 2012). However, the formal seed sector in Ethiopia continues to report considerable barriers to the uptake of improved seeds, and seed wastage at public seed enterprises and farmer Union stores has been a common occurrence. Although this is due to many factors such as institutional ineffectiveness, high seed price is one of the major factors that discourages smallholder farmers from investment in improved seeds. One may wonder then how these farmers might afford expensive patented GMO seeds from multinationals. Even in South Africa, where maize is the main staple and 90% of marketed maize is GM, smallholder farmers have been slow to adopt GM maize (McAfee, 2021).

Research shows that GM seeds are out of reach for smallholder farmers in most of Africa. It is simply too costly and too risky. Especially in the context of climate change and the tiny landholdings in countries like Ethiopia. So, who will they be selling GMO seeds to? Big new commercial actors in regions such as Gambella? Or is it hoped to be a means of credit and input provision for smallholders? If so, will crop insurance be similarly provided, in case of failure? With so much unknown, it is worrisome (Hall et al., 2015)

Risks and Controversies Surrounding the Use of GMOs

Despite the fact that the genes being transferred occur naturally in other species, there are unknown consequences to altering the natural state of an organism through foreign gene expression. After all, such alterations can change the organism's metabolism, growth rate, and/or response to external environmental factors. These consequences influence not only the GMO itself, but also the natural environment in which that organism is allowed to proliferate. Potential health risks to humans include the possibility of exposure to new allergens in genetically modified foods, as well as the transfer of antibiotic-resistant genes to gut flora. Horizontal gene transfer of pesticide, herbicide, or antibiotic resistance to other organisms would not only put humans at risk, but it would also cause ecological imbalances, allowing previously innocuous plants to grow uncontrolled, thus promoting the spread of disease among both plants and animals. Although the possibility of horizontal gene transfer between GMOs and other organisms cannot be denied, in reality, this risk is considered to be quite low. Horizontal gene transfer occurs naturally at a very low rate and, in most cases, cannot be simulated in an optimized laboratory environment without active modification of the target genome to increase susceptibility (Ma et al., 2003). In contrast, the alarming consequences of vertical gene transfer between GMOs and their wild-type counterparts have been highlighted by studying transgenic fish released into wild populations of the same species (Shymyrbekova et al., 2016). The enhanced mating advantages of the genetically modified fish led to a reduction in the viability of their offspring. Thus, when a new transgene is introduced into a wild fish population, it propagates and may eventually threaten the viability of both the wild-type and the genetically modified organisms (Devlin and Donaldson, 1992).

Opportunities Of GM Crops Production

Improving Crop Production and Productivity

Adopting new cultural practices to improve productivity, nutritional quality and pest control has slightly improved production at the cost of jeopardizing sustainable productivity. Biotechnology has played a great role in increasing global crop production and productivity in a sustainable way and also by conserving biodiversity (Akanbi, 2010). The influence of GM crops showed an increase in productivity; even though the profitability was higher in developed countries than developing countries (Klümper and Qaim, 2014). Conventional crop production techniques use a range of chemicals to maximize yields and most of the chemicals have negative impact to the environment. New genetically modified crops are being developed in order to reduce the use of agricultural inputs such as pesticides and artificial fertilizers. This will not only improve profitability but also improve sustainability and reduce adverse effects on the environment and human health (Baulcombe et al., 2014). Study revealed that, 37% reduction in pesticide usage and an increase in yield of over 21% was obtained by cultivating GM Crops(Qaim, 2010), which shows an increase in production and environmental benefit at the same time. Ethiopian economy is dependent on agriculture for food, industrial raw materials such as textile industry and export (Abuhay et al., 2021). However, despite adopting many kinds of production improvement programs, productivity is still very low (EDITION). This is a critical concept in fostering innovation to transform agriculture sector for more profit and industrialization in Ethiopia.

Production Crops for Abiotic Resistance

Abiotic stresses like frost, drought and increased salinity are a limiting factor to the growth of crops (Vinocur and Altman, 2005). Most crops are susceptible to elevated salt conditions that are rising due to irrigation and changing climatic conditions. A plant growing in salt conditions tries to keep salt away from newly emerging meristematic tissue. For example, tomato plants avoid the migration of salt to their reproductive parts by storing the elevated level of salts in their leaves. On the other hand, salt can be managed by transport mechanisms such as the sodium/proton antiport pump that enables a plant to seize sodium ions in the vacuole. One intensely studied example is AtNHX1 antiport. Transgenic tomatoes that over-express the AtNHX1sodium/proton antiport pump from Arabidopsis were able to survive and grow in saline conditions that too salty for ordinary tomatoes (Apse et al., 2003). The tomatoes grew, flowered, and produced seeds in a high-salt environment (Apse et al., 2003). Interestingly, the GM tomatoes can be safe for human consumption because the altered tomato had high sodium concentrations in the leaves, but not in the fruits, suggesting that the GM crop could be of agricultural values (Zhang and Blumwald, 2001). Another major problem in crop production is climate change and drought. Drought resistant transgenic horticultural crops can also be produced. FRI gene is one of the genes that improve drought resistance in different crop plants (Takeda and Matsuoka, 2008). Agrobacterim mediated transformation was used to transfer gene from barley (HVA1) that codes for late embryogenesis into mulberry plants and improved water deficiency stress (Nguyen and Sticklen, 2013). GM mulberry with barley Hva1 under a constitutive promoter (ACTIN1) was reported to enhance drought and salinity stress tolerance (Khurana).

Production of Crops for Biotic Resistance

Scientists are developing genetically engineered crops with new traits like increased resistance to pests, disease or environmental stresses. There are many applications of genetic engineering to develop genetically modified crops that are resistant to pests, diseases and different biological enemies on the field (Snow et al., 2005). Ethiopia has recently approved the cultivation of Bt Cotton and started confined field trials of Bt maize (Gebretsadik and Kiflu, 2018). which will have great impact to reduce pests and diseases damages and boost production. In Uganda, conventional and transgenic biotechnological approaches are being used in order to produce pest and disease resistant bananas. The main advantages of biotechnology in agriculture sector are producing tolerant crops to biotic and abiotic stresses (Saxena et al., 2016). Scientists have developed transgenic herbicide resistant crops for the commercial crops. It is possible to transfer these herbicide resistant genes in to plant. This will reduce the cost of production and ensure weed free plant growth and development for effective performance. The emergence of aphid resistance in Chrysanthemum genetically engineered to produce caffeine is of recent significant development (Kim et al., 2011).

GMOs and the General Public: Philosophical and Religious Concerns

In a 2007 survey of 1,000 American adults conducted by the International Food Information Council (IFIC), 33% of respondents believed that biotech food products would benefit them or their families, but 23% of respondents did not know biotech foods had already reached the market. In addition, only 5% of those polled said they would take action by altering their purchasing habits as a result of concerns associated with using biotech products (Phillips, 2008).

According to the Food and Agriculture Organization of the United Nations, public acceptance trends in Europe and Asia are mixed depending on the country and current mood at the time of the survey (Hoban, 2004). Attitudes toward cloning, biotechnology, and genetically modified products differ depending upon people’s level of education and interpretations of what each of these terms mean. Support varies for different types of biotechnology; however, it is consistently lower when animals are mentioned(Priest et al., 2003).

Economic, Social and Political Concerns

Economic concerns

The economic concerns of GM crops are consumers worried about patenting these new plant varieties will raise the price of seeds so high that small farmers and farmers in developing countries are unable to afford seeds for GM crops. There is also risk of bringing GM food to the market is costly and lengthy process. The other one is fear of introducing suicide gene in to GM plants which is viable for only one growing season or produce sterile seed that do not germinate(Naranjo, 2009).

Unintended Economic Consequences

Another concern associated with GMOs is that private companies will claim ownership of the organisms they create and not share them at a reasonable cost with the public. If these claims are correct, it is argued that use of genetically modified crops will hurt the economy and environment, because monoculture practices by large-scale farm production centers (who can afford the costly seeds) will dominate over the diversity contributed by small farmers who can't afford the technology. However, a recent meta-analysis of 15 studies reveals that, on average, two-thirds of the benefits of first-generation genetically modified crops are shared downstream, whereas only one-third accrues upstream (Demont et al., 2007). These benefit shares are exhibited in both industrial and developing countries. Therefore, the argument that private companies will not share ownership of GMOs is not supported by evidence from first-generation genetically modified crops (Phillips, 2008).

Social concerns

GM crops could affect the traditional social interaction of farmers in saving, reusing, sharing and selling farm saved seeds. This threats especially developing countries where such practices are common among farmers. Generally this threatens the long term food security of rural communities (Singh et al., 2014).

GM crops on religious and social aspect raised controversies in many countries where religion remain the dominant societal force, for example GMOs can be considered as halal or haram in Muslim communities (Safian and Hanani, 2005). The Cartagena protocol on biological diversity give emphasis on article 26 in saying "the parties in reaching a decision on import under this protocol or under its domestic measures implementing the protocol, may take in to account, consistence with their international obligations, socio-economic considerations arising from the impact of living modified organisms on the conservation and sustainable use of biodiversity, especially with regard to the value of biodiversity to indigenous and local communities. And the parties are encouraged to cooperate on research and information exchange on any socio-economic impacts of living modified organisms, especially on indigenous and local communities''. The protocol gives attention, every member country involved on GMOS and their product development and transaction should take in to account the social and economic affairs. Wendt and Isqeirdo, they pointed out the social threats of GM crops is that the private sector and powerful agribusiness companies could control the majority of GM research and markets. The intellectual property rights under world trade organizations are not sufficient to protect traditional knowledge and biodiversity. There need to be balance between protecting the right of traditional users and modern innovators (Eggers and Mackenzie, 2000).

Political concerns

The adoption of GM products is not solely on scientific considerations as also political motives plays a vital role in the adoption of GM technology. Political economy analyzes how economic theory and m8thods influence political ideology and studies how institutions and regulations develop under different circumstances. For example, there are major differences in biotechnology regulations among various countries and in particular between the EU and US. This difference may result from minor difference from consumer's preference but may have long lasting effect on the competitiveness of the sector. These political factors affect the trade and environmental regulations (Anderson and Yao, 2003). The other political concern is, countries should label genetically modified foods, for example USA do not label GM foods. There should be common consensus on labeling genetically modified crops and their products in all countries under law (Terefe, 2018).

Regulatory Weakness

Even more troubling is the weakness of Ethiopia's regulatory system, as many people are already consuming genetically modified foods without knowing what they buy from stores. According to the USDA report "Ethiopia does import processed agricultural products such as soybean and corn oils, as well as breakfast cereals made from GM ingredients." The report adds, "some food aid commodities, like corn-soy blend, which are GM products [used] for school feeding and humanitarian programs, [are] allowed to come to the country under a special waiver."(Sida, 2021). This clearly shows a regulatory vacuum and lack of accountability to inform the public on the kind of foods they buy from suppliers. Before introducing GMOs to Ethiopian agriculture, a strong regulatory system should be in place, public research should be improved, and studies of GMOs' socioeconomic values should be conducted by an independent body (Anandajayasekeram, 2008). The effective dissemination of conventionally bred, well-adapted crop varieties coupled with good agronomic practices can improve crop production and productivity among Ethiopian smallholders without the need for GMOs (Pretty and Bharucha, 2014). For this to happen, mistrust, and the imbalance in the agronomist–farmer knowledge exchange must be tackled. The critical problem in Ethiopia is the dogmatic condescension towards smallholders, and an uncritical faith in techno-scientific solutions, that is rampant within government agricultural institutions (Adyanga, 2014)

Conclusions and The Way Forward (Recommendation)

With the emerging of agricultural biotechnology science, many genetically modified crops have developed and commercialized to feed the world. With its rapid commercialization every year, concerns are raising continuously about safety issues of GM crops on human health, food/feed safety, on environment, social, economic and political. Some researchers are proved that GMOs could cause negative impact on human, animal and socio-economic. A number of genetically modified crops are reported at global level and attracted much attention. Though many concerns are also raise time to time, the application of GM crops must be fully analyzed case by case. Complete and transparent assessment of GM crops application and recognition of their long, medium- and short-term effects should be needed; this can less the debate and make more constructive. GMO can be a valuable tool for productivity improvement. Merits and impacts should be evaluated for individual GM varieties on a case-by-case basis rather than a blanket ban. National agricultural research systems should be engaged in GM R&D to prevent this tool from being a private sector monopoly. Effective and functional regulatory institutions are indispensable. I would like to draw attention to the following statements that illustrate the lack of awareness and regulatory protections in Ethiopia

- Ethiopia does not have uniform monitoring and testing mechanisms to detect GMO products.
- Ethiopia has no low-level presence policy [i.e., specifying the maximum amount of GMO ingredients that is allowed in food items].
- Ethiopia now appears to have broken from its past position and approved the environmental release of Bt-cotton and research trials on biotech maize.

There are no officially known active campaigns to discourage or scare consumers from eating food products containing GMO ingredients. This is in part because there is little consumer awareness of this technology combined with the fact that there are so few foods marketplace that are made from GE crops.

Therefore, based on the above conclusions the following recommendations are forwarded: -

- Ethiopia has to work toward revising its biosafety system to facilitate active participation of foreign technology providers and local researchers in the biotechnology sector so that it can harness the maximum benefits from developments in modern biotechnology.
- For this to happen, the current legal and administrative challenges related to regulatory issues must be corrected, and progressive policy dialog among the key stakeholders must be promoted.
- Putting in place a balanced, science-based and responsible biosafety system that encourages foreign investment and domestic innovation is a necessity if Ethiopia is to effectively advance its diverse interests of conserving biodiversity, protecting the environment and enhancing competitiveness in agricultural and other sectors of the economy.
- Implementing all Biosafety laws, regulations and protocols are important for safe product development and for safe utilization of the technology. Even if many countries have placed regulatory policies and regulatory bodies for research and development of GM crops but strict compliance to the biosafety guideline is still required in many developing countries, like Ethiopia.
- encouraging all sectors of society to contribute and participate in public debate and policy-making. Further research on the effect of biotech foods on humans and alternative control systems should be encouraged. . In addition, the use of effective enforcement of their standards is essential to fulfill the objective of consumers providing them with safe and wholesome products. Therefore, the overall public health impact of biotech foods can be minimized by the collaboration and contribution of farmers, clinicians, manufacturers, researchers, consumers and legislative and other food safety authorities.

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