



Original article

## PROSPECTS AND PROGRESS OF GENETIC ENGINEERING IN THE ENHANCEMENT OF FOOD SUPPLY IN DEVELOPING COUNTRIES

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### ABSTRACT

The application of biotechnology in the genetic modification of plants and Animals in food production has led to the appearance of genetically modified foods (GMFs) in the marketplace. The progress of genetic engineering and food supply in developing countries is determine by the government policies and acceptability of food samples by the populace. The use of biological agents to improve nutritional values has raised serious issues about genetically modified foods or plants all over the world. Consumers use a range of criteria in selecting food products, making purchase decisions, used sensory aspects, especially appearance, nutrients content and taste have always been their choice. Food security exists when all people have physical and economic access to adequate, safe, and nutritious food. Genetically modified food are produced to cater for the need of growing population. But the controversies are Genetically Modified foods really a good substitute for the natural and traditional foods which have been in existence? If Genetically Modified crops are safe, economically profitable, and environmentally friendly, why then has there been so much opposition, concern and controversy in recent years? If the scenario is so good, if so many millions of farmers and consumers are benefiting, if the increase in Genetically Modified crops is so impressive, and if poverty, malnutrition and hunger have been alleviated in developing countries, why then have some governments imposed bans and why are consumers stand against those products in many places around the globe? Is there any substance in these arguments against Genetically Modified Organisms? This paper discusses these issues as some of the factors for enhancing food supply in developing countries. Genetically Modified Foods may be the ultimate solution to hunger and poverty in a developing countries.

**Keywords:** Genetic engineering, food supply, genetically modified organisms (GMFs), developing countries.

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## INTRODUCTION

The progress of genetic engineering and food supply in developing countries depends on the government policies and acceptability of food samples by the populace. Consumers use a range of criteria in selecting food products and making purchase decisions. So also, they used sensory aspects, especially appearance, nutrients content and taste. Expected benefits of consumer traits has been estimated for some genetically modified (GM) crops as compared to their conventional counterparts [1]. Food security exists when all people have physical and economic access to adequate, safe, and nutritious food [2]. Unfortunately, food security does not exist for a significant proportion of the world population, which are estimated to be around 800 - 900 million people are undernourished, meaning that they are undersupplied with food products [3]; [4]. In some developing countries, not everyone view genetically engineered foods as a welcome development. Several people have expressed concerns in many areas that; genetically modified foods could change their nutritional value by improving not lowering vitamin content, taste or other nutrients [5]. Others point out that several genetic engineering projects are designed to increase, not lower the health attributes of foods, e.g., Vitamin 'A' enriched rice, iron, folate, and ascorbic acid [6]. In addition, health concerns about genetically modified organisms have attained almost equal attention as nutrient contents, appearance and taste on how safe they are when consumed. Another criteria is a relative newcomer to the range of consumer purchase considerations on the way the product has been produced. Others assert that locally-made is good and 'industrially

produced' is not so good; with a number of people making criticism in developing countries [7].

One major challenge of the future will be meeting the growing demand for food as the planet's population expands [3]. Farmers have been improving their crops for many years by developing new practices. Genetic engineers have turned to biotechnology to develop these new crops. Many of these plants are able to protect themselves from the bacteria, viruses and insects which damage them [4].

The world's population is believed to increase to 9–10 billion people by the middle of this century, with the wide majority of that increase taking place in poor, developing countries [4]. To keep up with the expected increasing population, agricultural productivity must double by 2050 [4]. Population pressure has already begun to affect the environment in large parts of the developing countries. Many more suffer from specific nutritional deficiencies, often related to insufficient intake of micronutrients [8]. Eradicating hunger is one of the priority of the developing countries, despite the increase in population [9]. But how to achieve this goal has been a subject of debate which are actually controversial. [10] reported that many producers and exporters from developing countries, as well as importers in developed country markets, are moving to capitalize on a growing demand, for a wider variety of food choices, including what used to be viewed as local foods from developing countries. Genetically modified (GM) crops are sometimes the solution to this controversies. Some see the development and use of Genetically Modified crops as key to reduce or eliminate hunger completely [11],

while others see these achievements as a threat to food security [12]; [13]. Genetic engineering is the technique of removing, modifying or adding genes to a DNA molecule in order to change the information it contains [14]. By changing this information, genetic engineering changes the type or amount of proteins an organism is capable of producing [15].

### **The Challenges of Improving Genetically Agriculture in Developing Countries**

The challenges of farming in developing countries are many and include geographical disadvantages, gender issues, corruption, poor governance, civil war, conflict, ethnicity and inadequate investment [16]. Indeed, rural infrastructure, including roads and irrigation systems, has largely contributed to food insecurity and poor supply. Since most of the farm labour in Africa is performed by women who lack a strong political voice, governments are less responsive to them than to their better educated and politically informed urban counterparts [4]. African farmers do not have access to the new, high performing crop varieties offered to India and China during the Green Revolution [4]. Investments in agriculture would vastly improve the plight of farmers as well as protect the environment from further degradation. Agricultural investments could thus provide poor farmers with better farming methods and better, climate-ready crops to help them manage through difficult times and with limited resources [4].

In general, agricultural development in developing countries such as sub-Saharan Africa will require improved farming techniques to bring about the sustainable intensification of crops. Besides improvements in plant varieties, better use of agricultural inputs, a reduction of food waste, better storage systems for harvested crops, the empowerment of women, and

improvements in roads and general infrastructure [14].

### **Applications of Genetic Engineering in Agriculture**

Agricultural biotechnology is a collection of scientific techniques used to improve plants, animals and microorganisms. Genetic engineering enables improvements that are not possible with traditional cross breeding of related species [17]. It has its presence in every sector of agricultural practice from livestock and poultry management, production of high yield varieties of rice and wheat to improving agribusiness. Agriculture in developing countries now accounts for slightly less than 10 per cent of GDP [18]. Agricultural biotechnology has help in increasing food production due to the facts that world population is increasing all the time [4]. Increased yields have been attributed to the use of improved crop varieties such as hybrids, genetically modified organism, better management practices and agrochemicals [15]. There are three possible pathways how GM crops could impact food security. "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life"[19]. First, GM crops could contribute to food production increases and thus improve the availability of food at global and local levels. Second, GM crops could affect food safety and food quality. Third, GM crops could influence the economic and social situation of farmers, thus improving or worsening their economic access to food. While agricultural commodity prices would be higher without the productivity gains from GM technology [20], impacts on food availability could be bigger if more GM food crops were commercialized. Lack of public acceptance is one of the main reasons why this has not yet happened more

widely [21]. Hence, a lot of controversy has been generated on the acceptance of GM foods; thereby creating two schools of thoughts those that are ready to accept GM foods and those that are reluctant in accepting GM foods [5].

### **Crops that need fewer applications of pesticides**

This inherent resistance thus reduces a farmer's pesticide use for controlling insect, and in turn requires less chemicals and potentially provides higher yielding Agricultural Biotechnology [4]. Microbial pesticides consist of a microorganism as the active ingredient. Half of the global GM crop area is located in developing countries. One notable exception is *Bacillus thuringiensis* (Bt) cotton, which is grown by around 15 million smallholders in India, China, Pakistan, and a few other developing countries [22]. Bt cotton was first commercialized in India in 2002. In 2012, over 7 million farmers had adopted this technology on 10.8 million ha equivalent to 93% of the country's total cotton area [22]. *Bacillus thuringiensis* (Bt) toxin gene has been cloned from the bacteria and expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio-pesticide [23]. Examples are Bt cotton, Bt corn, rice, tomato, potato and soybean. The use of Bt crops enhanced food supply in developing countries, by preventing attack by the spoiling insects [23]. Several genetic engineering are designed to increase, not to lower the health qualities of foods. Biopesticides reduces the use conventional pesticides as its biodegradation takes longer period [15].

### **Applications of Genetic Engineering to improve the taste and nutrition**

The tools of Genetic Engineering allow plant breeders to select single genes that produce

desired traits and move them from one plant to another [24]. *Agrobacterium tumefaciens* can contain a plasmid known as Ti plasmid. Gene of interest (GOI) is selected from the host organism. The GOI and the Ti plasmid are spliced together. When plasmid is introduced into *A. tumefaciens* it transformed in to immature plant cells and the plant grow [25]. Genetic engineering has offered opportunities to produce more nutritious and better tasting foods, higher crop yields and plants that are naturally protected from disease and insects [26]. For example, bitter lemon is resistant to soil nematodes whereas sweet orange is not. If the graft of sweet orange is incorporated in to that of bitter lemon it will transform to produce good taste. Genetic engineering offers the developing countries greater opportunity to utilise the technology in the production and enhancement of food supply [27]. The GM foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon synthetic pesticides and herbicides [28].

### **Demand and supply of GMOs in developing countries**

Many countries import the majority of their food supply due to the weather, climate and pests which may hinder the availability or production of food crops respectively [29]. Therefore, recognizing the need to incorporate GM foods or GMOs in the food supply chain has relieved them from paying such high prices for foods and well as concerns of food security [29]. Therefore, the magnitude of the introduction of GM crops may have a huge positive impact as it pertains to the ethical guiding principle of justice where a fair, equitable food supply is maintained. Climate change is also another environmental factor threatening food security, which may lead to malnutrition and

other health problems due to shortage of food [30]. GMO proponents focus on the need to substantially increase the quantity and quality of food available to the poor [31]; [32]. Doing that sustainably, in the words of one plant scientist, means that “increased food production must largely take place on the same land area while using less water” [33]. Most impact studies in developing countries focus on Bt cotton, because that is the most common GMO in commercial cultivation. Those studies find yield increases of 24 percent to 37 percent in China and India, respectively, versus a yield gain of just 10 percent in the United States [34].

#### **Government policies in GMOs in developing countries especially Africa**

By 2016, at least four countries have at some point in the past placed a GM crop in the market Burkina Faso, Egypt, South Africa and Sudan [35]. However, due to various political and technical setbacks, only South Africa and Sudan planted biotech crops in 2016. South Africa is one of the top ten countries planting more than 1 million hectares of biotech crops. South Africa continued to lead the adoption of biotech crops on the African continent with increased plantings of biotech maize, soybean and cotton totalling 2.66 million hectares in 2016 [36]. This is a 16% increase from the reported biotech crop area of 2.29 million hectares in 2015 [36] (Sinebo and Maredia, 2016). In Egypt, a ban on Bt maize was imposed over safety claims while the Burkina Faso Government put a temporary halt on Bt cotton plantings to address a short fibre length concern observed from the varieties farmers have grown over the last eight years [35]. Sudan in Northern Africa approved its first biotech crop insect resistant Bt cotton for commercial planting in 2012 with a single variety under the trade name Seeni 1 [35]. Another key obstacle is the widespread absence of sound regulatory policies to guide the development, testing, and

commercialization of GM crops [37]. Many African countries have not yet developed national biosafety laws or other regulatory mechanisms for biotech crops, and relatively few have progressed even as far as confined trials. In recent years, a few countries have adopted national biosafety policies and passed legislation to regulate the cultivation and import of GMOs, including in Nigeria (2015), Mozambique (2014), and Uganda (2012). But a recent report commissioned by the African Development Bank concluded that the regulatory environment on the continent was characterized by “confused and disaggregated” approaches and “inefficient and technically weak policies lacking in procedural rigor” [32].

#### **Conclusion**

Genetic engineering has aided in the progress of food supply to the developing countries through agricultural biotechnology. It has given to humans several useful products by using microbes, plant, animals and their metabolic machinery. Agricultural biotechnology, if adopted by the developing countries food supply will be achieved enormously. People perception about the genetically modified food should change. The GMFs have the potential to reduce many of the world’s hunger and malnutrition challenges, and to help protect and preserve the environment by increasing yield and reducing dependence upon synthetic pesticides and herbicides. Challenges ahead lie in many areas namely food labelling, safety testing, regulation and policies. Many people feel that genetic engineering is the unavoidable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits.

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