

## **GENETICALLY MODIFIED ORGANISMS: A SOLUTION TO FOOD SECURITY AND ENVIRONMENT**

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### **ABSTRACT**

The concern of food security and environment sustainability is having high priority due to huge population and alarming prices of commodity world-wide. International organisations are trying hard to find ways to remove hunger, poverty, and health issues. The per capita availability of food remains stagnant as the world's population is increasing, and any attempt to decrease poverty is further increasing demand for food. By 2050 world population will reach up to 9.5 billion but world seems inefficient to feed them. Generally, Asian and African agriculture is a gamble of monsoon which is highly erratic. Further, farmers are using different types of pesticides, insecticides and fertilizer etc. to increase production which are directly and indirectly influence the food quality and environmental sustainability. The goal of the paper is to show an alternative arrangement that the GMOs have potential to offer nutritious food as well maintain the environmental sustainability through analysing the present data of countries which adopted GMOs technique. In the 21st century Biotechnology has applied as one of the eco-friendly-technology. Many developed countries have opted to incorporate the technology to improve their productivity. One such way to meet the demand is by using Genetically Modified food (GM food). GM foods are produced from organisms that have had specific changes introduced into their DNA using the methods of genetic engineering. The paper attempts to suggest that scientists, policymakers, experts and farmers should collaborate to find new and creative ways to increase food production to arrange the growing demand of food in a sustainable way. The growing constraints of land and water availability, technological inventions could use for providing more sustainable and nutritious alternative for the coming generations.

**Keywords: GM Technology, Population, Food security, Environment**

## 1-INTRODUCTION

Food security exists when all people have physical and economic access to sufficient, safe, and nutritious food. Ironically, the secure food does not inevitable for significant proportion of the world population. Internationally, progressive fight against hunger is going on, yet an excessively large number of people still lacking with the food which they need for an active and healthy life. The latest available estimates show that about 795 million people are undernourished in the world (FAO 2015), more than one in four children affected by stunting, and 9% of children affected by wasting (IFPRI, 2015). The World Health Organization (WHO) defines three facets of food security as Food availability, Food access, and Food utilisation. Food availability is having enough quantities of food on a consistent basis, where Food access is having enough resources, both Economic and Physical, to get proper foods for a nutritious diet. Food utilisation is the appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation. Food availability is one of the most important dimensions for food security. There is a huge burden on the world to give food security to all the countries but the question arises that by which technology, countries could be the best provider for food security (Lamichhane, 2014). At present, any technique that can improve food production both in quality and quantity would be a welcome development (Reddy, 2015). The increasing demand for food poses major challenges to humankind. Agricultural sustainability is no longer optional but mandatory. It is most debatable among researchers as well as media for finding quality solution for formulating strategic food arrangement to keep pace with global population growth (Weiner, 2013). The unavailability of sufficient food in most of the region means the world suffers food insecurity (Michael Jahi Chappell, 2009). The biotech crop could be an alternative for increasing food production which leads to higher food availability. The five lead biotech developing countries in the three continents, Brazil and Argentina in Latin America, India and China in Asia, and South Africa on the African Continent, grew 47% of global biotech crops and it represent around 41% of world population (James 2014). Among these five developing countries, India is using cotton for biotech revolution named as Bt cotton and the success of this technology transformed the cotton importer country into one of the major exporter of cotton (James 2014). The emphatic production growth of cotton suggests that if India had cultivated other biotech food crops, the food availability could be the insignificant issue for the country.

According to the Intergovernmental Panel on Climate Change (IPCC) assessment, climate change will affect all aspects of food security. In particular, the tropical region, already most vulnerable to food insecurity, will be the most adversely affected. India, Bangladesh, Pakistan, Nepal, Philippines, Ethiopia, Nigeria, Madagascar and Yemen are the countries in the tropical region with the highest percentages of undernourished women and children under 5 (P.B. Reddy, 2013). Finding a solution is thus a priority for any government that wishes to stay in power. Another but important solution to solve food crisis is genetically modified foods (GMOs). GM technology help to give food security without affecting the environment, it is also provide sustainable food. There are more than ten food and fibre crops are under approved list for commercial planting, ranging from major commodities like maize, soybean, and cotton, to fruits and vegetables such as papaya, eggplant and squash (James Clive, 2014).

## **2. PROBLEM STATEMENT**

- To analyse the issues and challenges for food security and environment
- To examine the potential of GMOs to eradicate the emerging challenges
- To understand the traits of GMOs related with food and environment sustainability

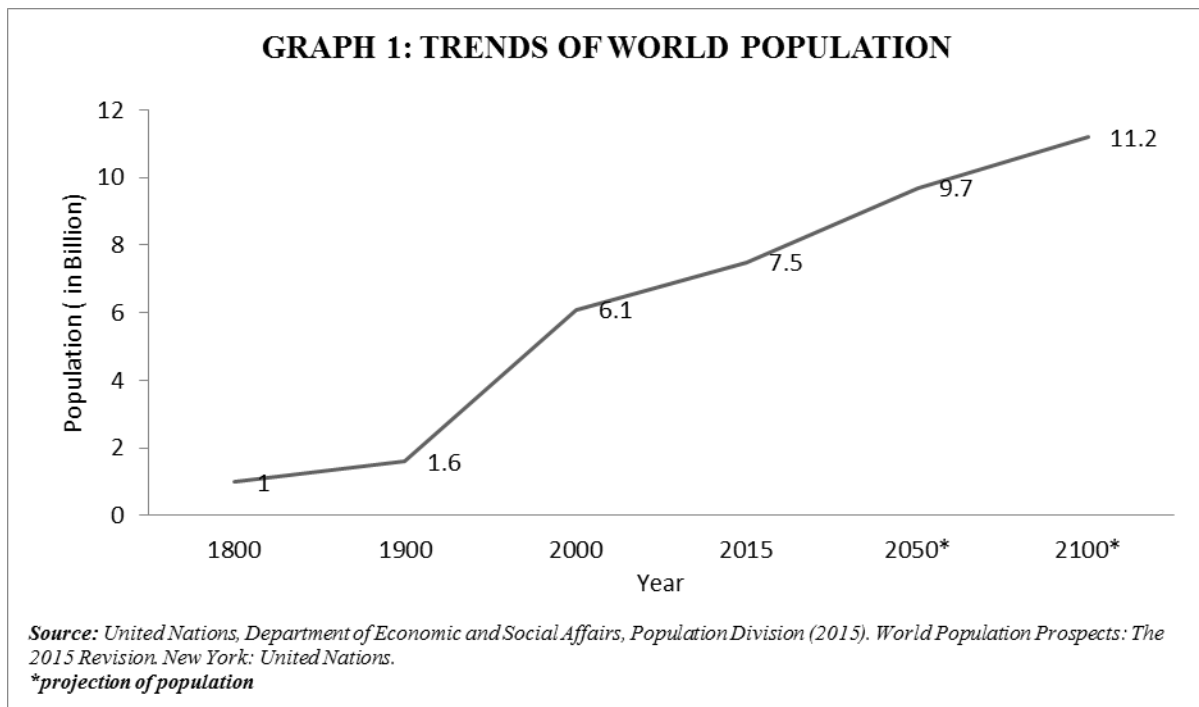
## **3. ISSUES AND CHALLENGES**

Problem of malnourished and hunger are decreasing in many developing countries but remain persistent in other countries, and food and nutrition security continues a serious of too many country (UN, 2013). The major problem related to global food security and environment sustainability are food production, price volatility, population growth and climate change. Climate change and its impacts on agriculture production plus increased population growth that would result in a deficit of global food production versus demand (P.B. Reddy, 2013). Agriculture is the primary source of food, but modern intensive agriculture is general burden on the environment, resulting in contamination of drinking water, erosion, soil degradation, and reducing biodiversity (Emile A. Frison, 2011). A key question is about how to attain a standard productivity level on existing land (Weiner, 2013). The Sustainable Development Goals (SDGs) signal a transformed commitment to end hunger and global poverty by 2030. Under Goal 2, which is a call “to end hunger, make food security and improved nutrition, and promote

sustainable agriculture,” it will be critical to make sure that all people, in particular the poor and people in vulnerable situations, have access to sufficient and safe nutritious food all year round (IFPRI, 2015). This goal is not possible to achieve with traditional agriculture techniques. An Indian and African country agriculture is totally depends upon the gamble of monsoon. For increasing the agriculture production, farmers are using different types of pesticides, insecticides and fertilizer etc. which are direct and indirect impact on the environment sustainability. India failed to meet the millennium development goal (FAO 2015).

### 3.1 Population

The growth of population in the poorest countries presents its own set of challenges, making it more difficult to eliminate poverty and inequality, to fight hunger and malnutrition. Between 1900-2000 population increases with unprecedented rate of growth by 284% but land are not increases with the proportion of population.



The projection of population in 2050 and 2100 are 9.7 and 11.2 billion respectively. World find out the alternative solution for feeding these populations in future. Developing countries are facing the major problem of food due to food unavailability.

### 3.2-Food Prices and Volatility

The impacts of climate change will also affect food prices and volatility. In developing countries farmers depend upon the rain because in developing countries have not irrigation facility in proper manner. In reality, food prices have increased due to a number of factors, including climate change, market volatility, increased petroleum prices, and biofuel demand, increasing the number of population of the countries (FAO 2014, 2015; IAASTD 2009). Higher food prices lead poor households to buy cheaper and less nutritious food items. For poor families, coping with rising food prices means eating less, cutting the number of meals per day and reducing the quality and variety of foods they consume. The impact of high food prices is more severe for the poor who rely on purchased food. Developing countries families tend to spend between 50-80 percent of their income on food, compared to less than 10 percent in some developed countries (P.B. Reddy, 2013).

#### **4. GENETICALLY MODIFIED ORGANISM**

Genetically modified foods also known as biotech foods developed through genetically modified organisms. GM crops are the crops whose DNA has modified by using genetic engineering techniques, with the aim to introduce a new trait to the plant which does not occur naturally in the species. Specific changes are possible in the DNA of these crops by genetic engineering techniques that encourage extra nutrients produced, faster growth and ability to resist diseases and other purposes. Almost in every area in the food production market is using genetic modification to produce foods that taste better, grow faster, resist disease and improve the amount of nutrients found in the world (Lamichhane, 2014). Application of GM crops in agriculture is most debated because of its direct and indirect inferences. The promoted benefits in the background of the potentially harmful effects on health and environment make this an issue of greater concern (Amanpreet, 2013).

#### **5. STATUS OF GM CROPS**

Table 1 show twenty eight countries are cultivating the GM crops with unexpected rate of growth. US hold first rank in the respect of area, it cultivated 73.1 million hectares of land for sowing the GM crops. At global level India hold the forth rank in the respect of area, but India

second largest producer of Bt-cotton in the world after china. In 28 countries, 20 countries are developing and eight developed country.

**Table 1: Global Area of Biotech Crops In 2014: By Country (Million Hectares)\***

Rank	Country	Area	Crops
1	USA	73.1	Maize, soybean, cotton, canola etc.
2	Brazil	42.2	Soybean, maize, cotton
3	Argentina	24.3	Soybean, maize, cotton
4	India	11.6	Cotton
5	Canada	11.6	Canola, maize, soybean, sugar beat
6	China	3.9	Cotton, papaya, poplar, tomato
7	Paraguay	3.9	Soybean, maize, cotton
8	Pakistan	2.9	Cotton
9	South Africa	2.7	Maize, soybean, cotton
10	Uruguay	1.6	Soybean, maize
11	Bolivia	1.0	Soybean
12	Philippines	0.8	Maize
13	Australia	0.5	Cotton, canola
14	Burkina Faso	0.5	Cotton
15	Myanmar	0.3	Cotton
16	Mexico	0.2	Cotton, soybean
17	Spain	0.1	Maize
18	Colombia	0.1	Cotton, maize
19	Sudan	0.1	Cotton
20	Honduras	<0.1	Maize
21	Chile	<0.1	Maize, soybean, canola
22	Portugal	<0.1	Maize
23	Cuba	<0.1	Maize
24	Czech Republic	<0.1	Maize
25	Romania	<0.1	Maize

26	Slovakia	<0.1	Maize
27	Costa Rica	<0.1	Cotton, soybean
28	Bangladesh	<0.1	Brinjal/eggplant
		181.5	

\* Rounded off to the nearest hundred thousand

*Source: Clive James, 2014.*

These countries are account 60% population of the world. In 2014, 18 million farmers planted more than 181 million hectare of land. A small poor country Bangladesh approved Bt Brinjal/Eggplant for the first time on 30 October 2013. After approval, within 100 days small farmers commercialized Bt-Brinjal on 22 January 2014. US approved innate potato in November, it is another food crop. In which low levels of acrylamide, by which carcinogen cause in humans. Potato is the fourth basic food staple in the world. A safer product and decreased wastage in a vegetative spread and perishable crop, can contribute to higher productivity and food security (James 2014).

## 6. GMOS: A Game Changer

Biotechnology has emerged as one of the environment friendly technologies in this era. Countries are transforming their scientific researches to improvise their efficiency and productivity in almost every field (Azadi 2009). GMOs are one of the most cited technology that addresses' gene revolution congruently as the green revolution (Pingali 2005). The seamless opportunity of growth, diversity and benefits attached with bio tech crops will continue to progress and they appear into a significant contributor for feeding a growing population. It appears as the fastest adopted crop technology in recent times, bio tech crops are definite solution to climate change and food security which is real challenge for consumers to producers around the world (James 2013). GM Food can benefit the consumer in two ways, firstly growing more food in less cultivated land and secondly it increases nutrient availability in foods. In developing countries where research and development and technological bases are weak and infrastructures are not strong (Morris 2005), adopting biotechnology by new firms means they are generally preparing a strategic response and not based on a real appreciation of environmental threats. It is certain that the applications of this technology can provide potential

contributions to sustainable agricultural productivity and new inputs for resource-poor and small-scale farmers (Thistle 2003). Genetic engineering technology has potential to transfigure agricultural productivity by designing plant level action plan (Subulade 2007). The advantages are further discussed below:

### **6.1 Robust Production**

The GMOs crops have potential to produce high yield with less water, pesticide resistant and grow faster. There are differences among researchers on the long-term effects of GMO foods on human health and environment issues. The meta-analysis during 1996 to 2013 shows that the yield of GM crops increases by 20%. Yield gains and pesticide reductions are larger for IR (insect resistance) crops than for HT (herbicides tolerance) crops. Further, yield and producers gain are higher in developing countries than in developed countries (Qaim 2014). Biotech crops have favourable impact on food security, sustainability and climate change which registered US\$133 billion value of increment through crop production (Barfoot 2014).

### **6.2 More Nutritious Foods**

According to the Food and Agricultural Organization of the United Nations, some GM foods have engineered to become more nutritious in terms of vitamin or mineral content. Golden Rice is an outstanding case of a lost or delayed prospect. It's a variety of rice supplemented with beta-carotene, a precursor to Vitamin A. Every year, about quarter million people who depend on rice for their dietary need goes blind due to dearth of Vitamin A. It has estimated that even a limited adoption of Golden Rice could have saved millions of people from blindness and death due to Vitamin A deficiency. Over time it is improving but regulatory pressure has prevented its introduction. But the GM crops have proved an impact on food quality and nutrient composition (Qaim 2013).

### **6.3 Declines in Food Prices**

Higher yield has significance in transforming lower costs of food prices and would further go downwards. The people in poorer countries spend almost half of their income on food and fibre, it means the availability of low-cost food has capacity to reduce poverty. The GM technology is



having an important role in alleviating hunger as well as poverty through increasing agricultural productivity and food availability cannot be unnoticed (Reddy 2013). The crop production by using genetically modified organisms (GMOs) can relieve many problematic issues which at present millions of Africans are facing. It is particularly evident in rural areas, where people depend primarily on agriculture for livelihood (Crewe 2010). The food availability at less prices can enable the countrymen to lead a healthy life.

#### **6.4 Stronger Crops**

The GM crops are more resilient to weather variations causes which quality yields are possible even under severe conditions. The shrinkages of farm land due to rapid urbanisation and uneven weather conditions are creating an undue stress on farmers' involvement with farming activity. Sometime farmers are using those lands which are not suitable for cultivation because of poor quality of soil. In such circumstances the genetic modified plants can resistant with such disorders and provide help in growing healthy crops. The research results of many user countries of GMOs indicate, that the GM crops have many advantages such as disease resistance, cold resistance, drought tolerance, herbicide resistant, nutrition availability and reduction of carbon dioxide from atmosphere through fuel saving and it also decline the soil. So, GM crops traits help to decline the food insecurity and maintain the biodiversity of the environment ((Lamichhane, 2014).

#### **6.5 Reduce Use of Pesticides**

The meta-analysis result of around 147 published biotech crop researches using primary survey of farms worldwide reconfirm the environmental benefits of biotech crops. The Study point out the impact of GM crops during the period of 1995-2014. It has concluded that chemical pesticides are decreasing by 37 percent and profits of farmer are increased by 68 percent (Qaim, 2014). To decreasing the use of pesticides provides nutritious food and combat with under nutrition and malnutrition issues. It helps to maintain the food security as well as environmental sustainability.

## 6.6 Decreases in Global Warming

Major threat of global warming is carbon dioxide. In intensive farming farmers used different farm mechanisation activities like tractors, tube-well etc. Due to this emissions of CO<sub>2</sub> increases sharply that is potential threat to the environment as well as human health. GM crops are helpful for declining the CO<sub>2</sub>. In 2013, it has reduced CO<sub>2</sub> emission by 28 billion kg that is equivalent to 12.4 million cars on the road for one year. This cost may be able to alleviate poverty of more than 16.5 million small farmers and their families (Barfoot, 2014).

**TABLE-2 SUMMARY OF CARBON SEQUESTRATION IMPACT 1996–2009**

<b>Crop/ Country</b>	<b>Trait/</b>	<b>Permanent Fuel Saving (Million Liters)</b>	<b>Potential Additional Carbon-dioxide Saving From Fuel Saving (Million Kg)</b>	<b>Potential Additional Carbon-dioxide Saving From Soil Carbon Sequestration (Million Kg)</b>
<b>US:</b> GM HT soybeans		835	2,295	37,755
<b>Argentina:</b> GM HT soybeans		1,885	5,185	50,707
<b>Other countries:</b> GM HT soybeans		235	646	9,528
<b>Canada:</b> GM HT canola		504	1387	17,188
Global GM IR cotton		137	378	0
<b>Brazil;</b> IR maize		20	56	0
<b>Total</b>		3,616	9,947	115,178

**Source:** Graham Brookes & Peter Barfoot (2011)

Table-2 shows the different type of GM crops with different traits of different countries. Total saving of fuel by different GM crops is 3,616 million litres that lead to decline the CO<sub>2</sub> from atmosphere by 9,947 million kg in the period of 1996 to 2009. It also helps to save addition of CO<sub>2</sub> from soil carbon sequestration that is equivalent to 115,178 million kg of CO<sub>2</sub> (in the period

of 1996 to 2009) that has not released in atmosphere. It contributes to decline the global warming that leads to maintain the environmental sustainability and also improve the human health.

## 7. CONCLUSION

Genetically Modified Organism appears as a potential solution of alarming food unavailability, resource limitation and emerging challenges in the agricultural crop production. World-wide, biotech foods are getting an overwhelming responses and its impact on environment and health is a proven fact of the matter. Along with, despite reluctance of some environmental groups, food demands are accelerating GM foods in the global market. Due to quality benefits attached with GMOs such as robust production, more nutrition, reduction in prices, stronger crops, less pesticide and reducing global warming are factors to change the game of acceptability of GM crops. There is a need of concentrated efforts from every vertical of stakeholders are require to increase awareness and practicality to induce GM technology with regulated framework. The high level experts' regulatory body are requiring adding GM crop cultivation practices. In the light of such inferences a need to integrate scientists, policymakers, experts and farmers to involve in food production by adopting latest technology to enable agricultural practices more sustainable. Technological inventions could help more sustainable and nutritious alternative for the coming generations.

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