

Published: January 31, 2023

Citation: Amofah G. K. and Badu S., 2023.

CONTROVERSY OVER HEALTH IMPLICATIONS OF GENETICALLY MODIFIED ORGANISMS: Which way for developing countries? Medical Research Archives, [online] 11(1).

<https://doi.org/10.18103/mra.v11i1.3275>

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**DOI:**

<https://doi.org/10.18103/mra.v11i1.3275>

ISSN: 2375-1924

## RESEARCH ARTICLE

# CONTROVERSY OVER HEALTH IMPLICATIONS OF GENETICALLY MODIFIED ORGANISMS: Which way for developing countries?

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### Abstract

The Ghana Public Health Association organized a scientific seminar in April 2014 to examine the introduction of genetically modified organisms (GMOs) into public use, and their potential health consequences. The seminar was driven by current public debate on the subject. Concerns have been raised about use of GMOs, especially in developing countries, for a variety of reasons including ethical and biosafety considerations. The seminar identified some of their advantages such as introduction of pest resistant, disease resistant, and drought tolerant crops; potential for reduced use of chemicals and pesticides; improving the nutritional properties of crops, and huge potential for production of pharmaceuticals and vaccines.

Potential health concerns raised included current efforts focusing primarily on a few crop/trait combinations of high commercial value; most trial designs are laboratory design and of short duration; increasing observation of trends in organ disease with use of GMOs, and lack of labeling of GMO products that hinder post-marketing surveillance.

There is the need to enhance local capacity to research the introduction and use of GMOs; to put in place appropriate regulatory mechanisms including, particularly, the labeling of their products, and long-term post-marketing surveillance for possible negative health consequences.

Furthermore, the appropriate state agency should put in place advocacy and communication strategies to keep the public informed about the health and other consequences of GMOs, for informed public choices.

## Introduction

There is universal agreement that the world's population is increasing at an alarming rate especially in developing countries, and this poses a major threat to food security. The latest projections by the United Nations suggest that the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100.<sup>1</sup> Climate change is likely to worsen available food supplies, which may lead to malnutrition and other serious health problems.

To address these concerns, Genetically Modified Organisms (GMOs) have been introduced to, among others, improve food production. According to the European Union, a GMO is any organism, apart from human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination.<sup>2</sup> Genetically Modified (GM) products include medicines and vaccines, foods and food ingredients, feeds, and fibers. There are 11 commercially available genetically modified crops in the United States: soybeans, corn (field and sweet), canola, cotton, alfalfa, sugar beets, summer squash, papaya, apples and potatoes.<sup>3</sup>

In Ghana, the Biosafety Act (2011), Act 831, was passed to establish the National Biosafety Authority with the objective of, inter alia, "to ensure an adequate level of protection in the field of safe development, transfer, handling and use of genetically modified organisms resulting from biotechnology that may have an adverse effect on health and the environment".<sup>4</sup> The law allows the application

of biotechnology in food crop production. Biotechnological tools have been used to modify agricultural produce in our agricultural research institutes contributing to better yields, pest and weather resistance.<sup>5</sup> The Act does not apply to "genetically modified organisms that are pharmaceutical for human use".

The Plant Breeders bill laid in Parliament on the 28th day of May 2013, on the other hand, seeks, among others, to provide for the grant and protection of plant breeder rights. Several deficiencies were identified in the bill including, lack of safeguards that are important to protect public interests, to prevent misappropriation of Ghanaian genetic resources, as well as to ensure fair and equitable sharing of benefits arising from the utilisation of local germplasm.<sup>6</sup> This bill has generated such controversy that it has been withdrawn pending further consultation. Not only in Ghana but worldwide, there has been widespread controversy generated since the introduction of GM crops, especially after commercialisation of the products<sup>7,8</sup>. Concerns have been raised about GM crops for a variety of reasons including ethical, biosafety (environmental impact, health), bioproperty, and biopolitical considerations.<sup>9,10</sup>

It is under this context that the Ghana Public Health Association (GPHA) organised a public scientific lecture on GMOs and their health implications on 3rd April 2014 to understand the science behind the technology and discuss its public health implications to inform policy. Experts from the College of Agriculture and Consumer Sciences of the

University of Ghana, Legon, and National Public Health Surveillance Department of Ghana Health Service presented carefully researched scientific papers on the subject, followed by thorough dispassionate discussions. A communique was prepared and shared widely after the scientific session to policy makers and the public arising from the conclusions and recommendations.

The aim of this paper is to review the key outcomes of this lecture to understand the science behind the GMO technology, discuss its public health implications and make recommendations to inform policy, especially in developing countries.

### Discussion

Despite all the controversies surrounding the use of GMOs what is clear from the discussions and review of literature is that there are many advantages and potential health benefits of introducing GMOs, especially in developing countries. The advantages include the following:

- Introduction of pest resistant, herbicide tolerant, disease resistant, cold tolerant, and drought tolerant crops with potential for increased crop yield.<sup>11</sup> The argument is that amid global warming, desertification and unfavourable climate change leading to worsening food crisis and famine, there is the need for better pest resistant and drought tolerant crops to mitigate the effects of these global crisis. GMOs provide a solution to achieve these objectives, increase crop yields and help solve the famine crisis in many parts of developing countries.

- Potential for reduced use of chemicals and pesticides on insect resistant plants, which will result in healthier food.<sup>12</sup> To withstand the worsening food crisis due to poor weather conditions, there is increasing use of chemicals and pesticides to improve food yield. Unfortunately, most of these pesticides and chemicals have adverse health effects especially in the long run. Use of GMOs is expected to reduce the application of these chemicals, leading to availability of healthier food.
- Improving the nutritional properties of crops to enhance human health through food fortification with desired vitamins and minerals.<sup>13</sup> The technology used for GMOs enables humankind to fortify available crops (with desired vitamins and minerals) to improve the nutritional properties of crops to enhance human health.
- GMOs provide huge potential for production of pharmaceuticals and vaccines which will be much easier to ship, store and administer than traditional injectable vaccines.<sup>14/15</sup> Another advantage advanced by proponents of use of GM technology is the huge potential for efficient and effective production of user-friendly non-injectable pharmaceuticals and vaccines. This has potential health benefits in developing countries where health workers must struggle to vaccinate the public with injectable vaccines, with their own logistic nightmares including vaccine hesitancy due to fear of injections.

- Potential for use of technology for Gene therapy - direct use of Deoxyribonucleic acid (DNA) to treat disease.<sup>16</sup> There are many chronic diseases that are currently incurable due to ineffective therapeutic remedies. GM technology offers the potential and the opportunity to develop life saving remedies for many such diseases. Such breakthroughs will benefit patients in developing countries who are currently struggling to access and finance the limited remedies available for many of these chronic diseases.
- Application in stem cell research - the manipulation of undifferentiated cells to replace damaged or diseased tissues in the body.<sup>17</sup> Linked to the above advantage is the potential application in stem cell research through manipulation of undifferentiated cells to replace damaged or diseased tissues in the body. The advantages of such a breakthrough are enormous in this era of increasing non-communicable diseases, including various types of cancers, if the necessary cautions are adhered to.

Notwithstanding the advantages and major potential public health benefits, several concerns and potential negative health impact have been articulated, including the following.

- Current efforts involving GM technology are focused primarily on a few crop/trait combinations that have high commercial value and occupy large international markets, hence are primarily profit driven.<sup>18</sup> This argument cannot be

discounted as translating results of a few carefully selected crop/trait combinations to the larger population of crops is at best questionable. There is even more concern when the few carefully selected crops may only come from those of high commercial, and therefore profit-driven value, which may not necessarily be those of interest for small-scale farmers in developing countries.

- Another concern is that public institutions are resource-limited and lack infrastructure and capacity to compete against private research institutions. There is poor access to advanced technology and weak regulatory capacity in many developing countries. The effect of this challenge is that the private sector will set the research agenda and design methodology to suit its short-term commercial rather than the longer-term public good. According to some experts, most of the trials supporting introduction of GMOs are not independently done and are commercially driven. The trial designs are laboratory design and of short duration. They argue that short-term studies may mask chronic toxicological effects including later developmental and reproductive effects.<sup>19</sup>
- There is also potential for unpredictable, unintended mutations in the organism with consequential medico-legal events.<sup>20</sup>
- Tendency to provoke allergic reactions. New pesticide residue effects in alimentary system may affect gut bacteria provoking peripheral immune and allergic reactions.<sup>21/22</sup>

- Lack of labeling of GMO products hinder post-marketing surveillance of the GMO products for safety considerations.<sup>23</sup> Very few people in developing countries take the trouble to check for labels on food. Manufacturers therefore hide behind this deficiency and therefore do not provide labels on food items for the buying public to check whether they are GMOs or not.
- Increasing trends in organ disease and GMOs use have been observed. According to Dora A and Arvanitoyannis IS, there is some correlation between organ disease, increasing GMO in food supply, and glyphosate herbal application with possibility of endocrine disruption. Organ disease mentioned include thyroid cancer; liver and intra hepatic bile duct cancer; hypertension; acute kidney disease; diabetes mellitus; autism; Alzheimer's disease; Parkinson's disease; senile dementia; inflammatory bowel disease – Crohn's and Ulcerative colitis; and rheumatoid arthritis.<sup>24</sup>

Though these have not been proven yet there is need to keep an eye on the correlation through further clinical/observational and epidemiological studies.

### Conclusion and recommendations

There is great potential to improve health, nutrition and food security through GMOs, and developing countries, including Ghana, should place themselves appropriately to benefit maximally from the technology. However, there is need to be cautious and move slowly. The development, testing and

release of GMO products must be appropriately regulated. This calls for regulatory structures that ensure that there is no harm to humans, animals and the environment. The current systems in place are not adequate and capable to perform these critical functions.

Protocols for new GMO trials and release of GMO crops should be transparently reviewed by an independent national regulatory body before approval. The regulatory, clinical trial and post-marketing monitoring and surveillance capacities in the country should be strengthened. Universities and research institutions should therefore be supported and equipped in biotechnology. There is need for longer, more-detailed transparent toxicological tests on all GMOs before approval and release to the market. All GMOs must be appropriately labeled as such for informed choice and to facilitate post-market monitoring of any health effects.

Lastly, the appropriate state agency should put in place advocacy and communication strategies to keep the public informed about the health and other consequences of GMOs, for informed public choices.

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**Conflicts of Interest Statement**

"The authors have no conflicts of interest to declare."

**Funding Statement**

The authors did not receive any funding for this work.

**Acknowledgements**

I thank Dr. Kwadwo Ofori for providing content to the topic during the scientific session. I am grateful to Prof Ofori Adjei for proofreading the initial communique, and to Prof Edwin Afari for overseeing the organization of the scientific workshop.

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