

Genetic Engineering Development and Acceptance in Sub Saharan Africa: Stakeholders and Public Opinion about GMO

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Abstract Many researchers and policymakers have brought about different solutions to the global issue of food insecurity. The limitations of providing sustainable resolutions to avert poverty and hunger in Africa have been tackled in diverse ways and has generated a number of controversies in the region. This paper aims to investigate issues pertaining to GE development and production in Sub Saharan Africa and to unearth and propose solutions to challenges restricting the development and production of GE crops in Sub Saharan Africa (SSA) by examining the opinions of policymakers and the general public in selected number of countries. A qualitative approach of interviews was employed to gain an understanding from different perspectives. A survey conducted in four Sub-Saharan African countries; Burkina Faso, Ghana, Malawi and South Africa revealed that, people are confident that GMO could solve the current agronomic problems but the fear of its potential harm on the environment and health is what deters them. Also, regulatory requirements are emerging as crucial hindrances to many of these countries. However, the study touched briefly on the potential of GMO solving these agronomic problems hence further research should emphasize the potential of GMO solving non-agronomic problems. Also, due to the busy schedule of many relevant stakeholders and respondents, it was difficult to get hold of them to be interviewed.

Keywords: agricultural biotechnology, genetic engineering, sub Saharan Africa, agricultural development; policymaker group

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1. Introduction

Food security currently continues to be a pressing issue in the world. It has resulted in a number of debates on global food [1]. The limitations of providing sustainable resolutions to avert poverty and hunger in Africa have been tackled in diverse ways. Agriculture continues to significantly boost the economic input of many African countries. The sector contributes about 70.5 percent of the labor in Africa and adds about 34.5 percent of Africa's GDP. Some policymakers and organizational group who are for genetically modified organisms (GMO) believe that, this modern technology can contribute massively to agricultural production and development as well as enhancing food quality in the developing world. In contrast, critics believe agricultural biotechnology undermines food security [2]. In as much as agriculture has seen massive progress, there still lie vast impediments with regards to productivity such as population growth, drought, and lack

of improved seeds, lack of irrigation equipment and silos, and many other challenges. The menace of food security crisis therefore raises questions and doubts about the future of agriculture and has paved way for novel incentive to a long-standing debate about the potential contribution of agricultural biotechnology to food security. More so, the acceptance and use of the new technological innovations in Africa could be challenging due to different policy regulations and weak R&D institutions.

Considering the growing population in Sub-Saharan Africa, the number of people that could benefit from GM crops and foods are so huge that, it could even be hailed as the "savior" and breakthrough for Africa. As stated earlier, Africa has over 65% of its population employed in agriculture and that is main source of survival for income and subsistence in that area. [3] Every continent or region has their own unique staple food. Just as the staple in Asia is rice, that of Sub-Saharan Africa is maize. It is the staple for over 350 million people and people in this region are growers of maize. Due to low productivity of labor in farming, many Africans remain poor and food insecure.

The rapid population growth and global warming continually pushes the production of maize into marginal areas with very little and unreliable rainfall. Indeed it's a shame that only 4% of cropland in Sub-Saharan Africa is irrigated [4]. Issues as such, only lead to increase drought risks to maize growers in the area in future. It is only logically right and ideal that, governments of African states accept and welcome this agricultural biotechnology, but to take a turn and accept it in Africa is not going to be an easy journey.

Agricultural Biotechnology has contributed greatly to the economies of countries that have adopted and commercialized its usage. It has produced valuable crops and food in some developing countries such as Argentina, Brazil, China and India. With regards to Africa, GM crops and food have been approved for commercial purposes in Burkina Faso, Egypt and South Africa whereas in Ghana, Kenya, Uganda, Nigeria and some other countries have the GM crop under confined testing. 42 African countries party to Cartagena Protocol but hardly have any implemented domestic biosafety frameworks.

Notwithstanding the wide range of benefits to farmers and consumers derived from GM crops and foods, many developing countries in Africa are still adamant in accepting and commercializing the use of this novel technological innovation. This is somewhat as a result of imperfect knowledge of the suitable development role for GM food and other biotechnologies that are products of promising innovation systems in the Region. The political, cultural and economic aspects of policy development must be taken into consideration when valuing the development of GE crops in Sub Saharan Africa [5]

This technology will be long and difficult because in Africa, (just as in Europe) transgenic technologies are screened and scrutinized using separate and much higher regulatory standards and more often than not require an approval from a national biosafety committee [6]. Researchers and scientists have paid attention and given their opinion as to why GMO ought to be introduced to developing countries [7] but to the best of our knowledge very little is said about why a land or a continent which is agriculturally bound has failed or delayed in adopting and commercializing GMOs. Many researchers such as [8] and [9] conducted in-depth research in this area but very little is said about the process of implementing effective and working biosafety regulations and commercialization as well as the rising hindrances that come along with them [10]. This study aims at finding out the general challenges associated with the adoption of GMO and its related biotechnology regulations and policies. The ever growing quest to understand GE crop acceptance in SSA brings a number of questions to mind.

1.1. The State of Technology Innovation Acceptance and R & D in SSA

Agricultural biotechnology research and innovation is very limited in many developing countries particularly in SSA. [11] This is partly due to limited funds, poorly equipped labs, lack of extensive education, lack of policy regulation support and many others. It is not surprising that, many African countries lag behind when it comes to

general technology innovation [12]. The total amount of GDP in many African countries is very minimal hence the contribution of part to R&D would ultimately be limited. Even though South Africa spends about 0.9% of their total GDP on Research and Development, only 5.5% is spent on Agriculture research. [13] There hasn't been any other African country which spend more than 0.5% of GDP on extensive agricultural research or R&D. [14]

In 2006, African leaders accepted and approved the Africa's Science and Technology Consolidated Plan of Action (CPA) that had African ministers of science and technology pledging to contribute 1% of the total GDP to R & D. However, this commitment has not been materialized partly due to democracy in many countries. [15] Democracy allows for frequent change of government and reshuffling. Many leaders after resuming office put a stop to other development initiated by the previous government and this lead to weak strategies and research systems with little or no innovative potentials.

Due to the low level of research and development in SSA, the implementation of agricultural biotechnology is difficult, hence the capacity of undertaking an effective GE project and other agricultural R&D projects is undermined [14]. This in conjunction with unavailability of financial and human resources limits or restricts the general innovative capability to conduct R&D and bring about unique GE crops and foods. Many SSA countries lack the biosafety regulatory framework to implement certain regulations that would promote the commercialization of GE crops and food. Nonetheless, there are few countries that have made efforts to develop strong biosafety system.

In a research conducted by International Food Policy Research Institute (IFPRI), it was discovered that, certain innovative capacity that can catapult the special GE traits of interest to national priorities ought to be measured against the possibility of gaining access to such modern technologies in another region. In as much as majority of SSA countries lack the capacity to undertake R&D, leaders and policymakers in SSA need to re-strategize to find a new way or different innovative capacity systems to deliver products to farmers and consumers [11].

2. Design of Study and Data Collection

2.1. Selection of Participant of the Survey

Burkina Faso, Ghana, Malawi and South Africa were selected for the survey because these countries have different political systems and different levels of economic growth. Also, we considered the fact that one or more of these countries have started GM production and commercialization as well as their stage in general R&D in GE crop field trials [6]. Agricultural biotechnology is a hot topic currently in most developing countries especially in Africa. Relevant policymakers and their corresponding representatives who are acquainted with the issue of biotechnology debate were selected in these countries through the help of some local key informants who are familiar with this topic; most of them being media journalists and local researchers at various national research laboratories or institutes and universities.

2.2. Data Collection

Data was collected from policymakers and representatives interviews from four Sub-Sahara African countries. 120 respondents from various institutions and organizations were selected from the four countries; 30 from South Africa, 32 from Malawi, 33 from Ghana and 25 from Burkina Faso (Table 1). It is important to note that, the power and potential of policymakers and stakeholders to influence and control decisions that can impact policies cannot be underestimated. Hence in order to gain a clear insight of issues pertaining to policy and institutions, it is necessary for stakeholders or policymakers to put forward information in their own way [16]. In doing so, employing a qualitative approach of interviews is an ideal way of gaining understanding from different perspectives as to know their reason behind what they have an exclusive view about the production and use of GMO. This approach is an ideal method with regards to the topic at hand since it creates an opportunity to delve deeply into issues which cannot be explored thoroughly via quantitative means.

The interviews were primarily based on unstructured and semi-structured questions which had issues to direct the views and opinions of policymakers on various aspect of GMO. The interview consisted of three parts. In part I, an introduction of both the interviewer and participants were made and the reason for the interview was established.

The participants went further to answer questions on the importance of various problems in domestic agriculture and the potential of genetic engineering for solving these problems. In part II interviewees were asked if the research capacity in the country was suitable and ready for the application and development of agricultural biotechnology; GMO to be precise. They were further requested to judge if field tests were underway and whether GMO was ready for adoption. In part III, respondents were asked about the general challenges associated with the adoption of GMO and how involved are the relevant policymakers or stakeholders in this issue of GMO production. The languages incorporated in the interview were English and French. Due illiteracy issues, some local farmers had their interview in their local dialects which were later interpreted.

2.3. Survey Response Rate

The selected stakeholder representatives and policymakers, especially with regards to development and production of GMOs in each country were first contacted personally and we made known to them the purpose of our meeting with them. These selected participants were guaranteed of confidentiality and that their opinions were not going to reflect the view of the institution they belong. Some participants accepted to the interview, others refused or gave a referral to another person with in depth knowledge about the study area.

Table 1. List of participating institutions and organizations from four SSA countries

Countries	Institutions and Organizations
Burkina Faso	Institute National et Agricole; Mosanto; SOFITEX; Farmers; Ministry of Secondary and Higher Education, Science and Technology; Crop Protection and Conditioning Directorate; University of Ouagadougou; Natural Substances Research Institute; The Catholic University of West Africa, Bobo-Dioulasso; Applied Sciences and Technology Research Institute;
Ghana	Ministry of Food and Agriculture; University of Ghana- department of Agriculture and Earth sciences; Ministry of Environment, Science and Technology; Noguchi Research Center; Environmental Protection Agency; Plant Protection and Regulatory Services Directorate; Kwame Nkrumah University of Science and Technology; Council for Scientific and Industrial Research; Crop Research Institute; Council for Scientific and Industrial Research; Local farmers; Food and Drugs Authority; Biotechnology and Nuclear Agriculture Research Institute; Savannah Agriculture Research Institute; Food Research Institute; Coalition for Farmers' Rights and Advocacy against GMO;
Malawi	Lilongwe University of Agriculture and Natural Resources (Luanar); Agricultural Research and Extension Trust; Kasinthula Agricultural Research Station; Lifuwu Agricultural Research Station; Makoka Agricultural Research Station; Mbawa Agricultural Research Station; Lunyangwa Agricultural Research Station; Chitala Agricultural Research Station; Chitedze Agricultural Research Station; Baka Agricultural Research Station; Bvumbwe Agricultural Research Station; Ministry of Agriculture; Local Farmers
South Africa	South African National Seed Organization; The Council for Scientific and Industrial Research; Department of Environmental Affairs; Agricultural Research Council; South African National Consumer Union; Agribusiness Chamber; Department of Agriculture, Forestry and Fisheries; Bayer Crop Science; university of Cape Town; local farmers; commercial farmers;

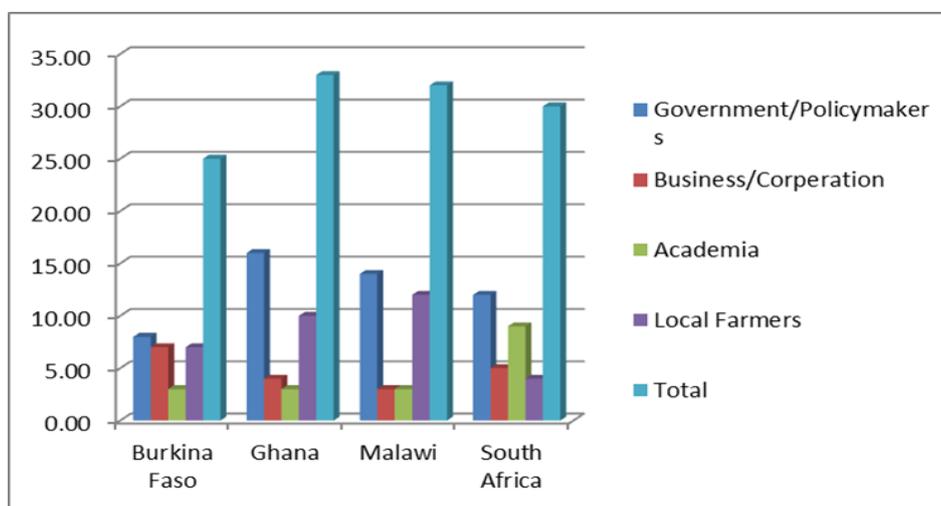


Figure 1.

One-on-one (stakeholders are engaged individually, either formally or informally); focus group workshop and town meetings were the method of interviews used in the study. Less than 20% of the total numbers of respondents were women. The interview interactions engaged individually gave us an insight about the current issue of food security and the important role GMO play in that, gave us the opportunity to know more about the research capacity and development, the role policymakers play in GMO and the various challenges restricting its adoption and usage. This was actively used among politicians, policymakers, parliamentary representatives, district chief executives, professors, local community chiefs, NGOs, churches and the press who consented to comment on this topic. A focus group workshop was crucial to data collection. A planned discussion on issues pertaining to GMO in a small (4 to 12 members) group of stakeholders took place. This allowed policymakers to interact and participate in the topic discussed. At research institutes and universities research laboratories, relevant group of scientists participated in a knowledgeable debate about the prospective role and importance of GMOs in agricultural development. The town meeting approach was used to enable individuals and farmers residing in a specific geographic area to discuss issues relevant to GMO in their community.

Different sectors such as agriculture, science and technology as well as environment influenced the selection of respondents based on their relevance to the topic. With this regard, the researchers had the opportunity to speak with some policymakers, scientific researchers, some local farmers as well as respondents from Non-Governmental Groups and other international donors and groups.

2.4. Data Analysis

The interview incorporated audio recordings and written notes. Each audio taped interview was later transcribed and was used as a primary data source. Once the interviews were transcribed, an overall summary was written based on the participant's responses to the demographic questions and the research questions from each interview. The data of this study were structured based on each activity and the kind of information provided mainly after reviewing the main data including that of literature and interviews.

2.5. Validity and Reliability

For the accuracy of the findings to be validated, the respondents ought to confirm the interview reports by reviewing the report and transcribed documents. This goes a long to ensure accuracy [17]. The multiple methods of data collection utilized triangulation of findings in order to be sure that the findings and conclusions were valid and reliable [18]. The respondents constantly checked the finding throughout the study in order to assure that, valid and correct conclusions or finalization is drawn from the data [19]. The data and the interpretations will then be given back to the respondents for their comment. The respondents make changes in their response wherever necessary by reviewing his or her answers. Then there will

be a discussion on the responses of the respondents and the interpretations of responses by the researcher. Now, the external auditor or supervisor will review the interview data and preliminary coding, themes, categories, and interpretations [20]

3. Results and Discussion

3.1. The Development and Challenges of Genetic Engineering

In the first part of the questionnaire, respondents were asked about the problems of domestic agriculture and the potential of genetic engineering to provide adequate solutions to these problems. Figure 2 & Figure 3 show that, in all four countries, the predominant problems identified were crop disease and pest infestation and genetic engineering had high potential in providing solutions to it. Notwithstanding, other common issues mentioned were drought and climate change which were predominant in all four countries. In South Africa and Burkina Faso, the potential of genetic engineering solving these issues was measured to be low. This affirms the results of research conducted by [21]. Moreover, issues relating to agronomy were considered to be of high importance as respondents from Burkina Faso, Ghana, Malawi and South Africa emphasized the importance of these issues. Climate change was considered to be a serious problem in Burkina Faso but less in South Africa. Likewise drought is considered to be a serious issue in Burkina Faso and Malawi but less in Ghana and South Africa. On the potential of GMO providing solutions to these problems, respondents from Ghana and South Africa believe genetic engineering has a low potential of providing solutions to the problem of drought and on the issue of climate change, apart from Malawi, all three remaining countries believe genetic engineering has low potential of providing solutions to climate change affected seeds.

The second part of the interview consisted of respondents answering questions with regards to the research capacity in the country and whether or not it was suitable and ready for the application and development of agricultural biotechnology. The first question was "what is the state of the research capacity in your country?" the second question was "do you see the research capacity as ready for the application of and development of agricultural biotechnology?" In an attempt to answer these questions, respondents were given a range of 'one to five' with one being the "low or no research capacity" and "not ready for biotechnology application" respectively; five indicated "high research capacity" and ready for the development and application of biotechnology" respectively. Figure 4 shows the accumulated average response from Burkina Faso, Ghana, Malawi and South Africa with regards to the state of research capacity and the application of agricultural biotechnology.

At this level, respondents from all countries apart from South Africa considered the research capacity of their country very low and had no hopes of being ready or suitable for the application of agricultural biotechnology. This is similar to the results of [22] in his research. At the same time, respondents from Burkina Faso, Ghana and

Malawi revealed that, the country lack funds to support R&D in the country and that, very little no funds of the nation's GDP is allotted for agricultural development. There exist lack of public and private investment in agricultural research and development in all three countries. However, a respondent in South Africa stated that, though about 5% of the nation's GDP is apportioned for agricultural development, and the research capacity seem to be ready for further application and development of agricultural biotechnology, it still doesn't go a long way to give 100% support to agricultural development and research.

In the third part of the interview, respondents were asked to answer questions related to the challenges associated with adoption and use of GMOs and the roles various policymakers play in this regard. The common issue identified in all four countries with regards to the adoption and use of GMOs includes perceived health risk, environmental risk, ethical concern, and strict biosafety regulations. In Burkina Faso a distinctive problem identified was the issue of shortened and light fiber of Bt cotton as compared to the heavy and long fibers of the conversional means. Figure 5 gives an aggregated

explanation to the results. The results further revealed that, all four countries have stringent biosafety regulations that prevent the commercialization of most of GM crops and foods that could be beneficial to the people of the nation. Apart from South Africa and Burkina Faso, the remaining countries are still in the field test and trial stages, awaiting for confirmation and approval from the biosafety committees. Even in Burkina Faso and South Africa, there are ongoing field test and trials for many GM foods. Most respondents from Ghana and Malawi viewed GMO to have higher health and environmental risk and believed it infringes on the ethics of the nation's culture. Nonetheless, respondents from Burkina Faso and South Africa mainly viewed biotechnology as an instrument to bring solutions to problems arising in the agricultural industries which the conversional method cannot solve. They believe this new biotechnology may improve food security and that; it wouldn't pose any serious health and environmental risks, since it has been tried and tested severally. Many respondents in all four countries however opined that, ethical concern in the nation is very crucial with regards to the use of GMOs. Most of them aren't happy with the current strict biosafety regulation in the country.

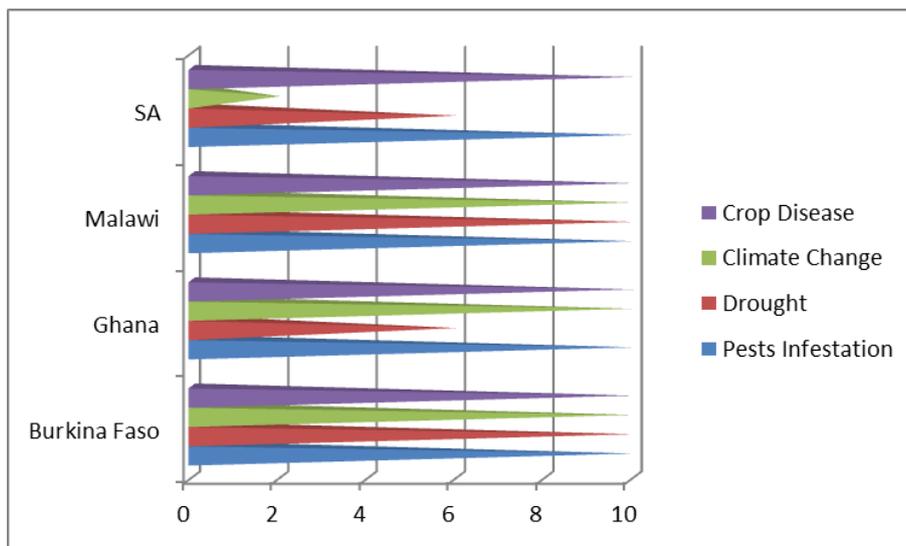


Figure 2. Various domestic agricultural problems

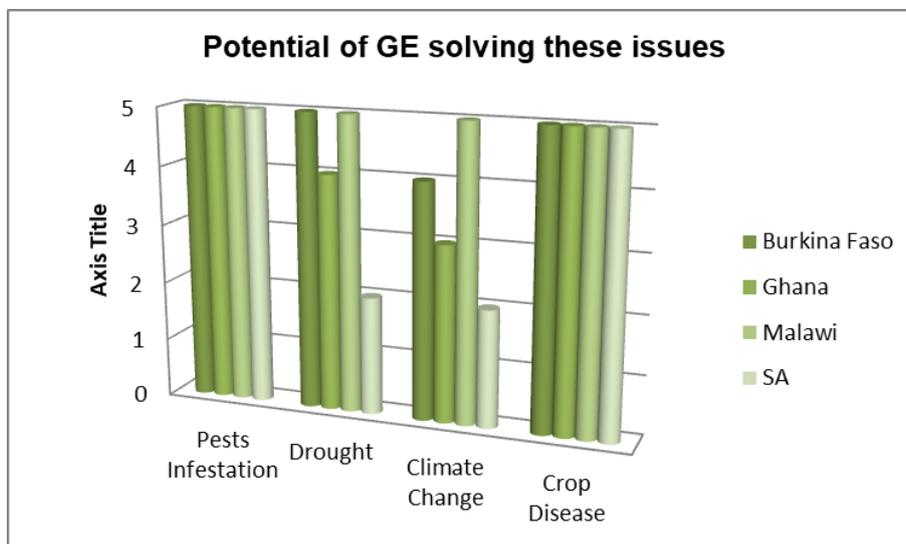


Figure 3. Potential of GE for solving these issues

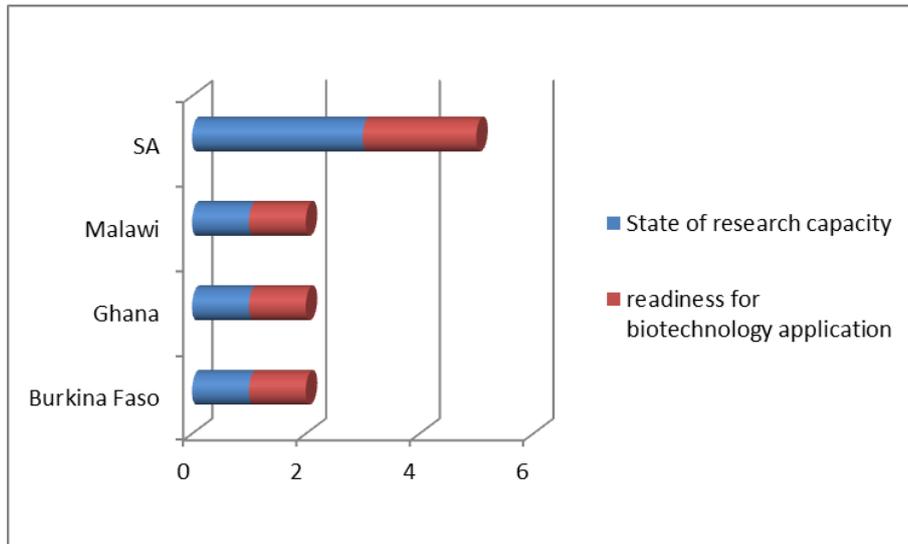


Figure 4. Research capacity and readiness for agricultural biotechnology application

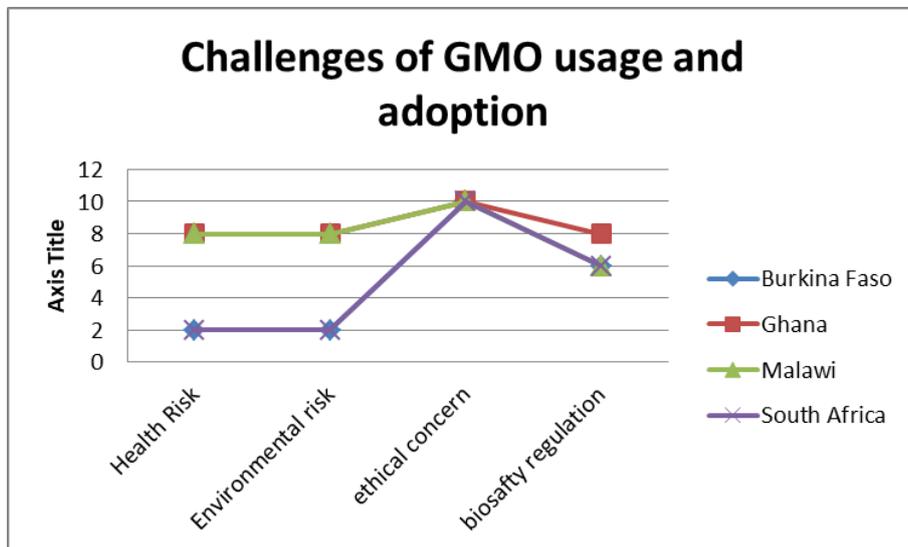


Figure 5. Perceived challenges associated with the use of GMO

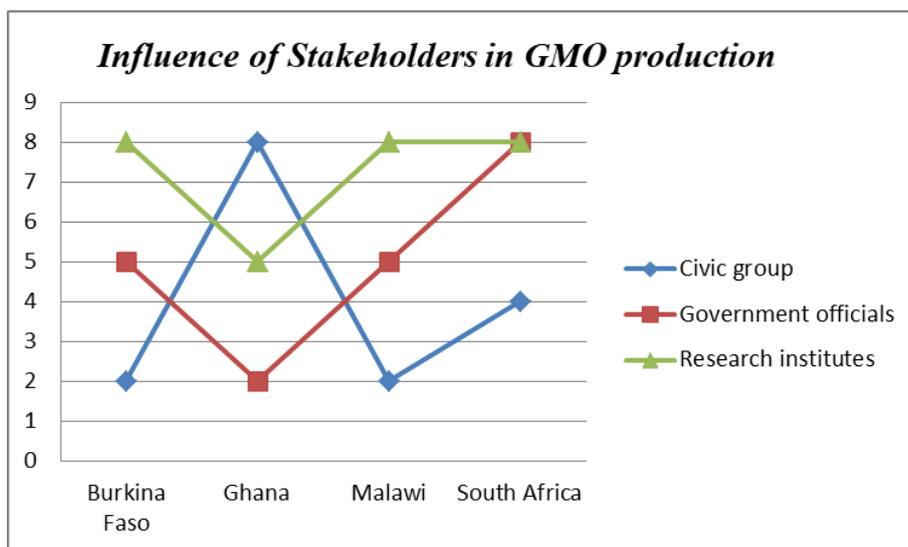


Figure 6.

On the subject of roles played by relevant policymakers or stakeholder groups in this regard, it was observed in Burkina Faso that, most respondents from civic groups

and some academic institutions as well as some government institutions concerned with environmental and social issues had negative opinion predominantly against GMO.

They had relatively lower influence in the issue of biotechnology adoption in the country. Respondents from research institutions and other scientific institutes strongly supported the use of GMOs since they believe it is capable of bringing solutions to the agronomic problems at hand. They had a relatively higher influence in the commercialization of GM crops in the country. Government officials and business groups were indifferent. They viewed the use of GMO as not life-threatening and nearly favorable with a medium influence rate. A similar observation was made in Malawi. Unlike in Ghana, respondents revealed that civic interest groups and academia strongly stand against the commercialization of GM food in the country. They have a high influence in the decision process. Unlike Burkina Faso where research and scientific institutes strongly influence the commercialization of GM crops, institutions in Ghana have less influence in that regard. Government officials and business groups like Monsanto have medium influence in this decision process. In South Africa, a few respondents from civic interest groups and other government institutions which support environmental protection strongly stand against the use of GMO in the country. Nevertheless, their influence is pretty much low. However, respondents from research institutes viewed GMO to provide adequate solutions to the numerous rising problems of agriculture and so do the government workers. These revelations affirm the research results of [23] and [22] in their researches. On a scale of one to ten, with one indicating a low influence and ten indicating a high influence, Figure 6 shows the aggregated accumulation of the general responses gathered on the role and influence stakeholders and policymakers play the issue of GMO production.

3.2. The Influence of Foreign Bodies and Pressure Groups in the Issue GMO in Sub-Sahara Africa

The issue of Agricultural biotechnology acceptance in SSA has drawn the attention of many multinational bodies. Some of these parties propagate the acceptance of this modern technology; others have a strong stance against its adoption. The African Union-New Partnership for Africa's Development initiated an approach that would ensure effective biotechnology and biosafety regulatory assessment procedures in the region. It is an effort geared towards maximizing the advantage of GE crops to promote economic growth and development. [24]

More so, the Alliance for a Green Revolution in Africa (AGRA) initiated the green revolution agenda that aims at integrating into corporate chains for export and promoting the growth of commercial small scale farmers which in turn lead to an increase in economies of scale over time [25]. Many other organization have highlighted it very crucial for policymakers and government of SSA countries to approve the commercialization of GM food and crops; and that it is vital to tackle the barriers to access this modern technology by evaluating and testing GMOs enthusiastically [26].

Other organization such as Greenpeace and Friends of the Earth International intensely accentuate their stance against GMOs. They argue that, the risk associated with

GMOs far outweighs the benefits derived from it to uneducated farmers; they further conduct campaigns and workshops against the arrangement of GM technologies in many SSA countries. [27] In as much as there may be some risks involved with the use of GMOs, the use of conventional crops isn't any better either. The influence of foreign bodies and international pressure groups play a vital role in this topic of discussion. More often than not, policymakers and stakeholders in SSA tend to be in a dilemma as to the messages about the suitability of GMOs in a national perspective [28].

3.3. Policy Implication for Biotechnology Researcha ND Development in Sub-Saharan Africa

The study proves that, in as much as there is advancement in public research in Sub Saharan Africa, different policies in these countries deters further advancement of this research [2]. Testing and commercialization are being held up by biosafety regulatory processes and the expertise that would have provided the necessary important information sharing and exchange opportunity is hindered by various organizational and customary obstacles [29]. The findings suggests that, to unearth the full potential of this modern technology, it is necessary to update or implement new policies since the existing policies are inadequate relative to the needs and requirements needed to explore the advantages of this modern Biotechnology.

Therefore, there's the need to create an effective capacity building in research development such that the efficacy of electronic biotechnology research would be enhanced in SSA [30]. This method will further improve the movement of data sharing between policymakers and research scientists in the region by reducing redundancies and eventually upsurge regulatory proficiency and reduce the cost of R&D [31].

Opposing GM campaigns make statesmen and policymakers hesitant to progress biosafety legislation or take decisions towards the release of biotechnologies [32] hence to advance the level of research on agricultural biotechnology and GM crops and food, it is important to introduce certain tactics to collective research such as heightening for the public sector to take a strong position in public negotiation or to even promote public interest by providing intellectual property donations for scientific research [33].

Moreover, an effective collaboration between public and private ventures will advance as commercial entities which are intended to implement a public interest research program. This will give it a touch of sovereignty and administration which are traits from the private and public areas [34].

Another important factor is that, to enhance biotechnology product development, commercialization and business capacity in SSA there ought to be greater financial commitment. Therefore this whole process demands resolute efforts by all policymakers and stakeholders via an efficient collaborations and partnership [35]. Mostly the central governments are expected to play a major role in harnessing coordination and regulation.

4. Limitation

Though the survey results proved that, many people in those four countries believed that agricultural biotechnology had the potential of solving many arising problems in agriculture, there also exist concerns about the possible negative impacts of this food on the environment and health as well as the fear of potential abuse of the technology in future. This research briefly talked about the potential of GMO solving a small part of the agronomic problems in agriculture (Pest infestation and crop disease). Future research can delve deeply into how genetic engineering can provide solutions to non-agronomic problems such lack of R&D investment, market for the products and infrastructure. This will go a long way to resolve the misunderstanding of the use of GMO in developing countries. Also, there was difficulty in communicating with respondents in Burkina Faso since the national language of the country is French and that of the researchers is English. Due illiteracy issues, some local farmers had their interview in their local dialects which were later interpreted. Also, due to the busy schedule of many relevant stakeholders and respondents, it was difficult to get hold of them to be interviewed.

5. Conclusion

From an overall perspectives of the findings, it is revealed that majority of the respondents showed a realistic opinion about the possibility of genetic engineering solving the rising agronomic problems and other natural factors in the agricultural sectors. It was viewed that, these countries have different perspectives of agricultural biotechnology due to their different economic level, political history and status and cultural and ethical values. Nonetheless, agricultural biotechnology have has proven beyond odds that it could greatly enhance agricultural productivity and therefore has the potential to contribute a great deal of socio-economic advantages to the African region [1]. Many SSA countries are challenged with food insecurities, affected by climate changes and various biotic and abiotic limitations lead to an overall decline in agricultural productivity and these factors could be alleviated through the use and application of this new technology. However, the existing unfavorable agricultural biotechnology development policy and extreme precautionary regulatory policies coupled with inadequate human, institutional and infrastructural capacity for biotechnology research deters the development, adoption and commercialization of GM crops and foods.

The study results are consistent with arguments made by [29] and [36] in their respective researches. The adoption of GMO in many SSA countries is challenged by stringent biotechnology regulations and policies.

Hence it is important for government and stakeholders to give a second thought to biotechnology development policy and biosafety regime. This would help create an empowering socio-political atmosphere for the development and disposition of this novel agricultural biotechnology.

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