Journal of African Interdisciplinary Studies (JAIS): **ISSN 2523-6725** (online)
February 2025 Vol. 9, No. 2
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Dynamics of Climate Change and Genetically Modified Crops and Implications on Food Security in Kenya: Perception, Awareness, and Knowledge in Embu County

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Abstract

The purpose of this article is to examine the dynamics of climate change and genetically modified crops and implications on food security in Kenya, with special references to Embu County, with the view of interrogating issues of perception, awareness, and knowledge in the local community. One of the most promising solutions for increasing crop yields in the face of climate change is through biotechnological research on genetically modified organisms (GMOs). However, in Kenya, the adoption of GMOs has been slow, likely due to differing perspectives on their benefits and drawbacks, as well as concerns regarding their safety for consumption. To better understand the current state of climate change and food insecurity in Embu County, Kenya, a study was conducted to shed light on the contrasting perceptions, levels of awareness, and knowledge among the local population. The study aims to identify effective strategies for engaging the public in decision-making and problem-solving related to these pressing issues. Through this research, we hope to contribute to the development of sustainable agriculture practices that can improve the livelihoods of farmers in Kenya and beyond.

Keywords: Climate Change. Genetically Modified Foods, Food Security

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Background

The World Food Programme (WFP) report of 2021 reveals a concerning fact that over 800 million people worldwide are facing food insecurity due to the adverse impacts of climate change, with a staggering one-third of the total number located in Africa. This is a critical issue that needs immediate attention as there is a growing concern that the current levels of agricultural production may not be sufficient to meet the needs of the increasing global population. While this paints a gloomy picture, there is still some hope in modern biotechnological techniques that have evolved to address the issue of food insecurity. These techniques include genetic engineering, precision agriculture, and bioremediation, among others. A majority of these techniques are aimed at mitigating the effects of food insecurity, as noted by Sefater et al. (2021). Therefore, it is essential to explore and harness the potential of these biotechnological techniques to ensure food security for everyone.

Climate change refers to changes in the average conditions of temperature and rainfall over a long time and is connected to food security in the sense that it has adverse effects on food production systems (Islam & Wong, 2017). Food security encompasses four dimensions: food availability, food accessibility, food utilization, and food systems stability (Sasson, 2012). GMOs are plants, animals, microorganisms, or other organisms whose genetic makeup has been modified in a laboratory using genetic engineering or transgenic technology (FAO, 2011, Non-GMO Project, 2016).

One of the nascent biotechnological techniques to mitigate climate change and food security is the use of genetically modified organisms (GMOs) to produce crops that have higher yields, resistance to pests and diseases, and enhanced nutrient composition. Although stagnating food crop yields make GMO technology imperative in Africa, particularly in Kenya, contrasting views about the benefits and safety concerns associated with it have made its acceptability very challenging. In Kenya, the government developed a working policy document (NCST, 1998) and passed a biosafety bill in parliament in 2009.

The law puts in place a rather stringent regulatory framework making the commercial production of GM products possible. The law was the result of a robust debate involving the government represented mostly by the Ministry of Science and Technology, the Ministry of Agriculture, members of parliament (MPs), nongovernmental organizations (NGOs), the scientific community including both public and private research institutes and universities, and civil society. The government and the scientific community were strong proponents of the bill, whereas many NGOs and civil society, supported by some MPs, were strong opponents. However, the proponents prevailed with the eventual passage of the bill.

Currently, the status of genetically modified (GM) crops in Kenya is in the development stage, with research and trials being conducted in contained laboratories and greenhouses. Ongoing research activities are focused on incorporating traits for insect resistance in maize, cotton, cassava mosaic disease, and viral disease resistance in sweet potato. These traits are being introduced through genetic modification to improve crop yields and reduce the use of harmful pesticides. The research is being conducted in a safe and

controlled environment to ensure that GM crops are safe for both human consumption and the environment. The trials are being carried out with the utmost care and attention to detail to ensure that the crops meet the necessary regulatory guidelines before they are released for commercial production.

In Kenya, food insecurity is a major issue, and consumers must focus on obtaining an adequate quantity of food, rather than worrying about the perceived risks associated with genetically modified (GM) products. While previous studies have largely concentrated on the opinions of urban consumers who are not typically producers, it is essential to delve into the viewpoint of food crop producers, who are both producers and consumers. To gain a comprehensive understanding of their stance on GM crops, further research is necessary. This research can provide valuable insights into the opinions of food crop producers and help in developing policies that address food insecurity and ensure a sustainable food supply in Kenya.

Statement of the Problem

Kenya has been grappling with the serious challenges of climate change and food insecurity, which have impacted the majority of its population. In this context, there have been growing concerns about the use of genetically modified organisms (GMOs) as a solution to these problems. In November 2018, several organizations, including the Route to Food Initiative, Kenya Biodiversity Coalition, Africa Biodiversity Network, and Greenpeace Africa, jointly issued a statement expressing their concerns over the Kenyan government's decision to allow GMOs in the country without proper public input. The organizations called for a more inclusive approach to addressing the issue of GMOs in Kenya.

Given the urgent concerns around food insecurity and the ever-increasing population in Kenya, it is imperative that the country adopts innovative and technological approaches to enhance agricultural productivity. To this end, a comprehensive analysis of the current state of food insecurity in Kenya is necessary. The study aims to reconcile divergent attitudes, perceptions, and knowledge regarding GMOs and their potential to alleviate the crisis. This analysis will take into account the social, cultural, economic, and political factors that shape the discourse around GMOs in Kenya. The study will also explore the potential of other, non-GMO-based solutions to food insecurity, such as agroecology and sustainable farming practices. Ultimately, the goal of this study is to provide useful insights and recommendations to policymakers, stakeholders, and the public on how to address the complex challenges of food insecurity in Kenya.

Objectives of the Study

The study aimed to delve into the views, beliefs, and comprehension of genetically modified organisms (GMOs) in addressing the challenges posed by climate change and food insecurity in Embu County. It focused on gaining a better understanding of the perceptions and attitudes of the local population towards GMOs, and to enhance our knowledge of how they can be used as a tool to alleviate these pressing issues. More specifically, the study sought to:

1. Establish the nexus between GM food crops and climate change and food security.
2. Bring to the fore the polarised perceptions, attitudes and knowledge on GM food crops in mitigating climate change and food insecurity in Embu County.
3. Generate practical suggestions for a comprehensive policy agenda for the uptake of GM food crops as a stopgap measure for mitigating climate change and food insecurity in Kenya.

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Research Questions

The research will be guided by the following questions:

1. What is the nexus between GMOs, climate change, and food insecurity?
2. Are GMOs adequate in mitigating climate change and food insecurity in Embu County?
3. What lessons and suggestions could be offered for the policy agenda for the uptake of GMOs as a stopgap measure for mitigating climate change and food security in Kenya?

Significance of the Study

Three crucial reasons make this study imperative.

The pressing issue of climate change in Africa and beyond has sparked discussions on how African nations can address recurring droughts and food shortages. A key topic at the 27th session of the United Nations Framework Convention on Climate Change (UNFCCC - COP 27) held in Egypt from November 6 to 20, 2022 was the use of GMOs as a potential solution to these challenges. Participants, including both government and non-governmental representatives from African countries, were urged to work together to combat the global issue of climate change.

Climate change has a profound impact on all aspects of food security, affecting food availability, accessibility, utilization, and the stability of food systems. Its impacts are diverse, ranging from short-term effects, such as frequent and extreme weather conditions, to long-term effects resulting from changing temperatures and precipitation patterns. One of the most pressing issues facing Kenya today is the recurring droughts and famines brought on by unprecedented weather conditions. As a result, the government has deemed it necessary to implement a comprehensive strategy to address the immediate and long-term effects of climate change on food security. T

The topic of how to mitigate climate change and food insecurity is of utmost importance. Yet, there has not been enough discussion on how to achieve this goal, even though the suitability of GMOs has been a prominent issue among both state and non-state actors. Therefore, there is a pressing need for a systematic exploration of the perceptions, debates, and prospects on the use of GMOs to address the issues of climate change and food insecurity. This exploration should also examine how GMOs can help enhance food availability, accessibility, utilization, and stability in Kenya.

The Study Area

Embu County is a region situated in the southeastern part of Kenya, bordered by Tharaka-Nithi County to the north, Kitui County to the east, Machakos County to the south, and Kirinyaga County to the west. The county covers an area of about 2,555 square kilometres and has a population of approximately 600,000 people. Agriculture plays a crucial role in the economy of Embu County, with the majority of the population relying on farming as a source of livelihood. The county is blessed with fertile soils and favourable climatic conditions, which support the cultivation of various crops. The main food crops grown in the region include maize, beans, potatoes, sweet potatoes, sorghum, cassava, and millet. These crops are not only consumed locally but also exported to other parts of the country. In addition, Embu County is known for its production of high-quality cash crops such as coffee, macadamia

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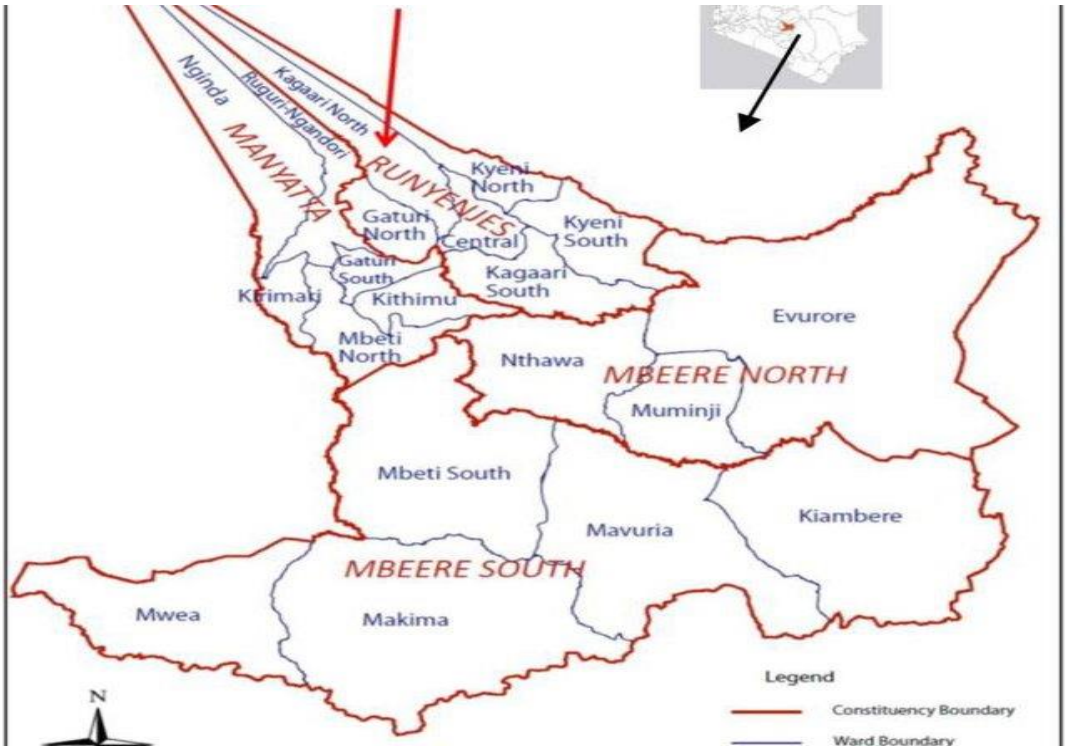
nuts, sunflower, tobacco, *muguka* (qhat), and cotton. These crops are a significant source of income for the farmers and contribute significantly to the economy of the county.

Embu County is one of the 47 counties in Kenya and is located in the eastern part of the country. The county has a population of over 500,000 people, and agriculture is the mainstay of the county's economy and the livelihood of the people. The sector employs over 70 per cent of the population, and 88 per cent of the households are engaged in agricultural activities. The county covers a total area of 2,818 sq. km and is divided into four constituencies, namely; Runyenjes, Manyatta, Mbeere South, and Mbeere North.

Manyatta and Runyenjes sub-counties are agriculturally productive areas, while Mbeere North and Mbeere South sub-counties are largely semi-arid. The county mainly relies on coffee, tea, macadamia, miraa, tobacco, and cotton as the main cash crops, while the main food crops are maize, beans, cowpeas, green grams, bananas, sorghum, tomatoes, pawpaw, avocado, and citrus fruits. Horticulture and dairy farming are widely practised as a source of food and income.

Despite having enormous potential to produce enough food, many farmers in Embu County are still vulnerable in terms of food security. The county government, in collaboration with various organizations, has been implementing various initiatives to improve food security, such as providing farmers with agricultural inputs, improving irrigation infrastructure, and promoting value addition to agricultural products. The county has also been promoting the adoption of climate-smart agriculture practices to mitigate the effects of climate change on agriculture.

Map of Embu County



Source: Embu County Government, Kenya, 2025.

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Review of Related Literature

This literature review analyzes the interplay between climate change, genetically modified (GM) crops, and food security in Kenya. It provides an examination of existing research concerning the impact of climate change on agricultural productivity, the role of GM crops in addressing food insecurity, public perceptions and awareness of GMOs, and the regulatory framework governing their adoption. By investigating these dimensions, this review seeks to offer a comprehensive understanding of both the challenges and opportunities associated with integrating GM crops into Kenya's agricultural landscape.

Climate Change and Its Impact on Food Security

Climate change is one of the most significant threats to global food security, particularly in Sub-Saharan Africa. Studies indicate that rising temperatures, unpredictable rainfall patterns, and extreme weather events negatively affect agricultural productivity (IPCC, 2021). Kenya, which relies heavily on rain-fed agriculture, has been experiencing prolonged droughts, floods, and pest infestations, reducing crop yields and threatening livelihoods (Njoka et al., 2016). These climatic challenges necessitate innovative agricultural technologies, including the adoption of Genetically Modified (GM) crops.

Genetically Modified Crops and Their Role in Food Security

Genetically Modified (GM) crops have been introduced as a solution to improve food security by enhancing crop resilience against biotic and abiotic stresses. Research shows that GM crops, such as Bt maize and drought-resistant varieties, have potential benefits, including higher yields, reduced pesticide use, and better adaptability to climate change (Karembu, Nguthi, Ismail, 2009; James, 2020). In Kenya, the government lifted the ban on GMOs in 2022 to address food shortages, but the implementation has faced resistance due to socio-political and ethical concerns (Ogola, Mwanzia, & Mutuku, 2023).

Perception, Awareness, and Knowledge of GM Crops in Kenya

Public perception and awareness of GM crops significantly influence their adoption. Studies show that Kenyan farmers and consumers have mixed opinions about GMOs (Wafula, Karembu, & Ngugi, 2022; Ogola, Mwanzia, & Mutuku, 2023). While some recognize their potential to mitigate food insecurity, others fear health risks, environmental concerns, and corporate control over seeds (Wambugu et al., 2019). Limited access to reliable information and misinformation from stakeholders, including media, policymakers, and advocacy groups, contribute to uncertainty. Research suggests that increased public education and transparent regulatory frameworks are necessary to foster informed decision-making regarding GM crops (Kimenju & De Groote, 2008).

Policy and Regulatory Environment

Kenya's biotechnology policy has evolved, with the Biosafety Act (2009) establishing the National Biosafety Authority (NBA) to regulate GMOs. However, the inconsistent government stance on GMOs—ranging from bans to approvals—has created confusion among farmers and stakeholders (Wafula, Karembu, & Ngugi, 2022). Strengthening regulatory policies and aligning them with climate adaptation strategies can enhance food security while addressing public concerns.

Conclusion

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The intersection of climate change, GM crops, and food security in Kenya is a complex issue requiring scientific, policy, and societal engagement. While GM crops offer promising solutions, addressing knowledge gaps, improving public awareness, and ensuring a balanced regulatory framework are crucial for their successful integration into Kenya's agricultural landscape.

Methodology

The research study in question employed a mixed-method approach, which involved exploratory and survey designs. The exploratory design involved conducting a thorough review of the literature on the subject matter, to obtain knowledge on local, regional, and global initiatives in the use of biotechnology and genetic engineering to mitigate climate change and food insecurity in Africa. The survey design, on the other hand, was utilized to identify samples for interviews, formulate research questions, and methods of data collection. The practical design of the study included elements of participatory appraisals, in which individual interviews yielded valuable opinions and perceptions on the dis/advantages and trade-offs associated with un/willingness to consume GM crops.

The researchers conducted a semi-structured questionnaire survey on 45 farm households, 90 farmers, and 30 consumers who were interviewed. Additionally, key informant interviews were conducted with 10 agricultural extension officers. During these interviews and questionnaires, the researchers focused on three main areas of inquiry. Firstly, the assessment of public perceptions, attitudes, and knowledge about GM products was carried out. Secondly, an investigation of consumers' willingness to use GM foods was conducted. Finally, the researchers aimed to identify the factors that influence consumers' attitudes and perceptions towards GM foods.

Overall, this study was a comprehensive exploration of the complex factors that influence public perceptions and attitudes towards GM foods in Africa. The mixed-method approach employed allowed for a thorough investigation of the research questions, and the use of participatory appraisals ensured that individual opinions and perspectives were fully taken into account.

Data Collection and Analysis

During January and March 2023, field research was conducted in the Runyenjes and Manyatta constituencies of Embu County. The research was aimed at collecting data from a variety of sources, including farmers, consumers, and agricultural extension officers, to better understand the awareness and perception of biotechnology and GM crops in the area.

To achieve this, a total of 12 agricultural extension officers were interviewed face-to-face, with 10 key informant interviews conducted to gather more information on their understanding of these concepts. Additionally, data was collected from 50 households, with 90 farmers and 40 consumers interviewed on their awareness and understanding of biotechnology and GM crops.

To assess the level of knowledge and perception of these concepts, respondents were asked whether they had heard or read about biotechnology and GM crops in general. Those who had indicated awareness and understanding of these concepts were then asked to either agree or disagree with follow-up statements related to GM crops. Respondents who had heard about GM technologies were also asked about their major sources of information and whether they shared information on GM crops with family, neighbours, and others.

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The responses gathered from these interviews were analysed using descriptive statistics to better understand the level of knowledge and perception of both farmers and consumers in the area. Overall, the research aimed to provide a comprehensive understanding of the current attitudes and perceptions towards biotechnology and GM crops in the Runyenjes and Manyatta constituencies of Embu County.

Data Collection Strategies

Key Informants Interviews

Interviews with key informants showed indications that commercialization of GM crops in Kenya is the ultimate aim, informed by anticipated benefits that are seen as capable of addressing looming food insecurity. Much progress has been made in the development of a GMO regulatory and institutional framework to manage research, development and release of GM crops in Kenya. However, they expressed concern over widespread negative perceptions tied to GMOs in the country which may affect commercialization of GM crops.

Sources of Information for Informants

Farmers and consumers are two groups that are actively seeking information on genetically modified (GM) technology. According to a recent survey, farmers primarily rely on various sources for their information on GM technology. These sources include newspaper articles (8%), extension officers (15%), radio (25%), television (18%), and other channels (20%). On the other hand, consumers mostly receive their information on GM technology from newspapers (12%), extension officers (10%), radio (30%), and television (33%). Both farmers and consumers seek information from diversified sources to ensure that they are well-informed about genetically modified technology.

Survey on Farm Households

According to a recent study, it was found that at the community level, only a quarter of the respondents were aware of GM crops before the study was conducted. Moreover, only a handful of people could accurately describe GM crops in simple terms. However, it was encouraging to note that 80% of the participants believed that GM technology had the potential to positively impact the food supply. The respondents indicated that they would like GM technology to address issues such as increased yields, reduced diseases and pests, and increased drought tolerance.

Furthermore, the study also revealed that a majority of the consumers (84%) preferred foods that would enhance nutrients such as carbohydrates, proteins, vitamins, and oil. This indicates the importance of addressing the nutritional aspect of GM crops to cater to the needs and preferences of the consumers. Overall, the study highlights the need for effective communication and education about GM technology to enhance awareness and understanding among the general public.

Findings and Discussion

Community attitudes and perceptions of GM crops

The study in question analyzed the viewpoints of respondents on the benefits and risks of genetically modified (GM) products, with a particular focus on the environmental and health impacts associated with the use of GM technology in food production. To obtain these insights, the respondents were presented with several statements, and they were asked to agree or disagree with them using a five-point Likert scale.

The findings of the study show that a significant proportion of community respondents, specifically 60%, held negative perceptions about the use of GM technology in food production, arguing that it is not natural. Additionally, 55% of the respondents expressed concerns about the potential loss of indigenous crops and biodiversity that might result from the use of GM products.

Furthermore, the study revealed that 23% of respondents were worried about the health risks associated with GM products, such as immune suppression, loss of nutrition, and antibiotic resistance. Overall, the study provides valuable insights into the attitudes and perceptions of the community towards GM technology and highlights the need for further research and education to address the concerns raised by the respondents.

Implications of the Results

The results of the study hold paramount importance for the agricultural sector. Genetically modified (GM) technology, in conjunction with appropriate policies, strategic partnerships, efficient regulatory systems, and effective communication, has the potential to make a significant contribution towards improving crop productivity, enhancing the livelihoods of farmers, and ensuring environmental sustainability.

The successful placement of GM crops in the market will depend on consumer expectations and demands. The adoption of GM technology by farmers and the consumption of GM food by consumers will be contingent upon their acceptance of the technology.

To ensure public acceptance of GM crops, it is crucial to raise awareness amongst the public. This awareness should be focused on the safety of GM crops with regard to food security and health. Additionally, ethical issues such as the impact on the environment, traditional farming practices, and the perceived 'unnaturalness' of the technology should be addressed.

It is also important to keep in mind that the adoption of GM crops by farmers and consumers will depend on the perceived benefits of the technology. Therefore, it is crucial to communicate the potential benefits of GM technology, such as increased crop yields, reduced use of pesticides, and enhanced nutritional value of crops.

Furthermore, it is necessary to establish a robust regulatory framework for the development and deployment of GM crops. This regulatory framework should ensure that GM crops are safe for human consumption and the environment.

Conclusion

The study highlights the critical need to enhance public awareness and acceptance of genetically modified (GM) technology. This objective can be pursued through effective communication strategies, well-defined policies, strategic partnerships, streamlined regulatory systems, and by clearly presenting the potential benefits of GM technology for farmers, consumers, and the environment.

Recommendations

As GM crops such as insect-resistant maize and cotton, mosaic-resistant cassava, and viral-resistant sweet potatoes have already been released in Kenya, it is now more important than ever to educate the public about this technology. The focus of this education should not only be on the safety of GM ingredients in food for human consumption but also on the ethical concerns surrounding the technology. Specifically, it is crucial to address the potential impact

of GM technology on the environment, traditional farming practices, corporate dominance, and the perceived "unnaturalness" of the technology.

Furthermore, there are multiple regulatory bodies with mandates that overlap, which could potentially create conflicts when it comes to governing GM technology. Therefore, it is essential to synchronize the mandates of these regulatory bodies to avoid any potential conflicts that may arise.

In addition, raising awareness about GM technology in Kenya is necessary to contribute to maintaining and improving food security. However, it is equally important to address concerns and regulate the technology properly to ensure its safety and sustainability.

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