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Public knowledge, attitude and perception on safety of Genetically Modified Products: A case study of Kiambu County in Kenya

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Abstract
Genetic Modification (GM) - the process of deliberately and skillfully transforming the genome of an organism isolating, inserting or altering the DNA segments of interest to introduce new traits, suppress or eliminate the undesirable traits. The approval, adoption and global commercialization of the GM technology is riddled with intense and emotional debates driven by lack of basic knowledge of the technology, media hype and pseudo-science interpretations of the benefits and the perceived risks. This has potentially affected knowledge acquisition, perception, and attitude among the society on the safety of GM foods, feeds and products. This study intended to determine the knowledge levels, perception and attitude among a diverse population of Kiambu County in Kenya on the safety of GM products. The study was carried out in Kiambu county of Kenya, a high potential, industrial, mixed farming and a metropolitan County, bordering Nairobi, Muranga and Machakos. The study aimed at determining the attitude, perception and knowledge of rural and urban dwellers in the County. The target groups were, smallholder farmer in Limuru, Kikuyu, North and South Gatundu (the main producers of food crops in the upper highland regions), the urban dwellers from Thika and Kiambu towns and the scholars from the Universities and tertiary institutions in Kiambu county. The study used a semi-structured questionnaire administered to 401 farmers in both rural and urban areas of Kiambu County. The results indicate that age, access and dissemination of information and potential benefits are most likely to influence the acceptance of biotechnology by Farmers. Major concerns expressed were health and environmental risks, lack of market for the GM products both locally and internationally and government ability to protect them from GM negative effects. Farmers perceived that high risks outweighed the potential benefits addressed by the GM technology. Data was analyzed using the statistical Package for Social Scientists (SPSS) Version 20 (IBM. Inc). The interpretation involved descriptive and inferential statistics. The findings are important in assisting policy makers and development organizations to design proper communication strategies for farmers when promoting biotechnology.

Keywords: *Genetically modified foods, Farmers, Attitude, Perception Kiambu County.*

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I. Introduction

Genetic engineering (GE) refers to the process of deliberately modifying the genome of an organism by isolating, inserting or altering the DNA segments of interest to introduce new traits and or to suppress or eliminate the undesirable ones (Winston, 2002). The organism obtained through the GE techniques is referred to as the genetically modified (GM) organism, which is inclusive of plants, animals, and microorganism (Winston, 2002; Bauer and Gaskell, 2002). GM crops include the pest-resistant cotton, maize, and Bt canola, herbicides tolerant crops such as glyphosate-resistant soybean, corn and cotton, glufosinate ammonium tolerant among others. Other biotechnology crops are viral disease resistant squash, potatoes, and papaya.

The debate on the GM foods has proven to be far-reaching and complex with many issues and involvement of diverse stakeholders. The controversies are attributed to the perceptions of risk and benefits and their influences on the decision-making, behaviour, and attitudes of both producers and consumers (Frewer et al., 2003; Finucane and Holup, 2005; Lobb et al., 2007).

The GM technology debate is pertinent with conflicting claims and subsequent counter-claims on the potential benefits and risks. In most countries, especially the developing countries, for instance, in Kenya, the advocates of GM foods and feeds have been frustrated by the consumer and public choices based on the perceptions of risks, which may have little or no resemblance to the actual risks posed by the GM products. Environmentalist, non-governmental and consumer organizations have expressed concern relating to the safety

of GM foods and feeds, which are based on religious, environmental, religious and consumer's choice due to inadequate labelling (Verdurme and Viaene, 2002). GM food safety assessment is a requirement in the European Union (EU) prior to the introduction of the product into the market. Similarly, continual post-market monitoring is compulsory to eradicate instances of unexpected risks to the public health and the environment. In Africa, South Africa is the only country with legal authorization to grow commercial GM crops (AfricaBio, 2003).

Consumer perception and attitude surveys on GM foods have been conducted in many countries such as US, EU and Canada and those with restrictions such as Japan and Philippines. Sub-Saharan Africa countries have diverse views on GM foods. Notably, Zambia accepts GM foods where all seeds should milled prior to importation into the county - an indication that the controversies are not on the food safety but on environmental release (Leahey, 2013).

Public perception studies indicate that most of the American consumers do not have knowledge on the availability of GM foods in supermarkets and most consume GM foods without realising (Hallman et al., 2003). The public debate on the direction biotechnology regulation should take has for a long been characterized by protests which eventually died down and formulation and implementation of industry friendly regulations without an incident (Gaskell et al., 2002).

Kenya has the research and development capacity to produce GM crops, which has been facilitated by technical cooperation with Monsanto and Syngenta. For instance, cooperation between Kenyan Agriculture and Livestock Research organization (KALRO) and International Maize and Wheat Improvement Centre (CIMMYT) facilitated the development of stem borer maize, however these crops were destroyed after 3 months at field trial stage (Okigbo et al., 2015). The availability of legal and regulatory framework enshrined in the Biosafety Act of Kenya of 2009 facilitate the establishment of National Biosafety Authority (NBA), a key regulator of all genetic modification activities in the country. This shows that the country is prepared to adopt the GM technology in future. Assessment of the consumer attitude towards the GM foods and feeds is still a new field of the social-scientific studies. Historically, this form of inquiry began in the late 1980s, with the assessment of benefits of various technologies (Hamstra, 1998). Consumer attitude is known to affect individual's intentions to buy and consume any product. Previous studies demonstrate that consumers recognize the benefits of GM foods and feeds, though the purchase intentions remain low due to perceived risks, which eventually outweighs the potential benefits (Muggleston et al., 2000; Saba and Vassallo, 2002).

Conducting a study on attitude, knowledge and perception towards GM technology would affect positively the policies and debate for future development, adoption and consumption of GM foods and feeds in Kenya (Njoka et al., 2011). Therefore, this study investigated the knowledge, perception and attitude of diverse Kiambu County residents on the safety of GM food and feeds.

II. Material and Methods

The Study Design

This was a cross-sectional study employed two non-probability sampling techniques namely convenience and purposive sampling. The convenient sampling procedure is where the researcher issues questionnaires to respondents as they become available for participation while the purposive sampling is where the researcher uses their own judgment to identify respondents for the study.

The study collected qualitative and quantitative data on socio-economic status and individual knowledge levels, attitude and perceptions of GM feeds and foods. Respondents were residents of the rural and urban areas of Kiambu County of Kenya (Figure 1 and 1.1), and interview employed semi-structured questionnaire with open and close-ended questions.

The study area

This study was conducted in Kiambu County, which consists of ten sub-counties namely: Gatundu North, Gatundu South, Ruiru, Thika East, Thika West, Githunguri, Kiambu, Limuru, Kikuyu and Lari. The County covers approximately 2,543.5 square kilometres area of which approximately 1,878 km² is arable land (Ministry of Devolution and Planning, 2013). Rainfall ranges from 600mm to 2000mm and temperatures from 70C to 340C in the upper highlands to the lower midlands, respectively. The County population is estimated to have 1,623,282 by the end of 2017, because of the high population growth rate of 2.81% (Kenya Population and Housing Census, 2009).

The favourable climate makes agriculture the dominant economic activity, which contributes, to 17.4% of the total county's income. The main cash crop grown is coffee, tea and pineapples while maize, beans, Irish potatoes are main food crops, mainly grown in upper highland by small-scale farmers. The most prioritized value chain addition of agricultural products includes the following; cows, chicken and bananas this is attributed to the readily available market and the availability of local food processing factories. Milk production has the highest quantity in terms of livestock production followed by beef, mutton, egg and poultry meat amongst others (Kiambu County Development Profile, 2013).

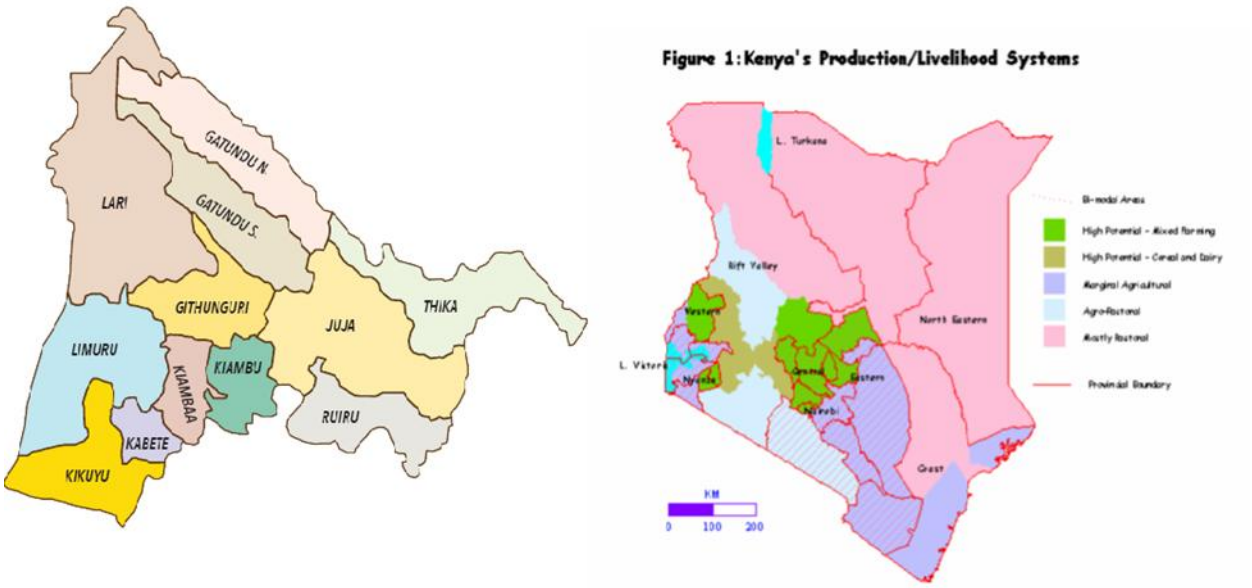

Figure 1.1: Constituencies of Kiambu County and its location in the Kenya's production/livelihood system map (KinuthiaKagai, 2011).

Study Population

Kiambu County is located in the high potential mixed farming regions in Kenya (Figure 1). The study population comprised of small-scale farmers in from Limuru, Kikuyu, North and South constituencies Gatundu, since they are the main producers of food crops in the upper highland regions. The urban study population targeted Thika and Kiambu towns, included Universities and tertiary institutions. The potential respondents were consenting residents in the study areas.

The sample size was determined using the Fischer's formula (Israel, 1992), as follows
n = z2 pq/d2

Where;
n- Is the desired sample size
z- Represents the normal standard deviation at the 95 % confidence interval
p- Represents the proportion in the target population estimated to have the study characteristics. In this case, p was assumed to be 0.5
q- Is 1-p = 0.5
d- Is the margin of error was set at ±5 %, to indicate the precision of the data.

The sample size of 384 was arrived as follows; (1.96)2 (0.5) (0.5)/ (0.05)2. The 384 respondents were statistically adequate since the entire population comprised of more than ten thousand people (Israel, 1992).

Data Analysis

The Statistical Package for Social Scientists (SPSS) Version 2 was used in data analysis according the study themes. The study findings are presented as mean, mode, median and standard deviation and the results rendered in tables charts.

III. Result

Socio-demographic profile of the respondents

The study investigated the following socio-demographic profile of respondents; age, gender, level of education, residential, means of livelihood and size of land as shown in table 1 and 2. Male were the majority constituting 64.1% (n = 257) of the study population, compared to females who were 31.7% (n = 127).

90.5% of the respondents were between 18 to 35 years old, while 9.2% were older than 36. This explains the influx of activities involving active youth in the County. On the marital status, 74.1% of the respondents were not married compared to 22.7% who were married. Almost all respondents had advanced education with 94.3% (n = 378) having University education, followed by secondary education at 4.5% (n = 18),

and primary 1.0% (n = 4). This reflects on the high level of education of the Kiambu residents due to many learning institutions and the nature of the residents drawn from all parts of the country.

On the distribution of the respondents, 82.8% (n = 332) were urban dwellers while 15.2% (n = 61) resided in rural communities of the study area. On the size of land for agricultural production, 36.9% (n = 148) are small-scale holders (< 0.8 ha), followed by medium scale holders (0.9 to 2 ha) at 22.2% (n=89), and then large-scale holders (> 2 ha) at 11.0% (n = 44). The summary of demographic profiles is shown in Table 1.

Table1: Descriptive statistics for the respondents' socio-demographic profiles

Variables	Frequency (%)
Gender	
Female	127 (31.7)
Male	257 (64.1)
Age Group in years	
18 – 25	174 (43.4)
26 – 35	189 (47.1)
36 – 45	32 (8)
46 – 55	5 (1.2)
Above 55	1 (0.2)
Level of Education	
Primary	4 (1.0)
Secondary	18 (4.5)
University	378 (94.3)
Marital Status	
Single	297 (74.1)
Married	91 (22.7)
Widowed	1 (0.2)
Place of Residence	
Urban	332 (82.8)
Rural	61 (15.2)
Size of Land for Agriculture	
Small scale holders (< 0.8 ha)	148 (36.9)
Medium scale holders (0.9 to 2 ha)	89 (22.2)
Large scale holders (> 2 ha)	44 (11.0)
Those without land	120 (29.9)

On what the respondents considered as the main means of livelihood, 49.6% (n = 199) indicated that crop production is extremely important, 33.7% (n = 135) and 29.7% (n = 119) indicated livestock production and trading as very important, respectively. The summary of means for earning livelihoods is shown in Table 2.

Table 2: Descriptive Statistics for the respondents' means for earning livelihood

Variables	Frequency (%)
Crop Production	
Extremely important	199 (49.6)
Very Important	96 (23.9)
Important	27 (6.7)
Not important	38 (9.5)
No response	41 (10.2)
Livestock production	
Extremely important	64 (16)
Very Important	135 (33.7)
Important	84 (20.9)
Not important	43 (10.7)
No response	75 (18.7)

Trading	
Extremely important	84 (20.9)
Very Important	119 (29.7)
Important	90 (22.4)
Not important	46 (11.5)
No response	62 (15.5)

Attitudes and Knowledge towards and for GMOs

In terms of the awareness of the GMOs, 89.3% (n = 358) of the respondents were aware, while a 10.7% (n = 43) were not. The respondents indicated agricultural shows, biotechnology companies, Universities, colleges, books and journals, electronic and print media, agricultural extension officers, public grapevine, newspapers and internet, government sectors on biosafety and phytosanitary measures, seminars and workshops as the sources of information.

In terms of trust to the scientists, 60.3% (n =242) indicated they would trust them to apply agricultural biotechnology appropriately, 37.2% (n = 149) said they would not and a 2.5% (n = 10) of the respondents did not give any answer.

Respondents were further asked the impact of GMOs in their own opinion, 56.9% (n = 228) stated they have a significant positive impact and 37.2% (n = 149) said they have negative impact, while 6.0% (n = 24) did not give any response. The study further investigated the level of awareness by asking whether the respondents knew any farmer growing GMOs in Kenya. 57.6% (n = 231) indicated they are not aware while 38.2 % (n = 153) said they are aware and 18.7% (n = 75) of these respondents specified that GMO maize is grown in Kenya, 8.7% (n = 35) tomatoes and 2.7% (n = 11) bananas, among other crops like mangoes, watermelon and tea.

Further, the study investigated the level of knowledge by asking the respondents to state the agricultural constraints they would like biotechnology to resolve. It was observed that 34.4% (n = 138) of the respondents would want yield potential increased, 28.2% (n = 113) the crops to be drought tolerant and 25.4% (n = 102) both crops and the planting materials be pest and disease resistant. However, 9.0% (n = 36) of respondents did not have any idea on any constraint they would like addressed.

On what GMO crops one would like to consume, 48.9% (n = 196) said maize, 18.5% (n = 74) bananas and 7.2% (n = 29) sweet potatoes. However, 6.7% (n = 27) did not have any choice. On the crop attributes they would like be improved or increased using 41.9% (n = 168) indicated vitamins, 36.9% (n = 148) proteins, 9.7% (n = 39) carbohydrates and 8% (n= 32) oil contents. However, 3.5% (n = 14) did not choose any of the nutrients. This is summarized in Figure 3.

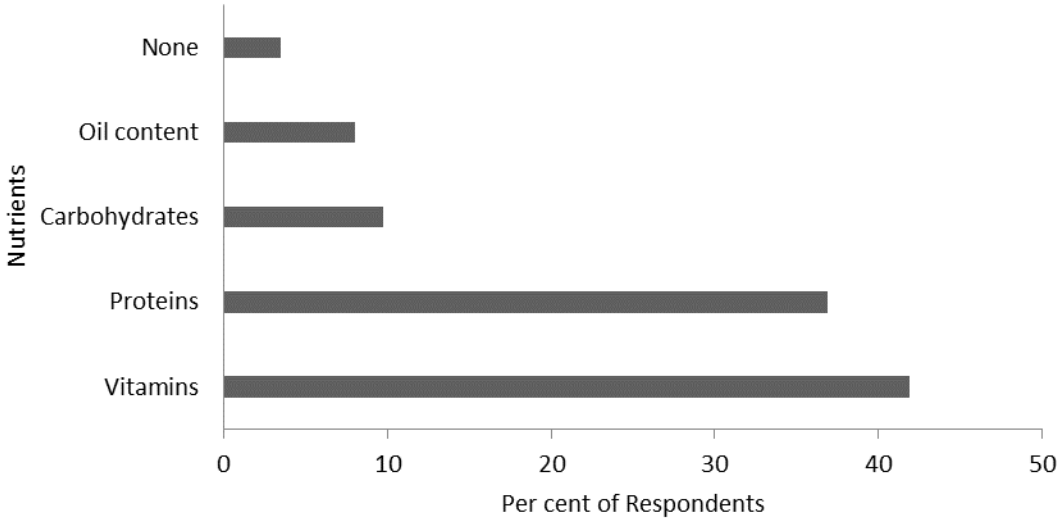

Figure 2: Shows the food attributes the respondents would like improved in Genetically Modified crops

On what would hinder them from growing GM crops, the respondents indicated the availability and cost of the seeds or planting materials as the major constraint with 59.1% (n = 237), knowledge of planting with 17.5% (n = 70) and nutrients/ fertilizer requirements and water with 5.5% (n = 22) and 2.2% (n = 9) respondents, respectively. 15.7% of the respondents did not have any hindrances. This is summarized in Figure 3.

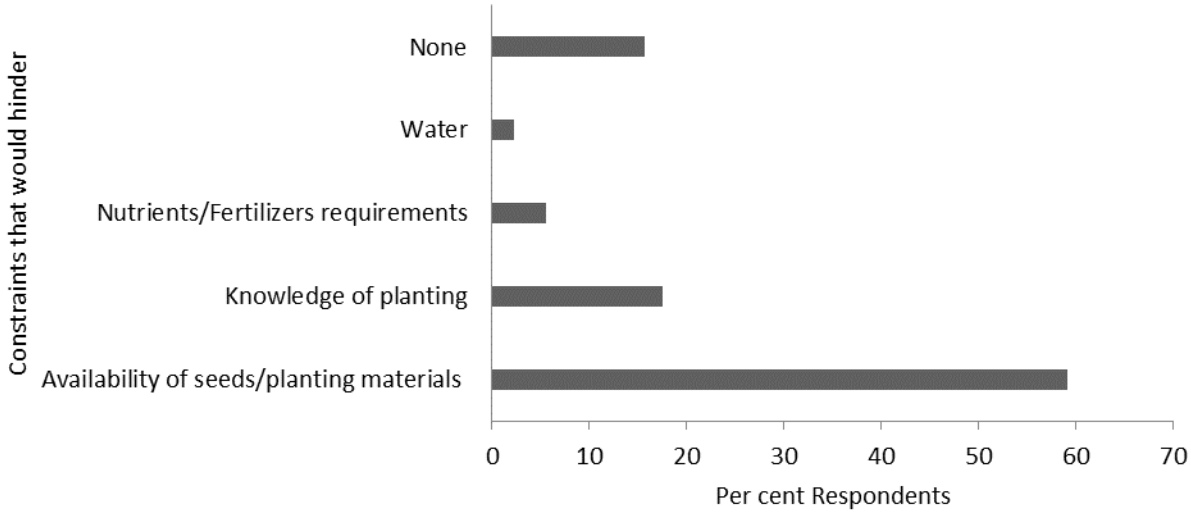

Figure 3: Shows the constraints that would hinder the respondents from growing GM crops

In terms of the willingness of the respondents to consume or grow GM crops, 27.4% (n = 110) were very willing, 31.7% (n = 127) somewhat willing, 38.9% (n = 156) reluctant or not willing to and 2% (n = 8) did not give a response.

On whether they were aware of government programs that encourage use of agricultural biotechnology, 39.7% (n = 159) of respondents were affirmative, while 57.9% (n = 232) were not and 2.5% (n = 10) did not give any response. Similarly, 67.3% (n = 270) respondents were not aware of any government policy on agricultural biotechnology, while 29.9% (n = 120) were and 2.7% (n = 11) did not respond.

Perception towards GMO

The respondent's opinion on human health impact of GMOs was examined and 54.6% (n = 219) presumed that GMOs have negative or harmful effects to human health, while 21.9% (n = 88) thought they do not. However, 23.4% (n = 94) were not sure of any adverse effects. On the effects of GMOs to species diversity in crops, 68.8% (n = 276) responded that agricultural biotechnology will reduce indigenous crops. Contrary, 16.2% (n = 65) presumed that GMOs would increase diversity while 15.0% (n = 60) indicated they have no effects.

Opinion on the way government is handling GMO issues was also sought. It was found that, 49.6% (n = 199) believed that government has enough capacity to protect farmers and the general public from risks associated with GMOs, while 35.4% (n = 142) thought not. However, 14.9% (n = 60) were not sure whether or not there is enough capacity in government to handle GMO issues.

In addition, respondents were asked to choose a statement that best describes marketing of GM products in the local market. 66.1% (n =265) of the respondents believe that Kenyans do not have enough knowledge to make an informed decision on the placement of GM in the market, while 24.2% (n =97) believes that Kenyans do not like GM products contrary to 7.5% (n = 30) who believes that Kenyans have accepted GM products. However, 2.2% (n = 9) did not choose any statement. Further the effects of GM products in marketing of export crops was investigated, 34.2% (n = 137) believe that Kenya will lose its export market, while 31.4% (n = 126) believed not. However, 34.4% (n = 138) did not choose any option, because they were not sure of the effects of GMs to the export market.

On the frequency of getting information about GMOs, a paltry 8.0% (n = 32) stated they never get any information compared to 58.1% (n = 233) who gets monthly, 20.7% (n = 83) weekly and 13.2% (n = 53) who gets daily. On sharing the GM information, 58.9% (n = 236) shares with friends, 28.2% (n = 113) with family members, 3.2% (n = 13) with neighbors, 1.0% (n = 4) with church members and 8.7% (n = 35) with other groups in society.

IV. Discussion

The socio demographic profile of majority of the respondents in this study was young active persons between ages 18-35 years, mostly not married, urban dwellers educated and middle (0.9 to 2 ha) to small scale farm (less than 0.8 ha) holders. This is confirmed by the fact that Kiambu is a cosmopolitan County with many institutions of higher learning, industries and trade centres, and thus the dominant age group would be youths in

tertiary institutions, self- employed and/or in employment in local industries and trading centres (Kiambu County Government, 2013). Kiambu County borders Nairobi, the Capital city of Kenya with men dominating in trade and urban farming hence the observation that majority of interviewers were male. In Ghana, similarly irrigated urban open-space vegetable farming is dominated by men and marketing of the same by females (Obuobie et al., 2006). Crop production is extremely an important economic activity for the majority of this population in addition to livestock production and trading (County Governments Act, 2012).

The level of education reflects on the significantly high number, more than three quarters of the respondents being aware of GMOs and getting information on GMOs on monthly, weekly and even daily basis. This points out that GMO information is available to the public and can be accessed by interested persons. All respondents indicated they shared any GM information they came across and they preferred sharing information with close friends and family members. Their sources of information were varied with most of it not supported by scientific facts, frequently used was newspapers, magazines and television and this concurs with the findings by Ekanem et al., (2004).

The source of information and degree of trust the public puts on it are powerful correlates of acceptance of biotechnology or predictors of the opinions and attitudes that influence acceptance (Legge Jr. and Durant, 2010). Despite the high number of information sources, the public is uncertain on how much to trust the public and this affects their attitude and perception about GMOs. According to (Jurkiewicz et al., 2014; Zhang et al., 2016), the media may be a biased source as compared to scientifically reliable sources. On the contrary, countries like Colombia (Schuler and Orozco, 2007), China (Curtis et al., 2002), France (Noussair et al., 2002) and America (Wunderlich and Gatto, 2015), successful uses the media and public lectures in educating the public to accept GM foods.

The fact that the respondents said they were aware of GMO did not seem to reflect on their knowledge level as quite a significant number of respondents indicated being aware of farmers who grew maize, tomatoes, bananas among other GM food crops in Kenya. This is misleading information because there is no approved GMO farming in Kenya. Similarly, a small proprtion of the respondents correctly explained what genetic modification meant. The underlying explanation could be poor effectiveness of the communication on government policies and the low levels of education on agricultural biotechnology among the public. These findings agree with Drott et al., (2013) observations that there is a huge knowledge gap and that a small group of people charged with driving policies are misusing their limited knowledge to cause confusion and fear within the society. Majority of the respondents were not aware of government policies on agricultural biotechnology or programs that encourage their uses (Biosafety Act, 2009). This is due to lack of clear information on exactly which policies or institutions are involved in control of agricultural biotechnology in Kenya.

More than half of the respondents stated that GMOs would have a positive impact and that they trusted scientists to apply agricultural biotechnology appropriately. Similar findings have been reported in Ghana (Buah, 2011), Tanzania (Mnaranara et al., 2017b), and South Africa (Gastrow et al., 2017), where respondents agree that GM technology will improve and / solve the food security problems but have concerns on their impact on biodiversity. Conflicting conclusions on trust in GM scientists and experts have however been reported in the United States (Funk and Kennedy, 2016; Wunderlich and Gatto, 2015) and Australia (Marques et al., 2015). This is further supported by the fact that the mandate of the scientists and scientific institutions is understood by the public despite the fact that science communication to the public is not effective (Benes, 2017; Vukičević et al., 2018).

Increase the yield potential of the crops, produce drought tolerance and pests and diseases resistant crops are some of the agricultural constraints the respondents would like biotechnology to solve. This concurs with a study in Ghana by Zakaria et al., (2014). Almost a half of the respondents indicated maize as the crop they would like biotechnology to improve followed by bananas and sweet potatoes because these are the main staple crops for many Kenyans (Muthoniand Nyamongo, 2010), and their choice is informed by the challenges faced in producing enough for the population. This observation is similar to a study done in Kenya by Anunda, (2011) who reported that 58% of their respondents agreed that GMOs would alleviate hunger. Respondents also further indicated vitamins and proteins main crop attributes they would like improved comparable findings were reported by Kagai, (2011) in Trans Nzoia, Kenya. This suggests that there is more acceptance of the GM technology when applied to address specific food problems.

Bett et al., (2010); Kimenju and De Groote, (2007), reported that urban consumers would likely accept GM maize in Kenya though there are concerns on GM impact on health and the environment. Equally, most respondents presumed that GMOs have a negative or harmful effect to human health and that the government has required capacity to protect farmers and consumers against the negative effects associated of GMOs. Contrary, a significant number of respondents also indicated that the government could not protect against these negative effects. Such conflicting responses imply ethical concerns on biotechnology in Kenya. This is the case for Tanzania where 59.6% (Mnaranara et al., 2017a), Ghana 35.9% (Zakaria et al., 2014), Europe 70%

(European Commission, 2010) and Kenya 47% (Bett et al., 2010), where respondents indicated ethical and moral concerns on GM foods

V. Conclusion

The application of GM technology has the potential to contribute significantly to Kenya's food output to feed its growing population. The majority of the respondents had some knowledge of biotechnology and would embrace GM technology if it addresses food and nutritional security. Appropriate policies, regulation, funding and effective communication will shape consumer expectations and demands thus drive acceptance of GM products in the local market. The source of GMO knowledge, which was mainly media, plays a critical role in forming perceptions and influencing the acceptance of biotechnology. Improvement in the information delivery by the government and concerns bodies will ease the adoption and acceptance of GM technology.

References

[1]. Benes, K. M. (2017). Overcoming barriers to engaging in science communication: An interview with science communicator Paige Brown Jarreau. Limnology and Oceanography Bulletin, 26(1), 6–8. doi.org/10.1002/lob.10159
[2]. Bett, C., Ouma, J. O., and Groote, H. De. (2010). Perspectives of gatekeepers in the Kenyan
[3]. food industry towards genetically modified food. Food Policy, 35(4), 332–340. doi: 10.1016/j.foodpol.2010.01.003
[4]. Biosafety Act. (2009). Biosafety Act of 2009. Retrieved on January 6, 2019, from
[5]. http://www.kenyalaw.org/lex/sublegview.xql?subleg=No. 2 of 2009
[6]. Buah, J. N. (2011). Public perception of genetically modified food in Ghana. American Journal of Food Technology, 6(7), 541–554. doi: 10.3923/ajft.2011.541.554
[7]. County Governments Act. (2012). County Governments Act, 2012. Retrieved January 9, 2019, from www.kenyalaw.org
[8]. Curtis, K., Mccluskey, J., and Wahl, T. (2002). Is China the market for genetically modified potatoes? AgBioForum, 5(4), 175–178. Available on the World Wide Web: http://www.agbioforum.org.
[9]. Drott, L., Jochum, L., Lange, F., Skierka, I., Vach, J., and van Asselt, M. B. A. (2013). Accountability And Risk Governance: A Scenario-informed Reflection On European Regulation Of GMOs. Journal of Risk Research, 16(9), 1123–1140. doi.org/10.1080/13669877.2012.743161
[10]. Ekanem, E., Muhammad, S., Tegegne, F., and Singh, S. (2004). Consumer Biotechnology Food And Nutrition Information Sources: The Trust Factor. Journal of Food Distribution Research, 35(1), 71–77.
[11]. Funk, C., and Kennedy, B. (2016). Public Opinion About Genetically Modified Foods And Trust In Scientists. Retrieved January 7, 2019, from http://www.pewinternet.org/2016/12/01/public-opinion-about-genetically-modified-foods-and-trust-in-scientists-connected-with-these-foods/
[12]. Gastrow, M., Roberts, B., Reddy, V., and Ismail, S. (2017). Public Perceptions Of Biotechnology In South Africa. South African Journal of Science, 114(1/2), 9–9.
[13]. Israel, G. D. (1992). Determining Sample Size Degree Of Variability. Florida.
[14]. Jurkiewicz, A., Zagórski, J., Bujak, F., Lachowski, S., and Florek-Łuszczki, M. (2014). Emotional attitudes of young people completing secondary schools towards genetic modification of organisms (GMO) and genetically modified foods (GMF). Annals of Agricultural and Environmental Medicine : AAEM, 21(1), 205–11.
[15]. Kagai, K. K. (2011). Assessment Of Public Perception, Awareness And Knowledge On
[16]. Genetically Engineered Food Crops And Their Products In Trans-Nzoia County, Kenya.
[17]. Journal of Developments in Sustainable Agriculture, 6(2), 164–180. doi: 10.11178/jdsa.6.164
[18]. Kiambu County Government. (2013). County Intergrated Development Plan 2013 – 2017. Kiambu, Kenya.
[19]. Kimenju, S. C., and De Groote, H. (2007). Consumer Willingness To Pay For Genetically Modified Food In Kenya. Agricultural Economics, 38(1), 35–46.
[20]. Leahey, A. (2013). Genetically Modified Organisms And Southern African Food Policy. CUREJ - College Undergraduate Research Electronic Journal.
[21]. Legge Jr., J. S., and Durant, R. F. (2010). Public Opinion, Risk Assessment, And Biotechnology: Lessons From Attitudes Toward Genetically Modified Foods In The European Union. Review of Policy Research, 27(1), 59–76.
[22]. Marques, M. D., Critchley, C. R., and Walshe, J. (2015). Attitudes To Genetically Modified Food Over Time: How Trust in Organizations and the Media Cycle Predict Support. Public Understanding of Science, 24(5), 601–618.
[23]. Mnaranara, T. E., Zhang, J., and Wang, G. (2017a). Public Perception Towards Genetically Modified Foods in Tanzania. The J. Anim. Plant Sci (Vol. 27).
[24]. Mnaranara, T. E., Zhang, J., and Wang, G. (2017b). Public Perception Towards Genetically Modified Foods in Tanzania. The J. Anim. Plant Sci, 27(2), 589.
[25]. Muthoni, J., and Nyamongo, D. O. (2010). Traditional Food Crops And Their Role In Food And Nutritional Security In Kenya. Journal of Agricultural & Food Information, 11(1), 36–50.
[26]. Noussair, C., Robin, S., and Ruffieux, B. (2002). Do Consumers Not Care About Biotech Foods Or Do They Just Not Read The Labels? Economics Letters, 75(1), 47–53.
[27]. Schuler, I., and Orozco, L. A. (2007). Managing Agricultural Biotechnology In Colombia. Electronic Journal of Biotechnology, 10(3), 0–0.
[28]. Vukičević, S., Kusić, Z., and Grgurević, L. (2018). Science Communication To The Public. Croatian Medical Journal, 59(2), 43–45.
[29]. Willingham, E. (2012, December 9). Seralini paper influences Kenya ban of GMO imports. Retrieved January 11, 2019, from
[30]. https://www.forbes.com/sites/emilywillingham/2012/12/09/seralini-paper-influences-kenya-ban-of-gmo-imports/#1c34746668a0
[31]. Wunderlich, S., and Gatto, K. A. (2015). Consumer perception of Genetically Modified Organisms and sources of information. Advances in Nutrition, 6(6), 842–851.
[32]. Zakaria, H., Adam, H., and Abujaja, A. (2014). Knowledge And Perception Of Farmers Towards Genetically Modified Crops: The Perspective Of Farmer Based Organizations In Northern Region Of Ghana. American International Journal of Contemporary Scientific Research, 1(2), 149–161.
[33]. Zhang, C., Wohlhueter, R., and Zhang, H. (2016a). Genetically Modified Foods: A Critical Review Of Their Promise And Problems. Food Science and Human Wellness, 5(3), 116–123.
[34]. Zhang, M., Chen, C., Hu, W., Chen, L., and Zhan, J. (2016b). Influence Of Source Credibility On Consumer Acceptance Of Genetically Modified Foods In China.