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# PUBLIC PERCEPTION TOWARDS GENETICALLY MODIFIED FOODS IN TANZANIA

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## ABSTRACT

Genetically Modified (GM) foods have generated wide interest and debate, mostly in developed nations and developing countries with fairly sufficient food supplies. There is, however, limited information on the view of the public in nations facing challenges of food shortage. To add to insights on how GM foods are viewed globally, this study investigates the public's perception of GM foods in Tanzania through a survey (*N*=287). Results show a fairly reasonable level of awareness of GMOs(crops, foods) in Tanzania (49.1%),awareness varies across occupational groups, with regulatory authorities having the highest level of awareness (88.9%), followed by academicians (62.7%), media (60.0%), and farmers (24.0%). Academicians and regulatory authorities consistently have stronger positive perceptions of GM foods, whereas farmers and media, in general, tend to express more concerns over the risks and ethical issues of GM foods. Findings suggest benefit perceptions of GM foods might be a pre-condition for supporting GM foods, whereas risk perceptions might influence the development of GM foods by stressing the need for continuous scientific research to address concerns over risks. Understanding this is important for policy makers and development organizations in shaping the future ofagricultural biotechnology.

**Keywords:** Genetically modified foods, Perception, Awareness, Occupation, Tanzania.

## INTRODUCTION

Genetically Modified (GM) foods have raised controversies, mostly in developed nations and developing countries which have fairly sufficient and stable food supplies. For example, a recent Eurobarometer (European Commission, 2010) survey shows that over half of the respondents believe that GM foods might put the environment, health and socio-economic climate at risk. In China, whether staple food using GM technology should be commercialized has been a topic of heated debate, evidenced by the highly publicized debate between science popularizer Fang Zhouziand TV host Cui Yongyuan. Meanwhile, public opinion is also divided on the issue (He *et al.,* 2015). There is, however, limited information on the view of the public in nations that face the challenge of food shortages. By focusing on Tanzania, which serves as a window to offer a glimpse into the African public's perception of GM foods, this study attempts to add to the understanding of how GM foods are viewed globally.

Public perception towards Genetically Modified (GM) foods is crucial in the understanding of modern bio-technology and agricultural development [1] .This is because public perception of GM foods might influence government regulation, consumer acceptance and farmer adoption of agricultural biotechnology. Chronic hunger and malnutrition pose a persistent threat for the hundreds of millions of Africans. Modern biotechnology is therefore seen as a form of emerging technology that can potentially reduce hunger and malnutrition, and is anticipated to play a crucial role in advancing socio-economic development. African governments and development organizations in the agricultural sector have recognized the need to mobilize resources in support of public awareness and knowledge to adopt modern biotechnology.

Meanwhile, public attitudes and perceptions of GM foods are divided. Some perceived GM foods as reducing labour and production costs, increasing productivity, satisfying nutritional needs, and improving economic and environmental conditions. Others perceived GM foods ashazardous to health, ethically unnatural, and possibly leading to a loss of biodiversity (Hossain *et al.,* 2002).

The divided public perception of agricultural biotechnology in Africa has led African governments to make efforts in: (i)supporting a number of studies to gauge the proven benefits and risks of GM technology in the hope to eradicate its potential risks to human and the environment; (ii) facilitating greater involvement of stakeholders in GM technology such as farmers, the private sector, scientists, consumers, academicians and the media to engage in dialogues for greater acceptance of GM foods and; (iii) promoting the understanding of

[1]The production of Genetically Modified Organisms (GMOs) utilizes transgenic technology that takes into account of the inclusion and/or exclusion of genes (World Health Organization, 2011).

food safety and environmental impact (International Food Policy Research Institute, 2012).

Despite efforts made by African governments and international donors for the adoption of GM technology, the technology continues to face a low level of acceptance by society, even though the scientific evidence regarding environmental and health effects of GMOs is still emerging. However, as of yet there is little conclusive evidence on the exact negative consequences of GM foods on health and the environment. Public interest and concerns over GMOs have been growing in recent times and are now top on national governments and the world agenda. This is of particular relevance to Africa as reducing poverty remains one of the major challenges in the region.

These scenarios are the case for Tanzania, whose population presently stands at approximately 44.9 million and continues to grow. By 2050 the population is projected to rise to 89.8 million. The increase in population may pose a serious challenge to poverty reduction. As Molinelli and Ciliberti (2005) argued that GM technology might offer a solution to these challenges, but the poor understanding of potential risks of GMO to society might explain the limited acceptance of GM technology in the country.

The public notion that safety measures be instituted by governments when dealing with GMOs in general and GM foods in particular,is important for the development of GMOs in Tanzania. The country is a signatory to the Convention on biodiversity and the Cartagena Protocol on biosafety and recognizes the need to formulate sound policy, legal and institutional framework for ensuring safe use and application of modern technology. Therefore, the country is obliged to enhance public awareness, engagements and educational development on the safe transfer and utilization of genetically modified organisms considering risks to human, animal health and the environment (United Nations, 1992).

Development promotion in modern biotechnology with particular focus on agricultural biotechnology is being actively supported by governments, the World Bank, the African Development Bank and other international financial institutions including the private sector with particular focus on promoting public understanding and awareness of the beneficial adoption, safe use and application of modern bio-technology to address food insecurity concerns and conservation of the environment (The Government of Tanzania, 2012). All these efforts require research to examine the level of public perception towards GM foods. Studies thus far have looked at some of the key determinants to sustained agricultural development in general and industrial biotechnology in particular. The studies on public perception towards GM foods in developing countries are scant. Tanzania, facing an average level of food insecurity challenge with an average poverty level among African nations, provides a good representative case for such a study. The present study, therefore, aims to (i) empirically evaluate the level of public awareness and perceptions of GM foods and (ii) provide policy implication for promoting public consciousness and perception of GM foods in Tanzania.

**Literature Review:** This aspect reviews existing studies on public perception towards GM foods in the context of developed and developing countries. Public perceptions on biotechnology have been reasonably studied in developed countries. For example, Eurobarometer surveys on biotechnology conducted in 1996, 1999 and 2000 shows mixed public perception about the long-term benefits of biotechnology and that majority of the Europeans demonstrated less support towards GM foods and perceived GM foods to be risky to human health, environmental and socio-economic climate (De Groote and Bergvison, 2004). A recent Eurobarometer survey (European Commission, 2010) shows 31% Europeans agreed that GM foods are good for the domestic economy, 50% disagreed and 19% don't know; 23% agreed that GM foods do no harm to the environment, health and socio-economic climate, 53% disagreed and 24% don't know; while 70% agreed that GM food is fundamentally unnatural. Comparingthe 2010 results with those of 1996, 1999 and 2000, it appearsthe European public perception about GM foods remains fairly stable in the recent two decades.

Moreover, the study conducted by Heslop (2006) on the US consumers' perception towards biotech crops indicated that approximately 70 percent of foods processed (e.g., canola, corn and soy) sold in supermarkets comprises some ingredients obtained from GM crops due to high biotech adoption capacity of corn and soybean. However, many US consumers seem to be uninformed about genetically modified ingredient substance regarding manufactured foods due to limited disclosure of information. From a socio-economic perspective, consumers' perceptions and attitudes towards GM foods are likely to be positive and having a tendency to be more supportive when tangible benefits are associated with GM foods. This suggests that consumers' perceptions of GMOs not only drives the development of state agenda but also influences the development of international trade regarding GM technology.

A survey conducted in the United States in 2011 on consumers' perception of genetically modified crops shows that regulation issues of labelling and branding of GM foods was amajor concern among industries, government and trade associations due to a different set of rules established which are not consistent with international trade standard, making it extremely difficult to coordinate bio-safety standards among countries in international outlook (Evans and Ballen, 2013).

Despite extensive studies on public perception towards GM foods in developed countries, a very limited number of public perception studies have been conducted in developing countries. A large segment of the society in developing countries are seldom aware regarding the emergence of GMOs and are likely to care more about risk in their daily life rather than long term potential risks of the emerging technology. Nonetheless, there are public perception and interest groups in these countries tending to reject the emergence of GM foods. Their rejections have led to protests that have attracted the attention of the media and other pressure groups to pile up pressure on politicians, policy makers and the government to respond to these concerns. Therefore, public interest counts towards the developments of GM foods (Grossman and Endres, 2000).

In Asia, a survey conducted on public awareness and perception by the Asian Food Information Centre (AFIC) in Indonesia, China and the Philippines in 2002 shows that the majority of the respondents were aware of the existence of GM foods in their everyday meal and were careless about potential risks to their health, but paid more attention to the potential benefits that GM foods can provide (AFIC, 2003). These benefits include improved nutritional value, resistance to bacterial and viral infections and cheaper food price (resulting from reduced production cost and increased productivity) (AFIC, 2003). Comparing public views regarding the benefits of GM food in China and Europe, Lü's (2006; 2009) research show that 20% of Europeans agreed with the statement that GM food would bring benefits to a lot of people whereas around 67-68% of Chinese agreed with it.This might mean that at the time (Chinese data were collected in2003), compared with Europeans, the Chinese valued the benefits of biotechnology more. This result is consistent with the study by AFIC.

A few studies have been conducted in Africa. Aerni and Bernauer (2005) examined the South African public opinion and indicated that the government of South Africa approved field trials with new transgenic varieties and several transgenic crops such as herbicide-resistant soybean and Bt cotton for commercial purpose with no regard to the public about its approval process for GM crops. The approval granted by the government to commercialize GM crops with disregard to the public interest attracted the attention of non-State actors including NGOs to oppose the government regulatory actions in support of the interests of multinational companies while neglecting public views and inquiries regarding approval to commercialize GM crops (Aerni, 2005).Similarly, Bio-watch South Africa, an advocacy group for the right of the society filed a lawsuit against the government (Njobeni, 2004). However, these developments have attracted the attention of the South African government to ensure that GM foods are safe for human health, the environment, and socio-economic climate and to involve non-State actors on issues of public concerns regarding GMOs.

The study by Bett *et al.* (2010) to investigate the perspectives of gatekeepers in the Kenyan food industry towards genetically modified food indicates that on average 82% of the respondents (i.e., 79% of respondents from supermarkets and 87% of respondents from milling companies)were aware of genetically modified crops, around two thirds of all respondents agreed that GM technology can increase food productivity, has the potential to reduce pesticide residues in the environment, and is a sure method of developing pest resistant crop varieties. However, some respondents were concerned about environmental and health risks. 13% of the respondents agreed with the view that "GM crops are harmful to the environment."On average, 62% of respondents agreed "The possibility that consuming GM foods might lead to an increase in antibiotic resistant disease to humans is a big concern to my company."On average, 47%of the respondents agree with the statement that "Genetic modification is tampering with nature."

The survey study on farmers' knowledge and perception regarding GM crops in Ghana by Zakaria *et al.*(2014) indicates that 64% of the respondents were aware of GM foods. 75% of the respondents agreed that GM foods improve yield, pest resistance and drought tolerance. Results also show that 60.5% respondents were concerned about the likely occurrence of GM foods relating to the risk of policy defects, environmental, health, and safety. 35.9% agreed that GM crops are artificial crops created by scientists. Despite these concerns, the majority of the respondents indicated that commercialization of agricultural biotechnology can help improve the country's food security agenda. Zakaria *et al.* (2014) conclude that necessary institutions should engage farmers on information, education and training to reduce their level of misinformation and increase their knowledge of GM technology.

In Tanzania, the planned introduction of two GM crops including maize and cotton has raised challenging concerns, such as the right of choices and access to information about safety (Lewis *et al.*, 2010).Bio-safety regulations, branding of GM foods, increasing people's awareness through workshops, meeting, and training about the safe usage of GMO are being pursued by the Tanzanian Government as a way to respond to concerns of public views regarding GMOs (The Government of Tanzania, 2012).In terms of public awareness, a survey by the Government of Tanzania (2012) administered in three agro-ecological areas of Tanzania (namely "Dodoma", "Morogoro" and "Samie") indicated that on average 32.7% of the respondents were aware of the term GMO. In spite of the insights gained, this particular study did not cover the capital city- Dar es Salaam (where the headquarter for the administration of bio-safety issues is located) and did not address

perceptions of trust in the capacity of government on the handling of GMOs as well as ethical issues relating to GM foods, which are worthy of inquiry and are addressed in the present study.

In a study on Genetically Modified Organisms (GMOs) and food security in Africa, Mnaranara *et al.*(2015) contend that modern biotechnology should be pursued carefully within ethical frameworks, assessing the socio-economic impact of modern biotechnology to ensure that adverse effects are avoided and the interest of the present, as well as future generations, are protected. A bottom-top approach is required through which policy makers should involve actors spanning from the poor to the rich class of society who may be affected by the potential impacts of modern biotechnology, promote public awareness and active participation through civil societies, and balanced information to the public is essential. The level of awareness, education and information dissemination are vital to promoting public perception towards GM technology as it is observed in the study of Zakaria *et al.*(2014).

This review of the literature shows the debate on modern biotechnology remains an unsettled puzzle, however, from a consequential perspective, whether GM products should be pursued depends on whether risks can be outweighed by the benefits, and this, in turn, requires more scientific research evidence. According to the 2011 assessment on agriculture biotechnology in Africa, commissioned by the International Food Policy Research Institute (2012) and financed by the African Development Bank (ADB), the safety record of the technology suggests that the process of genetic modification, by itself, posed no significance risk to human health or the environment. However, the level of misinformation, low awareness about bio-technology in African countries is extraordinarily high, and issues of complex systems of laws and regulations came out as limiting factors behind the actual introduction of bio-technology (International Food Policy Research Institute, 2012). It is thus,prudent to undertake a study on the level of public perception toward GM foods in Tanzania.

## MATERIALS AND METHODS

Twocities (Dar es Salaam and Morogoro, with a population size of 4.3 million and 2.2 million respectively), and two agricultural rural towns (Shinyanga and Singida, with a population of 1.5 million and 1.3 million people respectively) of Tanzania were selected for this survey. The total population size for the four locations is approximately 9.3 million people (The United Republic of Tanzania, 2014). Dar es Salaam and Morogoro are characterized by high rainfall and fertile soil with tertiary agricultural learning institutions and farming communities. Dar es Salaam, although with fertile, has little agricultural practices; it contains the majority of the regulatory authorities. Singida and Shinyanga are prone to drought and arid in nature but have farming communities.

The survey was conducted during October 2014 and March 2015. The questionnaire included questions on demographics, awareness, and perceptions towards GM foods including ethical aspects of GM foods. The provision was also made in the questionnaire for any other comments respondents may have about GM foods. The survey questions were adapted from a sample of Eurobarometer 52.1 questions (Melich, 1999) and Biotechnology-Eurobarometer 73.1 questions (Eurepoean Commision, 2010).

A total of four occupational groups constitute the respondents: (i) academicians, (ii) regulatory authorities, (iii) farmers, and (iv) media. The choice of occupations is consistent with previous research on Africans' perception of GM technology (Aerni, 2005; Lewis *et al.*, 2010; The Government of Tanzania, 2012; Zakaria *et al.*, 2014) and is explained as follows:

The regulatory body is a key stakeholder who is responsible for regulating risks concerning GM technology. Academicians also form part of the occupational groupings for this survey on grounds that issues of GM technology can be taught at institutions/universities and some of them engage in research works that may relate to GM foods. This development can help in changing the level of public view about GM foods. The media disseminates information on issues of GM technology and may influence public perception and awareness about GM foods. Finally, it is important to note that farmers constitute the majority of the sample; this is purposive as farmers largely engage in agriculture where agricultural bio-technology is applied and if anything goes wrong with the technology, they could suffer devastating consequences. These, therefore, justify the selection of these four occupational groups for this survey.

Ten questionnaires were pilot tested (five in the urban area of Morogoro and five in the rural area of Shinyanga, respectively). The questionnaire was adjusted and improved based on issues identified through the pilot test. A total of 379 questionnaires were distributed, out of which 287 questionnaires were filled and returned.

The survey data were analyzed using descriptive statistics, charts and percentage levels of the occupational groups (academicians, regulators, farmers, and media) on the perception of GM foods. The International Business Machine (IBM) Statistical Package for Social Sciences (SPSS) for windows was employed in the study.

## RESULTS AND DISCUSSION

In general, 49.1% of the sample are aware of GMOs (crops, foods), which is above the awareness level (32.7%) reported in the study by the government of

Tanzania in 2012. The Tanzanian case suggests that a reasonable proportion of the public are aware of GMOs. Tanzania, being a signatory in recent times to the Convention of biodiversity and Cartagena protocol on biosafety, is obliged to formulate sound policy, legal and institutional framework to promote public awareness of GM technology; such policies and frameworks may govern, for example, the dissemination of information on the handling and use of GM technology in the context of biological conservation (The Government of Tanzania, 2012). However, only 10.5% of the respondents are aware of the existence of regulation, with regulatory authorities, media, academicians, and farmers accounting for 5.6%, 1.0%, 3.1% and 0.8% respectively.

In comparison, the surveys conducted in Ghana by Zakaria *et al.* (2014) and in Europe by the European Commission (2010) reveal a general awareness level of GMOs of 64% and 84% respectively. These results differ from the result of our study. This may be due to the fact that the majority of our respondents are farmers with limited education. We speculate that there is probably high literacy rate and educational level in the European countries than African countries and that most of the respondents in Ghana may have an appreciable education and knowledge about GM technology. This, therefore, might explain the reason for the high level of awareness of GM foods in the European countries and in Ghana. The level of awareness in Kenya (82%) is above that of Ghana (64%) and Tanzania (49.1%), as respondents of the Kenyan survey were gatekeepers in the food industry. Summary results of the awareness level of GMOs are shown in Table 8.

In Figure 1, respondents were asked about their awareness level of GMOs (crops, foods) and awareness about the existence of any regulation on GM products. It was found that regulatory authorities had the highest level of awareness of GMOs (crops, foods)(88.9%), followed by academicians(62.7%), media (60%), and farmers (24%).On the existence of any regulation of GM products, regulatory authorities had the highest level of awareness (35.6%), followed by academicians(10.8%), media (10.0%) and farmers (1.6%). The results show that regulatory authorities and academicians show higher levels of awareness for both questions.

Interestingly, farmers constitute the majority of the respondents but registered the lowest level of awareness in both questions. Comments put forward by some farmers in this survey show they believe some officials of government and some local scientists introduced GMO in the country even before the bio-safety law was in place without wider participation and consultation with the majority of farmers on GM issues. Therefore, it might be argued that the probable cause for the low level of farmers' awareness could be a result of limited access to relevant information and participation, coupled with limited educational level. Modern biotechnology could be viewed as novel and complex in nature and hence cannot be expected to be readily understood by individuals with relatively limited education.

Analyzing awareness level by education among those who reported being aware of GMOs (crops, foods), 27.7% are bachelor degree holders, 25.5% hold an advanced degree(Master and Doctor), 19.1% are still on study, 12.8% are ordinary and advanced level equivalents (high school graduates), 13.5% have primary, secondary and vocational education level. 1.4 % of the respondents have no formal qualification. This may mean that direct exposure of respondents with advanced educational level might have influenced awareness on agricultural biotechnology, as these occupational groups have a bankable platform to access information about modern biotechnology via academic curricula, websites, journals, electronic documentations, including workshops and meeting participation.

Figure 2 shows awareness by gender.44% of female respondents were aware of GMOs (crops, foods) whereas 52.6% of male respondents were aware. It may be that men are more exposed to agricultural practices and participate in workshops, seminars and training in agricultural development, while the majority of women in rural areas are housewives and take care of the home and family.

Figure 3shows the responses to statements on perceptions of benefits regarding GM foods. For the statement "GM food will increase yields and offer a solution to Tanzania's food problem,"27.9% of respondents strongly agreed, 18.1% agreed, 6.3% disagreed, 17.1% strongly disagreed,19.9% of respondents neither agreed nor disagreed and 10.8% had no opinion. Once we collapse "strongly agree" and "agree", 46% agreed with the statement, whereas when we collapse "strongly disagree" and "disagree," 23.4% disagreed with the statement. ("Agreed" [2] and "Disagreed" [3] ). By occupation breakdown, 53.3% of regulatory authorities "Agreed," 53.3% of media "Agreed," 59.0% of academicians "Agreed" and 33.4% of farmers "Agreed" for this statement. Table 8 shows that Tanzania (46%), Kenya (67%), Ghana (75%) demonstrated a fairly reasonable level of support of benefit perception of GM foods, an idea that is less favored in Europe (31%). It can, therefore, be argued that African countries focused more attention on the benefits GM food can bring to society. We speculate therefore that, African countries may have high potential to accept GM foods than Europe.

[2]"Agreed" means the sum total of strongly agree and agree.

[3]Similarly, "Disagreed" is the sum total of strongly disagree and disagree. This notation is used throughout the study where applicable.

For the statement "Production of GM foods is cheaper," 43.5% of respondents "Agreed," 24.4% respondents "Disagreed," 20.9% of respondents neither agreed nor disagreed and 11.1% had no opinion. With regards to occupation, 53.3% of regulatory authorities "Agreed," 36.6% of media "Agreed," 57.8% of academicians "Agreed," and 32.6% of farmers "Agreed."

Regarding the statement "GM foods pose no danger for future generation", overall, 34.9% of respondents "Agreed," 26.5% "Disagreed," 25.1% of respondents neither agreed nor disagreed and 13.6% had no opinion. In terms of occupation, 37.8% of regulatory authorities "Agreed," 26.7% of media "Agreed," 35.7% of academicians "Agreed," and 35.0% of farmers "Agreed."

Academicians and regulatory authorities consistently evaluated GM foods to have greater benefits. However, the academicians have greater support for the idea that GM foods can bring benefits than the other occupational groups. This idea is less supported by farmers and media. The authors are constrained to conclude entirely that academicians perceived more actual benefits of GM foods than the other respondents. We do speculate that the academicians have more positive expectations about the benefits of GM foods as they are often involved in science and technology issues at universities or at research institutes dealing with biotechnology.

Figure 4shows the responses on the perception of risks regarding GM foods. 37.1% of the respondents "Agreed," 23.2% "Disagreed," 28.8%, neither agreed nor disagreed and 10.8% had no opinion, for the statement "GM food can damage people's health." By occupation, 51.2% of regulatory authorities "Agreed," 76.7% of media "Agreed," 54.2 % of academicians "Agreed" and 53.3% of farmers "Agreed." Results further show the sharp contrast in risk perception—recognition of risks in Tanzania (37.1%), concerns over risks in Ghana (60.5%), Europe (53%) and Kenya (13% on environmental risks and 62% on human health risks) in (Table 8). In other words, Ghana and Europe have demonstrated higher concern levels of risk from GM foods on the environment, health and safety than Kenya and Tanzania. Combined with the considerable support for the benefits GM foods can bring to society in these countries/regions (Table 8), it is understandable that public opinion about GM foods is mixed and remains an unsettled puzzled with the debate still ongoing.

For the second statement "If anything went wrong with GM food it would be a worldwide problem", the result reveals that 55.8% of respondents "Agreed," 25.8% of respondents "Disagreed," 12.5% of respondents neither agreed nor disagreed, and 5.9% had no opinion. The occupational group breakdown indicates that, 35.5% of regulatory authorities "Agreed," 61.3% of media "Agreed," 59.0 % of academicians "Agreed," 53.3% of farmers "Agreed."

Risk perception is also examined using the third statement "The risks from GM food are acceptable," overall, 34.8% of the sample "Agreed," 26.2% "Disagreed," 25.4% neither agreed nor disagreed, and 13.6% had no opinion. Occupationally, 40.0% of regulatory authorities "Agreed," 23.4% of media "Agreed," 35.0% of academicians "Agreed," and 35.7% of farmers "Agreed."

Results indicate that the media rated the risks much higher than regulators, farmers, and academicians. We speculate that the commercialization and adoption approvals granted by African governments on issues of GM foods without media participation might leave room for the media to suspect more risks than benefits that GMF can bring to the society. We speculate also that, the media might perceive that the government is not being transparent in the handling of GM foods issues. These scenarios may influence them in reporting balanced information to the public on GM foods matters and be more sensitive to the risks from GM foods. However, the regulatory authorities, academicians, and farmers perceived less risk of GM foods and have demonstrated high acceptance of the risks from GM foods, they may likely believe that the risk from GM foods can be mitigated by technological development.

Figure 5shows the responses to other statements on public perceptions of GM foods. 53.3% respondents "Agreed," 24.7% "Disagreed" with the statement "Deciding on the issue of GM food is so difficult that public perception about it is a waste of time," 13.9% of respondents neither agreed nor disagreed and 8.0% had no opinion. In the occupational sense, 40.0% of regulatory authorities "Agreed," 35.5 % of media "Agreed," 55.4 % of academicians "Agreed," and 61.2% of farmers "Agreed."

Regarding "I am worried that this new technology is being driven more by profit than by the public interest," 54.0% of respondents "Agreed," 15.7% "Disagreed," 19.5% neither agreed nor disagreed, and 10.8% had no opinion. By occupation, 51.1% of regulatory authorities "Agreed," 70.0% of media "Agreed," 54.2% of academicians "Agreed," and 51.2% of farmers "Agreed."

For the statement "GM food should be legalized in Tanzania and farmers allowed to grow them immediately," 45.7% of respondents "Agreed," 23.7% "Disagreed," 20.9% of respondents neither agreed nor disagreed, and 9.8% had no opinion. By occupational breakdown, 53.3% of regulatory authorities "Agreed," 34.9% of media "Agreed," 59.0% of academicians "Agreed," and 43.3% of farmers "Agreed."

Results show that the media have less support for "deciding that GM food is so difficult that public perception about it is a waste of time". Meanwhile, the

media are concerned that "GM foods are being driven more by profit than by public interest." On the statement, "GM foods should be legalized and farmers allowed growing them immediately," the media less agreed to the idea than the other occupational groups.

Clearly, the results indicate that the media are consistent in their concerns over GM foods and GM technology and believe it is not a waste of time to understand public opinion. We speculate that the media expect greater participation and engagement with the government and state institutions that are handling GMF issues. Comments advanced by some media practitioners in the survey have shown that the government introduced GM foods in the country with limited participation and engagement with the media. Limited participation and engagements with the media on GMF issues might make the media hold opposite views from the government and resort to reporting information to the public not in the interest of the government. Such information might influence public opinions and perceptions to increase pressure on the government to respond to concerns on GM foods. The government of Tanzania should strive to enhance active participation of the media to ensure credible and reliable information is being transmitted to the public about GMF matters.

Figure 6 shows the responses on ethical perception by occupation. For the statement "Food from genetically modified crops is artificial," 59.6% of respondents "Agreed," 15.4%"Disagreed," 16.1% neither agreed nor disagreed, and 8.8% had no opinion. By occupation, 55.5% of regulatory authorities "Agreed," 76.7% of media "Agreed," 60.2% of academicians "Agreed" and 56.7% of farmers "Agreed."

On "GM technology is not an ethically acceptable method for producing animal feed", 42.8% of respondents "Agreed," 23.5% "Disagreed," 21.4% of respondents neither agreed nor disagreed, and 12.3% had no opinion. By occupational breakdown, 31.1% of regulatory authorities "Agreed," 33.3% of media "Agreed," 43.4% of academicians "Agreed," and 48.8% of farmers "Agreed." For the third statement "There is a lack of transparency to the public about research and information on GMO," 59.7% of the respondents "Agreed," 20.1% "Disagreed," 9.5% of respondents neither agreed nor disagreed, and 10.6% had no opinion. By occupation, 66.6% of regulatory authorities "Agreed," 73.4% of media "Agreed," 57.8% of academicians "Agreed," and 55.2% of farmers "Agreed."

Results in Figure 6reveal quite an interesting picture. For one thing, none of the occupational groups are consistent in their evaluation on the ethical perspectives of GM food and technology. Results further indicate mixed ethical evaluations. Compared with other occupation groups, the media tends to accept more to the notion that "Food from genetically modified crops is artificial and there is a lack of trust and transparency to the public about research and information on GMO matters". Evaluating the first and third statements, it can be observed that a considerable proportion of all occupational groups(over 55% for each group) support the view that "Food from genetically modified crops is artificial and there is a lack of trust and transparency to the public about research and information on GMO matters". This implies, apart from concerns over risks of GM foods, there are also concerns over the ethical and moral acceptance of GM technology in Tanzania. This is the case for Ghana (35.9%), Kenya (47%) and Europe (70%) on ethical concerns as presented in (Table 8).

When respondents were asked "Would you eat GM foods if they were cheaper," 39.7% of respondents would eat, 31.4% would not eat, and 29.9% don't know. By occupation, 51.1% of regulatory authorities, 47.3% of academicians, 46.7%of media, and 29.5%of farmers would eat (Table 7).

On the question "What is your view of GM foods in terms of consumption," the general picture reveals 22% of the respondents perceived GM foods consumption as harmful, 23.3% as not harmful, and 54.4% as unsure. By occupation, 13.3% of regulatory authorities' perceived GM food consumption as harmful, 40% of media, 18.1% of academicians, and 23.3%of farmers believed so respectively (Table 7).

In terms of trust on the capacity of government agencies to handle GM foods safely, overall, 25.1% of respondents had high trust on government capacity, 28.9% had low trust, 20.6% had no trust, and 25.4% were not sure. Occupationally, 33.7% of academicians placed high trust, 23.3% of farmers, 22.2% of regulatory authorities, and 13.3% of media had high trust in the capacity of government agencies to handle GM foods safely (Table 7).For regulatory authorities in particular, during informal discussions held during our field work, some of these members mentioned that lines of responsibilities relating to GM foods safety issues seemed not defined and assigned clearly enough among the central government, local government, and other government agencies. Although our observations may not be exhaustive, they suggest some sort of disconnect unclear lines of operations and coordination among the various regulatory organs topromote the safety of GM foods. This might be a potential reason for reportedlevel of trust in members of regulatory authorities on government capacity.

On the issue of government funding of GM research, 19.9% of the respondents held the view that "funding on GM research must be banned," 51.9% held the view that "GM research should be funded more", and 28.2% were not sure. By occupation, 36.7% of media indicate that funding for GM research must be banned followed by farmers (24%), academicians (15.7%) and regulatory authorities (4.4%) (Table7).

As the majority of the farmers in the sample reside in rural areas and are considered poor, one would expect that they will eat GM foods when it is cheaper, but interestingly, their responses indicated otherwise. This may imply that they too have concerns either over the risks of GM foods to human health or the environment. We speculate their unwillingness to eat GM foods might be attributed to more expectations on the consequences about the risks of GM foods.

**Table 1.Classification and description of respondents**

| Occupation | Description |
|---|---|
| i) Academician | Students/lectures who teaches and does research at a universities or colleges |
| ii)Regulatory authorities | Regulatory body/institutions/agencies officially engaging in the administration of statutory affairs. |
| iii) Farmers | Individuals/institutions involve in agricultural activities |
| iv) Media | Reporters/press |

**Table 2. Description of questionnaires distributed and returned**

| Occupation | No. of questionnaires distributed | No. of questionnaires returned |
|---|---|---|
| Academia | 93 | 83 |
| Regulatory authorities | 74 | 45 |
| Farmers | 172 | 129 |
| Media | 40 | 30 |
| **Total** | **379 (100%)** | **287 (75.73%)** |

**Table 3.Demographic profile and distribution of respondents**

| Occupation | Frequency | Percent |
|---|---|---|
| Regulatory authorities | 45 | 15.7 |
| Media | 30 | 10.5 |
| Academia | 83 | 28.9 |
| Farmers | 129 | 44.9 |
| **Total** | **287** | **100.0** |

**Table 4.Gender distribution**

| Gender | Frequency | Percent |
|---|---|---|
| Male | 171 | 59.6 |
| Female | 116 | 40.4 |
| **Total** | **287** | **100.0** |

**Table 5.Educational level of respondents**

| Education | Frequency | Percent |
|---|---|---|
| Vocational level | 42 | 14.6 |
| A level or equivalent | 7 | 2.4 |
| O level or equivalent | 28 | 9.8 |
| Bachelor degree or equivalent | 54 | 18.8 |
| Masters/Ph.D. or equivalent | 38 | 13.2 |
| Others | 46 | 16.0 |
| No formal qualification | 22 | 7.7 |
| Still studying | 48 | 16.7 |
| Don’t know | 2 | 0.7 |
| **Total** | **287** | **100.0** |

**Table 6.Location of respondents**

| Location | Frequency | Percent |
|---|---|---|
| Dar es Salaam | 64 | 22.3 |
| Morogoro | 73 | 25.4 |
| Shinyanga | 72 | 25.1 |
| Singida | 78 | 27.2 |
| **Total** | **287** | **100.0** |

**Table 7.Public perception of GM foods by occupation (other statements)**

| Occupation | Would you eat GMfoods if they were cheaper? | | | What is your view of GM foods in terms of consumption? | | | Do you trust the capacity of government agencies to handle GM food issues safely? | | | | What would you say about government funding of GM research? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Will eat | Will not eat | Don't know | Harmful | Not harmful | Not sure | High trust | Low trust | Do not trust | Not sure | Must be banned | Should be funded more | Not sure |
| Regulatory authorities | 51.1 | 31.1 | 17.8 | 13.3 | 40 | 46.7 | 22.2 | 28.9 | 20 | 28.9 | 4.4 | 62.2 | 33.3 |
| Media | 46.7 | 43.3 | 10 | 40 | 33.3 | 26.7 | 13.3 | 50 | 6.7 | 30 | 36.7 | 40 | 23.3 |
| Academia | 47.3 | 36.1 | 16.9 | 18.1 | 31.3 | 50.6 | 33.7 | 31.3 | 19.3 | 15.7 | 15.7 | 61.4 | 22.9 |
| Farmer | 29.5 | 25.6 | 45 | 23.3 | 10.1 | 66.7 | 23.3 | 22.5 | 24.8 | 29 | 24 | 43.4 | 32.6 |

**Table 8.Summary of key results for comparison with existing studies**

| Country/Region | Statement/Question | Percentage Support Level |
|---|---|---|
| | **Awareness/Knowledge** | |
| Tanzania (2014-2015) | Are you aware of GMOs (crops, foods)? | 49.1% |
| Ghana (2014) | What do you know about GMO and GM crops? | 64% |
| Tanzania (2012) | Have you ever heard of the word GMO? | 32.7% |
| Kenya (2010) | Have you heard about genetically modified crops? | 82% |
| Europe (2010) | Have you heard about GM foods? | 84% |
| | **Benefit Perception** | |
| Tanzania (2014-2015) | GM food will increase yield and offer a solution to Tanzania food problem. | 46% |
| Ghana (2014) | GM foods improve yield, pest resistance and drought tolerance. | 75% |
| Kenya (2010) | Use of GM technology in food production increases productivity and offers a solution to the world. | 67% |
| Europe (2010) | GM foods are good for the national economy. | 31% |
| | **Risk Perception** | |
| Tanzania (2014-2015) | GM food can damage people's health. | 37.1% |
| Ghana (2014) | GM foods are risky to policy defects, environmental, health, and safety. | 60.5% |
| Kenya (2010) | GM crops are harmful to the environment. | 13% |
| | The possibility that consuming GM foods might lead to an increase in antibiotic resistant disease tohumans is a big concern to my company. | 62% |
| Europe (2010) | GM foods harm the environment, health, and socio-economic climate. | 53% |
| | **Ethical Issues** | |
| Tanzania (2014-2015) | Food from genetically modified crops is artificial. | 59.6% |
| Ghana (2014) | GM crops are artificial crops created by scientists which are different from natural crops. | 35.9% |
| Kenya (2010) | Genetic modification is tampering with nature. | 47% |
| Europe (2010) | GM food is fundamentally unnatural. | 70% |

Source: Tanzania(2014-2015) refers to the present study
Zakaria*et al.* (2014)
The Government of Tanzania (2012)
Bett*et al.* (2010)
European Commission (2010)

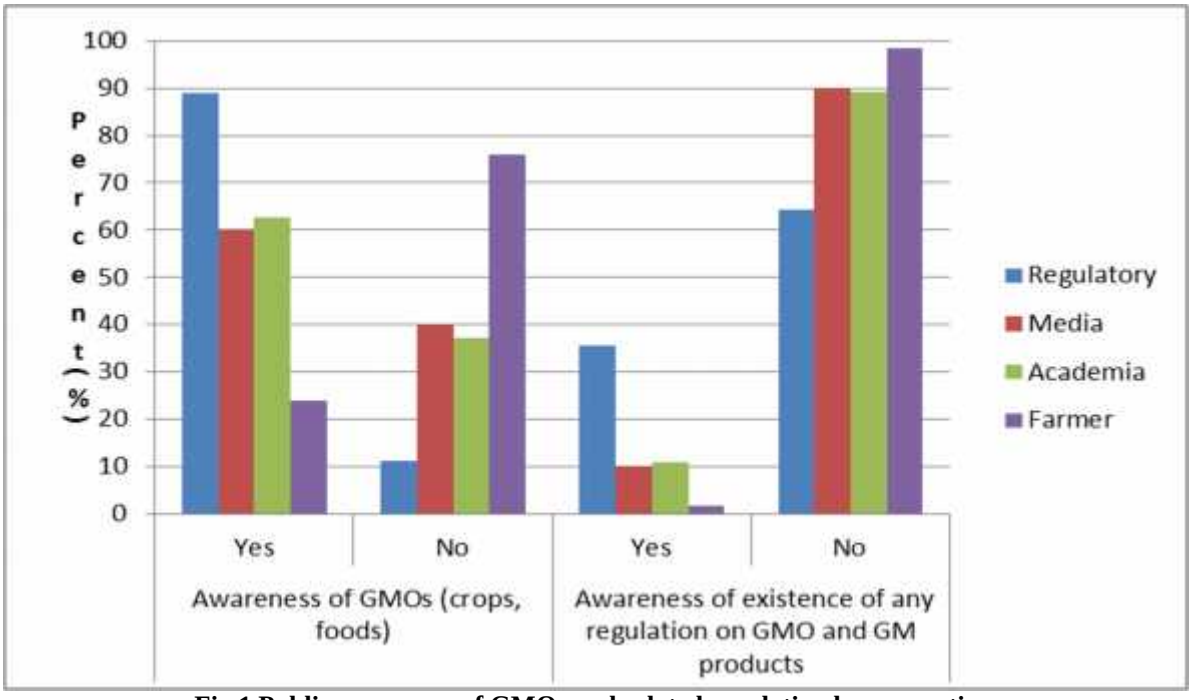


**Fig.1.Public awareness of GMOs and related regulation by occupation**

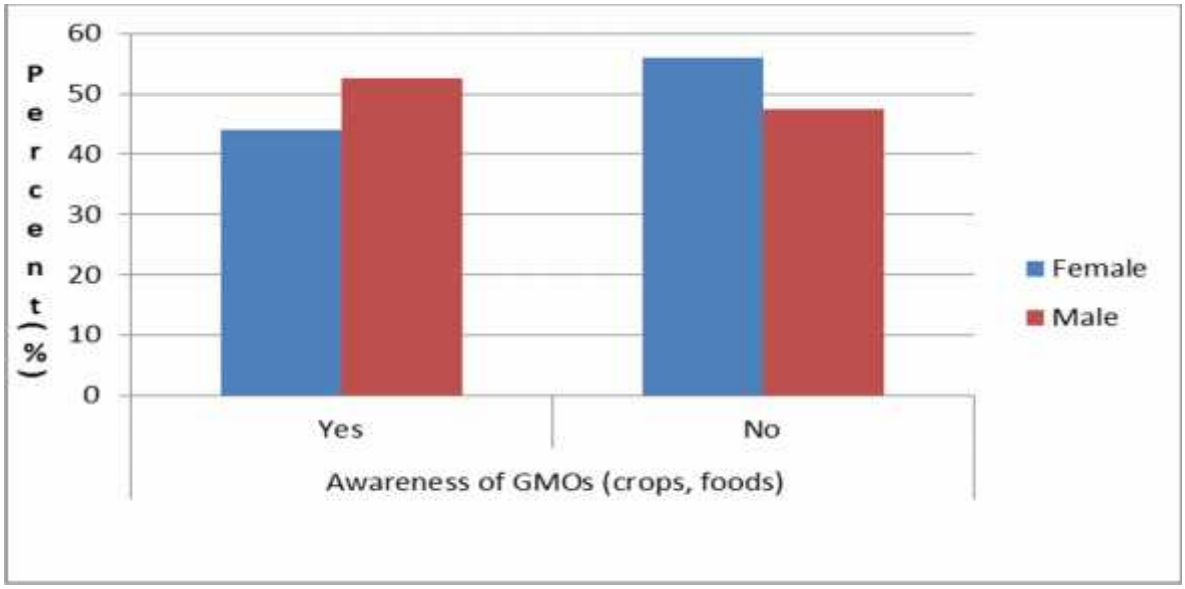


**Fig.2.Public awareness of GMOs by gender**

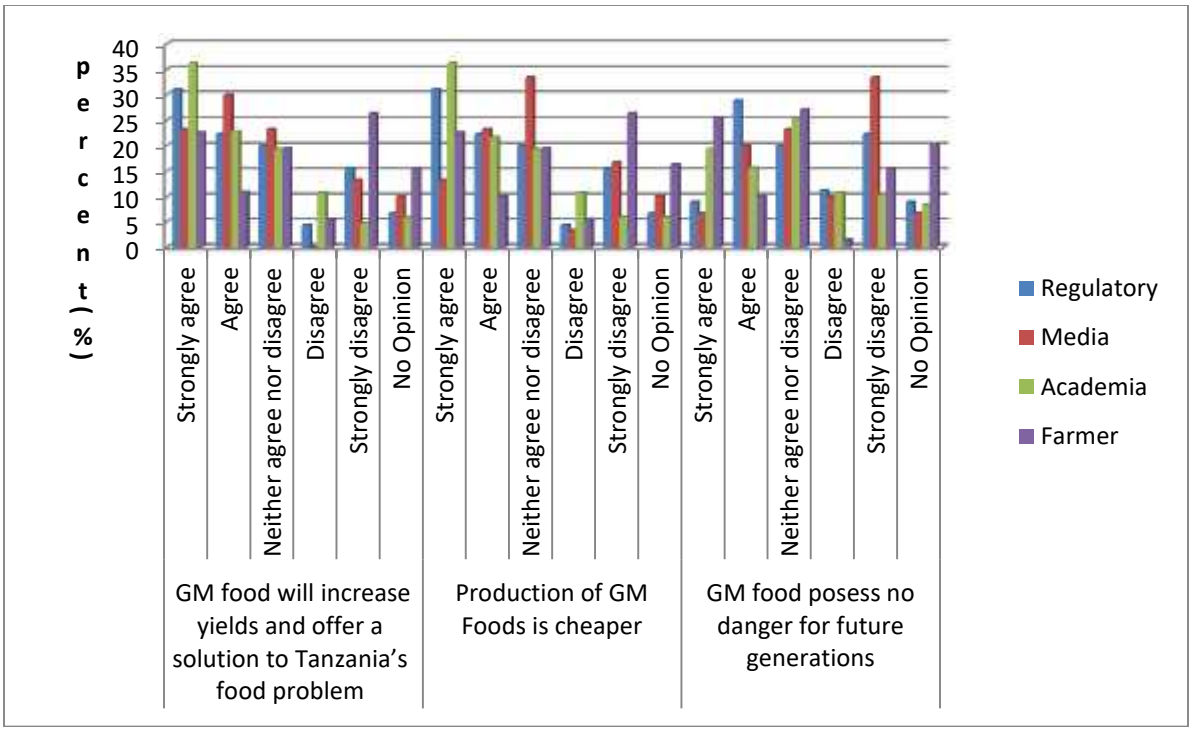


**Fig.3. Public perception of benefits of GM foods by occupation**

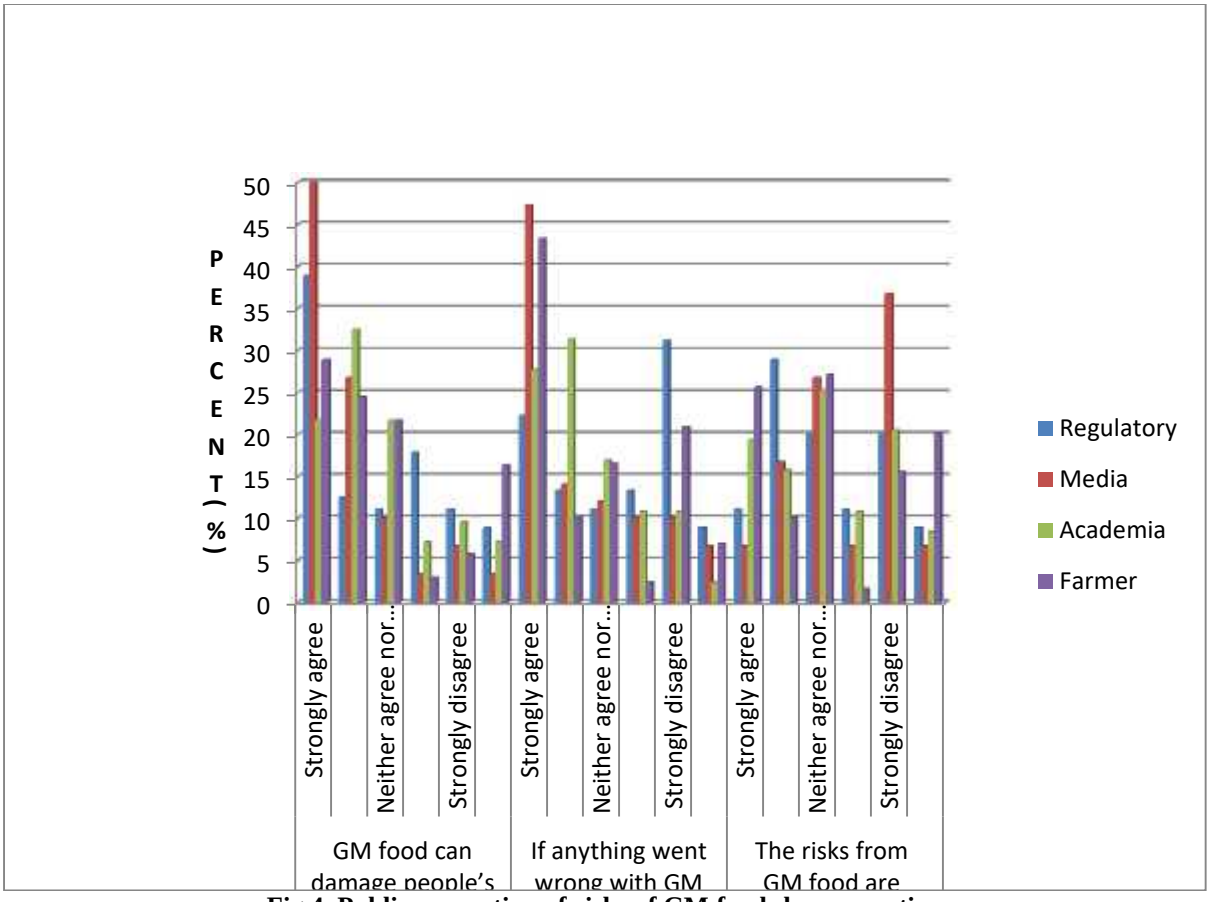


**Fig.4. Public perception of risks of GM foods by occupation**

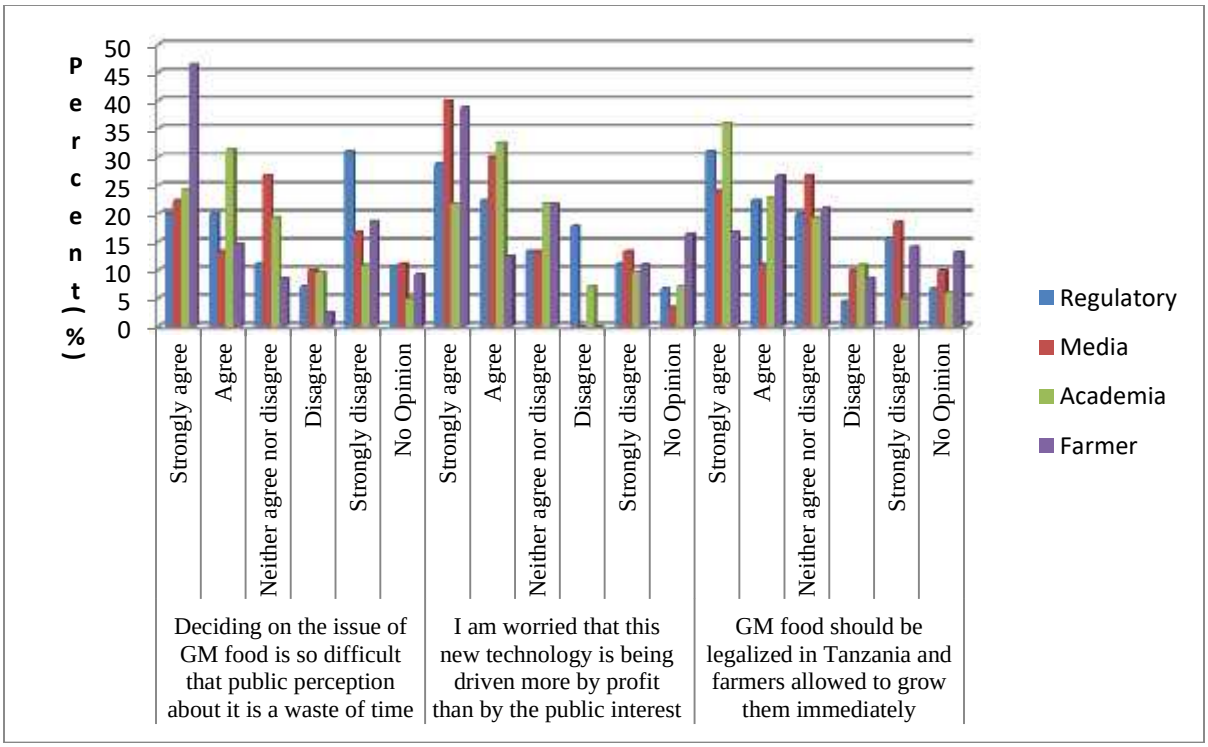


**Fig.5. Public perception of GM foods by occupation (other statements)**

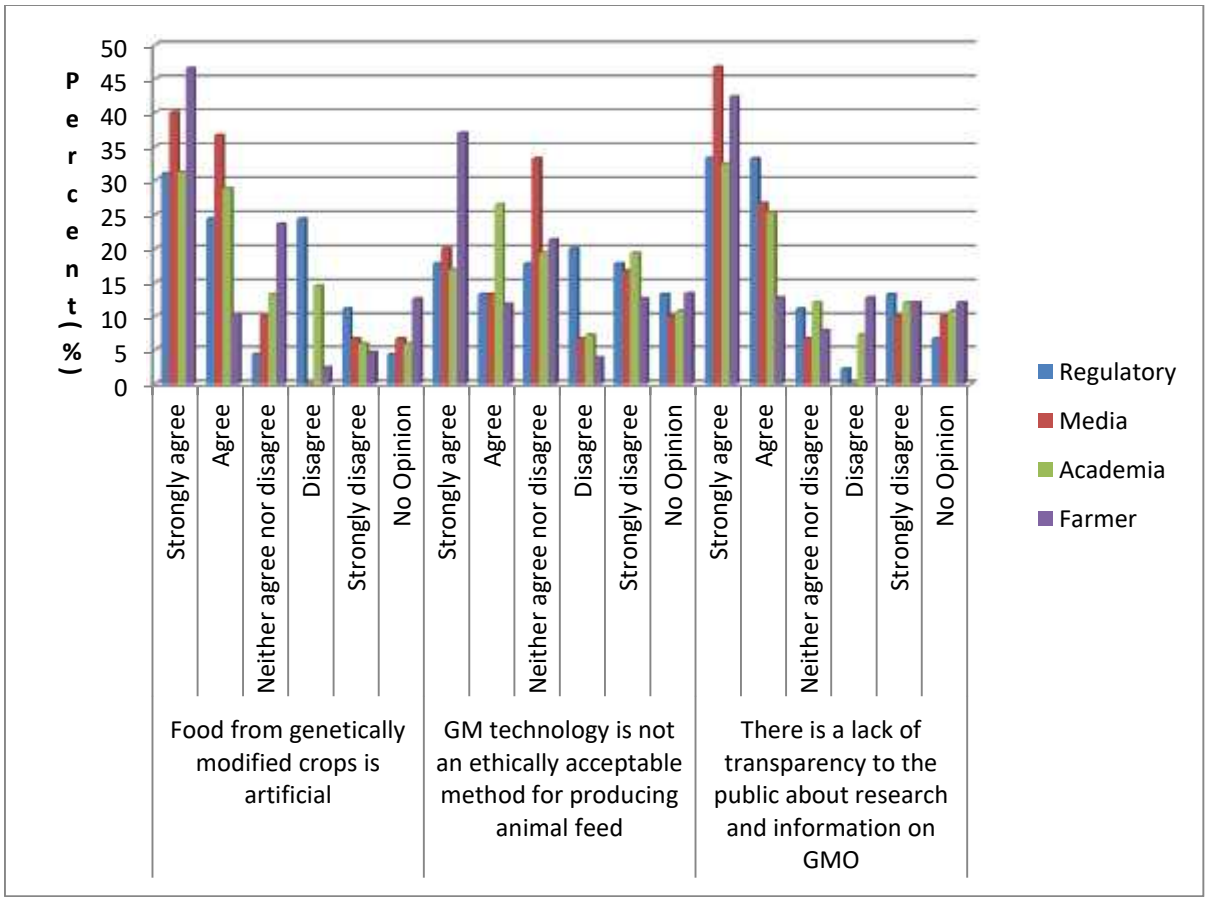


**Fig.6. Ethical perception by occupation**

**Conclusion:** The study investigates the level of public perceptions towards GM foods in Tanzania by means of the survey across occupations using descriptive statistics. In general, there exists a fairly reasonable level of awareness of GMOs (crops, foods) in Tanzania with a proportion of 49.1% and is below that of the study in Ghana and Europe. Regulatory authorities had the highest awareness level, while farmers had the lowest awareness level.

The results reveal that academicians and regulatory authorities consistently have stronger positive perception towards the benefits GM foods might bring to society. However, this view is less supported by farmers and media due topotential concerns over the risks of GM foods to the society.

Regarding the artificial nature of GM foods/crops, 59.6% respondents in the present study agreed with the view that GM foods are artificial; the percentage was 35.9% in Ghana (on GM crops) and 70.0% in Europe (on GM foods). Hence, between nations, there seem to be great disagreements over the basic nature of GM foods.

This study contributes to the literature by providing an empirical analysis using descriptive statistics in determining the level of public awareness and perception towards GM foods in Tanzania. This study also employs comparative analysis with existing studies on GMF issues to further provide broader understanding to readers, academicians and policy makers including governments on issues relating to public opinion and attitudes about GM foods.

Our findings have implications not only for policy makers in Tanzania but also for development organizations that are assisting in the growth process of modern agricultural biotechnology in Sub-Saharan Africanas well as other developing countries to address issues of limited information, participation, education, gender and unclear regulations. The primary weakness of the study is the scope of survey locations within limited resources. However, the study was designed in such a way to provide a balanced representation of rural and urban areas and occupational groups. Sufficient data are obtained for a proper empirical analysis on the Tanzanian public's perceptions towards GM foods.

On this basis, we look forward to future research on public perception towards other GM applications in Africa to further provoke policy discourse. Despite data limitation, our findings provide a solid foundation in promoting public perception towards modern biotechnology.

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