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# STAKEHOLDERS' PARTICIPATION IN BIOTECHNOLOGY POLICY FORMULATION AND THEIR PERCEPTIONS TOWARDS GENETICALLY MODIFIED FOODS IN NAIROBI PROVINCE, KENYA


**By**

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## DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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## DEDICATION

This work is dedicated to my family: my husband Onesmus and our children Larry, Sharon and Ryan for their patience, support and encouragement.

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## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| **AIDS** | - | Acquired Immuno-deficiency Syndrome |
| **Bt** | - | *Bacillus thuringiensis* |
| **DNA** | - | Deoxyribonucleic Acid. |
| **FAO** | - | Food and Agriculture Organization |
| **FDA** | - | Food and Drug Administration |
| **GE** | - | Genetic Engineering/ Genetically engineered |
| **GM** | - | Genetically Modified |
| **GoK** | - | Government of Kenya |
| **GMO** | - | Genetically Modified organism |
| **HIV** | - | Human immuno-deficiency Virus |
| **ICT** | - | Information and Communication Technology |
| **ICTSD** | - | International Center for Trade and Sustainable Development |
| **IPRs** | - | Intellectual Property Rights |
| **KARI** | - | Kenya Agricultural Research Institute |
| **MOEST** | - | Ministry of Education science and technology |
| **NCST** | - | National Council for Science and Technology |
| **NBC** | - | National Biosafety Committee |
| **NGOs** | - | Non-Governmental Organizations |
| **rDNA** | - | Recombinant Deoxyribonucleic Acid |
| **SCBD** | - | Secretariat of the Convention on Biological Diversity |
| **SPSS** | - | Statistical Package for social Sciences |
| **UNEP-GEF** | - | United Nations Environment Programme – Global Environmental Facility |
| **USA** | - | United States of America |

## ABSTRACT

Genetic engineering technology refers to the manipulation of an organism's genetic make up by introducing or eliminating specific genes through modern molecular biology techniques. The technology may however pose public health risks to consumers. As a result of the potential risks of genetically modified foods to human health and the environment, there is widespread recognition that all key stakeholders should be involved in the formulation of the biotechnology policy framework for Genetically Modified Organisms. This study sought to find out whether all key stakeholders participated in the formulation of the national biotechnology policy and to explore their perceptions towards genetically modified foods. A descriptive cross-sectional study was conducted in Nairobi using the stakeholder- based approach. Purposive and probability proportionate to sample size sampling procedures were used to select a sample of 282 respondents. Data was collected using questionnaires and SPSS used to process data. Descriptive statistics were used to summarize data and the Chi-square test used to assess relationships among variables. The findings of the study indicate that over 80% of stakeholders had not participated in the formulation of the national biotechnology policy. Another 80% thought that the government does not involve the public in decisions concerning genetically modified organisms. There was a significant statistical association between respondents' participation in policy formulation and their profession ($\chi^2$=10.698, P=0.03). The results indicate that many of the respondents are positive that genetic engineering technology has the potential to improve sustainability of agriculture (78.7%) and secure food security (92.6%). However, more than a third of respondents (66.3%) feared that GM foods could harm human health. Another 86.2% feared that GM foods could be harmful to the country's biodiversity. There was a significant statistical association between respondents' level of education and their perception of risk of GM foods to human health ($\chi^2$=5.727, P=0.017). There was also a significant statistical association between respondents' profession and their perception of risk of GM foods to human health ($\chi^2$=81.303, P< 0.001). The study concludes that all key stakeholders should be involved in policy making and in the general discussion on whether or not to introduce GMOs in the country. The study recommends that there is need for collaboration between researchers and key stakeholders including the public on goal setting and implementation. The study also recommends that a general public survey on knowledge and perceptions of GM foods be carried out to find out how the general public views the application of genetic engineering technology in agriculture.

# CHAPTER ONE INTRODUCTION

## 1.1 Background to the study

The major technological revolutions sweeping through the world today are biotechnology and information and communication technology (ICT). Of these technologies, biotechnology has raised serious public health concerns. Biotechnology is a general term that refers to any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use (FAO, 2001). Genetic engineering (GE) technology, a major subset of biotechnology is a process by which scientists are able to pinpoint the individual gene which produces a desired outcome, extract it, copy it and insert it into another organism (Barrett and Flora, 2000). This process involves the manipulation of an organisms' genetic make up by introducing or eliminating specific genes through modern molecular biology techniques like recombinant DNA (rDNA) technology. A genetically modified organism (GMO) is therefore, an organism into which one or more genes have been introduced into its genetic material from another organism through modern biotechnology techniques (Barrett and Flora, 2000; Juma and Mugabe, 1994).

The revolution relating to genetic engineering in the last 25 years has led to a huge industrial transformation in the fields of agriculture, foodstuffs, chemicals, medicine, forestry and pharmaceuticals. The resulting new products promise to have tremendous benefits in the fields of agriculture, human health and the environment. Powerful tools provided by science and technology in recent years have had profound impact on the food and agriculture sector worldwide. Innovative production and processing methods have revolutionized many traditional systems, and the world's capacity to generate food products for its growing population has evolved at an unprecedented rate (FAO, 2001).

Persistent poor agricultural production and rising food insecurity in sub- Saharan Africa have placed the role of GE technology in human development into sharp focus (Mugabe, 2003). Since 1995 when the first genetically modified plant was commercialized, genetic engineering has been used in agriculture to generate plants/food crops that; have innate resistance to pests, insects and diseases, an innate tolerance to herbicides and the production of cheaper and more effective vaccines against livestock diseases (FAO, 2001). Future application of GE technology in agriculture promises to produce crops that are stress tolerant. Proponents of the technology look at it as the panacea for solving food insecurity and related public health problems (Kendall *et al.*, 1997).

Indeed public health has benefited enormously from biotechnology for example, in the preparation of recombinant DNA vaccines (Ingco and Nash, 2004). Application of GE technology in agriculture has provided an immense potential for devising new ways of increasing the potential nutrient contents of foods like for example enhancing vitamin A content in rice thus help in reducing micronutrient deficiencies (Goklany, 2000). The technology has the potential for increasing yields in agriculture and thus may help secure food security in developing countries, may also lead to development of foods with medicinal benefits such as genetically modified rice which has the potential to provide an alternative oral vaccine for hepatitis B. Plants can also be genetically engineered to clean up heavy metal pollution from contaminated soil (Cohen, 2001; Ingco and Nash, 2004).

Besides the above mentioned benefits accrued from genetic engineering, there are a number of challenges in its application for human health and development. There is indeed an undeniable danger that unexpected negative side effects might come along with the new technology. The past negative experiences with agricultural technologies and

pharmaceutical products showed that inappropriate use of a new technology can have serious consequences for people and their environment (FAO, 2001).

The major public health concerns about GM foods include: GM foods may introduce unknown allergens into the food supply (FAO, 2001; Goklany, 2000), may cause toxic reactions in individuals consuming GM foods thus threatening human health. Foreign genes might alter nutritional value of foods in unintended ways and may result in foods lower in quality and nutrition (WHO, 2005). Further worry about GM foods arises from the practice of using antibiotic resistance genes as marker genes to measure the success of a genetic modification. Were this resistance to spread to pathogenic bacteria, it could cause great harm of decreased efficacy of antibiotics and accelerate the trend towards resistance to existing antibiotics thus threatening public health (Leeder, 2000). Cultivation of GM crops requires application of more herbicides than non-GM varieties which increases the risks of health hazards to farm workers (Persley, 2003). Patenting GM products makes them expensive and inaccessible to the poor in developing countries and this affects food security as well as public health (Wekesa, 2006). GMOs may also affect human health indirectly through detrimental impacts on the environment or through unfavourable impacts on economic, social and ethical factors (WHO, 2005).

GM foods may also introduce genes that may have profound impact on vegetarians or which may affect cultural and /or religious beliefs of certain groups. For example, tomatoes genetically engineered with anti freeze gene from fish may cause problems to vegetarians as they may consume a non- vegetarian diet unknowingly. This raises the issue of the right to make informed choices (Barrett and Flora, 2000). Closely linked to this is the debate on whether or not GM products should be labelled. Two schools of thought exist

in this regard. The European school of thought holds the view that labelling would enable consumers to make informed choices while the American school of thought considers that GM and non-GM products are 'substantially equivalent' and therefore there is no need to label GM products (Newell and Glover, 2003).

There is also the concern that intellectual property rights (IPRs) of inventors lead to high costs of genetically modified seeds thereby placing them out of reach of developing country farmers. This situation is complicated by technology use agreements that ban the saving of harvested seeds for re-planting (Wekesa, 2006). About a third of humanity depends on saved seeds for their survival (Barrett and Flora, 2000). Additionally, some new strains of crops being developed by biotechnology companies have a terminator gene inserted into them to prevent farmers from keeping seeds produced by their crops for the next season and this creates an over-reliance on biotechnology firms for seeds (Leeder, 2000). Placing the control of crop production into very few hands through patent- protected agriculture removes local and national control of food production and this can affect food security and eventually public health (Barrett and Flora, 2000). The potential of GMOs to upset the balance of nature is another concern to the public. GMOs are novel products which, when released into the environment, may cause ecosystems to adjust, perhaps in unintended ways and cause harm to the environment. There is also concern that outcrossing of GM crops with wild populations may cause genetic pollution and lead to biodiversity loss (FAO, 2001). Besides, large scale production of GM crops may lead to monoculture and therefore diminish biodiversity (Wekesa, 2006).

Knowledge and participation of all relevant stakeholders is vital in ensuring that biotechnology and biosafety policies do not conflict with religious and cultural beliefs of

societies. The Cartagena Protocol, which is an internationally binding legal instrument calls upon state parties to enhance public participation in the safe transfer, handling and release of GMOs (Kameri-Mbote, 2002). The emphasis on participation and consultation is premised on the idea that the involvement of all stakeholders is critical to the effectiveness of any regulatory framework (Glover, *et al.*, 2003). Kenya is a signatory to this protocol and is thus obligated to adopt public participation policies (Kameri-Mbote, 2002). Moreover, participation by all key stakeholders and transparency in regulatory process commands broader and deeper respect and in the end would serve society interests better (Katerere-Mohamed, 2003; Scoones, 2003). Policies drafted with involvement of all stakeholders also command public credibility and respect and helps build public trust. Continuing efforts need to be made by regulatory authorities to elicit the views of a wide range of stakeholders and to ensure that stakeholders' views are taken into account in decision making and policy processes (Glover, 2003).

Increasing concerns about safety of GM foods as well as growing environmental and ethical concerns give consumers an important role in the process of successful biotechnology adoption. For example, Zimbabwe witnessed the sneaking in and illegal planting of Monsanto's B*t* cotton for trials on a few large-scale farms (Katerere- Mohammed, 2003). As a result of civil society advocacy for public participation in decision making, regulatory authorities actively engaged scientists, corporations, research institutions and government officials in defining technological futures consistent with their livelihood vision (Katerere-Mohammed, 2003). In Zambia, debate around the right to choose led Zambia's president in August 2002 to reject GM food aid to avert food crisis in the country. The decision was made on the basis of a national debate that included NGOs, farmers, women's groups, church leaders, members of parliament and Zambian scientists and economists. In India,

public participation led to a slower acceptance of GM crops accompanied by well formulated policy and setting up of requisite regulatory structures (Scoones 2003).

Whereas there are isolated cases of GM activity in Kenya (Odame et al., 2003), it is not clear whether all key stakeholders were involved in the formulation of the national biotechnology policy framework for GMOs. No single study has been done in Kenya in this regard. This study looked at stakeholders' participation in the formulation of the national biotechnology policy as well as their perceptions towards GM foods.

## 1.2 Statement of the Problem

Whereas genetically modified foods hold a promise to secure food security and deliver other public health benefits to consumers, they may nonetheless be associated with a myriad of public health risks. This makes it imperative that all key stakeholders be involved in decisions made concerning GMOs. This would serve to mitigate the public health risks associated with GM foods by advocating for rigorous testing of these foods before they are released to the market and act to ensure safety of GM foods to consumers. In Kenya, there are limited trials on GMOs especially on insect resistance involving Bt maize and Bt cotton (Odame et al., 2003). Additionally, the country has a draft Biotechnology Policy and a Biosafety bill has been tabled in parliament for discussion. Whereas the Cartagena Protocol provides for participation of all key stakeholders in decisions made about GMOs, It's however not clear whether all key stakeholders in the country participated in drafting the biotechnology policy. This study sought to find out whether all key stakeholders participated in the formulation of the biotechnology policy framework for GMOs and to explore their perceptions towards genetically modified foods.

### 1.3 Research Questions.

i. Have all key stakeholders participated in the formulation of the national Biotechnology Policy framework for GMOs?

ii. What are the perceptions of stakeholders towards genetically modified foods?

### 1.4 Hypotheses.

i. All key stakeholders have not participated in the formulation of the national Biotechnology policy framework for GMOs.

ii. Stakeholders have negative perceptions towards genetically modified foods.

### 1.5 Objectives of the Study.

#### 1.5.1 Broad Objective

To investigate stakeholders' participation in the formulation of the national Biotechnology policy and to explore their perceptions towards GM foods.

#### 1.5.2 Specific Objectives

i. To investigate whether all key stakeholders participated in the formulation of the national Biotechnology policy framework for GMOs.

ii. To determine stakeholders' perceptions towards genetically modified foods.

### 1.6 Significance and Anticipated Output

This study will act to show the pattern of stakeholder participation in the formulation of the national Biotechnology Policy in the country. The outcome of the study will provide an input to secure a high level of democracy in relation to the debate about GMOs. The study will also act to urge policy makers to develop strategies that emphasize on ensuring safety

of GMOs and also give recommendations towards developing sound policies on GMOs through public involvement in decision making.

## 1.7 Limitations of the Study

Biotechnology is a broad and wide field. This study predominantly focused on agricultural biotechnology and specifically genetically modified foods. Owing to the technical nature of the subject of study, the study was carried out in Nairobi Province. Respondents were recruited mainly from the stakeholders expected to be involved in the biotechnology debate in Kenya, most of whom are in Nairobi Province.

## 1.8 Operational Definition of Terms

**Biodiversity** - The variety and variability of life on earth including all plant and animal species.

**Biosafety** - Precautions taken to reduce the risks from GMOs- these include possible harm to human health and the environment.

**DNA** - Deoxyribonucleic acid is the chemical building block of the genetic information in the cell from which genes are composed.

**Food security** - When all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle.

**Genetic Engineering/ Modification** - is a process by which scientists are able to pinpoint the individual gene which produces a desired outcome, extract it, copy it and insert it into a host organism so that it expresses the desired characteristic.

**GMO** - Any organism whose genetic makeup has been altered by insertion of small fragments of genetic material to enhance desired characteristics.

**Intellectual Property Rights (IPRS)** - Rights given to inventors when an invention is deemed useful to society and confers protection for a specified period of time.

**Public participation** - Process of engaging all key stakeholders in making decisions concerning GMOs and in risk assessment for GMOs.

**Stakeholder** - is an intermediary or representative of a broader group impacted (positively or negatively) by decisions made about GMOs and who is expected to participate in the debate about GMOs.

**Bt Crops** - These are GM crops that carry a gene from the soil bacterium *Bacillus thuringiensis* which produces a protein that is toxic to certain insects.

# CHAPTER TWO LITERATURE REVIEW

## 2.1 Introduction

This chapter contains a discussion of the literature review related to the topic of study and includes: Introduction, the state of agricultural production in Kenya, history of agricultural biotechnology, Stakeholders' participation in agricultural biotechnology, potential benefits of GM foods/crops, potential risks of GM foods/crops, risk assessment and regulation of GMOs and biosafety regulation framework in Kenya.

## 2.2 The State of Agricultural Production in Kenya

Agriculture is the most important sector in the Kenyan economy given its contribution to employment, foreign exchange, food and its linkages with other sectors of the economy (Odame *et al.*, 2003). The sector contributes 26% of GDP, generates about 60% of total foreign exchange earnings and provides 70% of Kenya's employment (Mugabe and Clark, 1998). The sector provides nearly all food requirements for the nation and the bulk of raw materials required for the industrial sector. As such, it has an important role to play with respect to development efforts to eliminate poverty and food insecurity (Odhiambo et al., 2004). In the last ten years or so, the performance of the sector has been steadily declining. With 80% of the Kenyan population (majority of whom are poor) living in the rural areas, the poor performance of the sector has serious implications on poverty and living standards of the people. Declining agricultural productivity has led to under-employment, food shortages and poor nutritional status (Odame *et al.*, 2003). Although the contribution of agriculture in Kenya's economy and food production has been well articulated, the potential contribution of GE technology in agriculture and its associated risks have not been addressed. This study sought to investigate if stakeholders view GE technology as having the potential to contribute to alleviating food insecurity in the country.

The causes of poor agricultural production and food insecurity are many, complex and interrelated. They include poverty, which is the lack of purchasing power, unstable climatic changes, lack of appropriate technologies, natural disasters, poor infrastructure and decline in arable land (Mugabe, 2003). The problem has been worsened by the HIV/AIDS pandemic. The disease affects food security and nutrition in that adult labour is often removed from the affected households. These households will have less capacity to produce or buy food, as assets are often depleted for medical or funeral costs. Furthermore, the agricultural knowledge base will deteriorate as individuals with farming and science experience succumb to the disease (FAO, 2001). These articles comprehensively address the underlying causes of food insecurity but do not address the potential of GE technology in addressing the problem of food insecurity. This study looked at the potential contribution of GE technology in food production and alleviation of food insecurity.

The urgent need to achieve food security in African countries requires that the problem of inadequate agricultural problems be addressed, so that food production can be increased and nutritional standards raised (Nnadozie *et al.*, 2003). Modern biotechnology is recognized as having great potential for the promotion of human well being, particularly in meeting critical needs for food, agriculture and health care (Ingco and Nash, 2004). There was need therefore to investigate stakeholders' perceptions on the contribution of genetically modified foods to promoting human well being and meeting these critical needs.

## 2.3 History of Agricultural Biotechnology

Biotechnology has been in use for thousands of years, both for traditional methods such as brewing and fermentation that were in use as early as 6,000BC, as well as newer methods such as cross-breeding of food crops and tissue culture that have been used since the late

nineteenth century (FAO, 2001). Gregor Mendel's pea experiments identified the principles of inheritance and laid the foundation for conventional agricultural biotechnology. Crick and Watson's discovery of DNA's double helix structure in the 1950s ushered in the era of genetic engineering. Presently, the term biotechnology has come to refer specifically to genetic engineering technology (Barrett and Flora, 2000).

Genetic modification involves five steps (Hain, 2005): in the first step, the gene containing the desired characteristic is taken out of the source organism and modified so that it expresses itself in a certain way later on when it is in its new host plant. Secondly, the gene is cloned or mass-produced to make thousands of copies. In the third step, the gene is packaged with two other copies of DNA that control how the gene will work once it is inside its new organism. The first piece, called the 'promoter', is attached and controls whether the gene is switched 'on' or 'off' all the time, some of the time or none of the time. The second piece, called a 'marker gene', is also attached to the gene of interest so that scientists can test whether the gene, and so the desired characteristic, has been transferred. The fourth step involves the insertion of the gene package into the cells of the plant being modified either using a gene gun or using bacteria called *agrobacterium.* Lastly, the genetically modified plant is crossed with the best varieties of the conventional crops in order to get a variety that has the best characteristics that conventional crops and genetic modification can deliver (FAO, 2001).

Modern biotechnology is evolving rapidly. The adoption of agricultural biotechnology represents the fastest adoption of a new technology in the history of agriculture (Masood, 2005). The first transgenic plants were produced experimentally in 1983 by means of *Agrobacterium*-mediated gene transfer (Persley, 2003). Commercial cultivation of

transgenic crops began in 1995 and by 2002, there were approximately 58.6 million hectares of GM crops growing in sixteen countries (Wakhungu and Wafula, 2004). In 2005, ninety million hectares of land was planted with biotech crops by approximately 8.5 million farmers in twenty one countries (James, 2006). There is expansive growth and commercialization of GMOs and this called for a study to establish stakeholders' perceptions of the application of genetic engineering technology in agriculture.

Genetic engineering technology has been used to achieve four broad goals: to change product characteristic; e.g. the genetically modified tomato with prolonged shelf-life (Barret and Flora, 2000). To improve plant resistance to pests and pathogens; for example, GM maize genetically modified to resist specific insects (WHO, 2005). To improve productivity e.g. crops are genetically modified to be for example drought resistant (Chet, 1993). To improve their nutritional value e.g. golden rice contains a high level of beta-carotene- a vitamin A precursor which helps protect against visual impairment and blindness (Persley, 2003). There was need for a study to investigate Kenyan stakeholders' perceptions towards the application of genetic engineering technology in agriculture.

## 2.4 Stakeholders' Participation in Agricultural Biotechnology

Current public debate on the commercialization of agricultural biotechnology products has underscored the importance of public participation in risk assessment and decision-making pertaining to GMOs (Juma and Gupta, 1999). A number of countries have launched programs aimed at including the public in decisions involving the use of biotechnology in agriculture (Kameri-Mbote, 2002). Since stakeholders are taken to represent the public, there was dire need to investigate stakeholders' participation in decision-making about GMOs in developing countries such as Kenya.

The notion that public participation in environmental decision-making is important to policy success has been underscored in numerous international policy instruments (Glover, 2003). Since the 1992 Earth Summit in Rio de Janeiro, the inclusion of requirements of public participation in international conventions and agreements has become almost a matter of course (FAO, 2005). Principle 10 of the Rio Declaration states that 'environmental issues are best handled with the participation of the all concerned citizens at the relevant level (Glover, 2003; Glover et al., 2003). At the national level, each individual shall have appropriate access to information concerning the environment and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Similarly, article 1 of the Aarhus Convention of 1998 on *Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters* states that 'each party shall guarantee the rights of access to information, public participation in decision-making and access to justice in environmental matters' (FAO, 2005).

The Cartagena Protocol on Biosafety which is an internationally binding legal instrument on GMOs was adopted in January 2000 and entered into force in September 2003. The Protocol aims at comprehensively addressing concerns raised about biotechnology (Kameri-Mbote, 2002). Article 23 of the Protocol focuses on public awareness and participation. The Protocol calls upon parties to promote and facilitate public awareness, education and participation concerning the safe transfer, handling and use of GMOs (SCBD, 2000). This article commits countries to have established ways of ensuring public participation (Kameri-Mbote, 2002). The article does not however address ways of ensuring public participation in risk analysis and decision making. This study addresses stakeholders' participation in policy making and gives recommendations on ways the government can enhance public participation.

The joint FAO/WHO Codex Alimentarius Commission recognizes risk communication as essential in risk assessment of GMOs. Risk communication is an interactive process involving all interested parties, including government, industry, academia, media and consumers (FAO, 2005). The Commission notes that risk communication includes transparent safety assessment and risk management decision-making processes. Effective risk communication should include responsive consultation processes that are interactive. The views of all interested parties should be sought and relevant food safety and nutritional issues that are raised during the consultation should be addressed during the risk analysis process (FAO, 2005). There is much emphasis on public participation depicted by several legislations and international conventions. However, the mere fact that international instruments mandate public participation does not mean that such activities will automatically occur (Glover, 2003). There was therefore, need to find out whether all key stakeholders participated in the formulation of the national Biotechnology policy for GMOs since these stakeholders are expected to sensitize the general public on GMOs.

### 2.4.1 Why Public Participation is Necessary

Biotechnology is not evolving in a socio-political vacuum. The public have a direct interest in scientific advances yet they are not participating in the GM debate (Mugabe, 2003). Public participation in policy processes and decision making is understood to be a central element of good governance and suitable development (Glover, 2003). This is because in principle, participation should contribute to better-informed, more appropriate and effective, more legitimate and more broadly - owned decisions and policies. Arguments in favour of public participation in policy debates often stress that participation is key to an effective policy (Glover, 2003). In the biosafety context an additional argument is also fore grounded by the proponents of biotechnology: that information provision and enabling of

participation are key to ensuring that biotechnologies become accepted by a skeptical world and worried public (Glover *et al.*, 2003). These articles recognize the importance of public participation but efforts have not been made to find out whether public participation has been part of the process of adopting GMOs in developing countries. This study addresses stakeholders' participation in the process of adopting GMOs in Kenya.

Principle 10 of the Rio Declaration commits parties to provide individuals with appropriate access to publicly-held information and to give them the opportunity to participate in decision making. It also provides that environmental and health issues are best handled with the participation of all concerned citizens at the relevant level (Glover, 2003). Public participation is vital in ensuring that biotechnology and biosafety policies do not conflict with religious and cultural beliefs in society (Kameri-Mbote, 2002). Besides disseminating scientific information, effective public participation also aims at minimizing sceptism and building trust between biotechnology and end users of biotechnology products (Kameri-Mbote, 2002). This implies that regulatory processes need to be transparent and participatory. It was therefore important to investigate stakeholders' participation in policy decisions since these stakeholders are involved in sensitizing the public about GMOs.

The Biosafety protocol obligates parties to provide individuals with appropriate access to publicly-held information and to give them the opportunity to participate in decision making (SCBD, 2000). Since Kenya is party to the Cartagena Protocol, it is obligated to embrace public participation and thus the need to investigate stakeholders' participation in policy formulation for GMOs in the country. Providing access to information is an essential pre-requisite for effective and inclusive public participation (McGee and Norton, 2000).

Public participation has an important role to play in ensuring the effectiveness of the national biosafety framework for practical reasons. In order for the Protocols' rules on the risk assessment and risk management of trade in GMOs to be conducted smoothly and safely, it is necessary to ensure that various stakeholders and affected parties are aware of what the rules are and what obligations they entail. Various private and individual groups such as farmers, laboratory technicians, not to mention public officials such as customs officers and government inspectors will need to know how to handle GMOs in transit safely. The implementation of Article 23 is driven not only by the need to promote public involvement in the biosafety decision-making process and regulatory framework, but by a more direct and practical need to inform relevant stakeholders about how to implement the rules on the ground (Glover, 2003). It was therefore necessary to find out whether key stakeholders in Kenya were involved in drafting the national biotechnology policy.

A number of industrialized countries have launched programs aimed at including the public in biotechnology assessment and decisions involving the use and application of modern biotechnology. While a number of African countries such as Egypt and Burkina Faso have put in place biosafety guidelines and frameworks, these do not articulate explicitly the issue of dissemination of information regarding biotechnology risks and benefits. The rapid pace of technological change and the wide-ranging nature of the perceived effects of biotechnology necessitate much greater public participation in policy formulation (Kameri-Mbote, 2002). Kenya has a draft biotechnology policy pending approval by parliament and this necessitated the need to investigate whether all key stakeholders were involved in drafting this policy.

### 2.4.2 Points/Stages at which the Public can Participate

GMOs are being commercially produced in developing countries and it is expected that more GM products will be produced in future in a greater number of developing countries. Given the wide ranging nature of the perceived risks of GMOs and increased application of GE technology in developing countries, it's necessary to involve the public in decision making processes concerning GMOs. The main places in the decision-making process where the public could be involved include: involving the public in National policy dialogues like for example in New Zealand; the public can also participate in developing regulatory framework for GMOs (FAO, 2005). Kenya is one of the countries that the UNEP-GEF project has assisted to develop a national biosafety framework (Juma and Gupta, 1999). There is need to find out whether public participation was facilitated. The public could also participate in the approval of individual GM products. Approval of GM products falls under the broad umbrella of risk analysis, a discipline of key importance for regulating health and environmental risks. Risk analysis follows a structured approach comprising of risk assessment, risk management and risk communication. Risk communication is relevant to public participation. The public can also participate in Post - release monitoring of GMOs after individual GM products have been approved (FAO, 2005). Although no GM foods have gone up to commercialization stage in Kenya, there have been field trials carried out in different parts of the country which necessitate public participation.

### 2.4.3 Mechanisms of Public Participation

Sharing information and raising awareness invites participation because it enables citizens to consider issues and form opinions about them. There are various mechanisms of public participation. These include: *creating enabling legal frameworks* like for example, in

Bolivia, laws on public participation help facilitate meaningful public involvement in biosafety decision making; *having routine opportunities for public comment* like for instance in Canada and the United Kingdom, applications for regulatory approval are published in a register with opportunities for public comment as a matter of routine; *Using the media e.g. newspapers, radio and TV* also provide useful routes for informing the public about biotechnology, biosafety regulations, applications for regulatory approval, and opportunities for public comment and participation (Glover *et al.*, 2003). Glover and colleagues summarize ways in which different countries have sought to promote and facilitate public awareness and participation in the design and implementation of their national biosafety frameworks. No studies have looked at public participation in the biotechnology debate in the Kenya. This study sought to investigate stakeholders' participation in biotechnology policy formulation and recommends tools the government can utilize to embrace public participation in decision making concerning GM foods.

## 2.5 Potential Benefits of Genetically Modified foods/ Crops

Continued expansion in the use of transgenic crops will depend on the benefits obtained by farmers in cultivating transgenic instead of conventional crops (Persley, 2003) Modern biotechnology is a powerful tool that presents a range of potential human health, environment, social and economic benefits (Ingco, 2003). GE technology could contribute directly to enhancing human health through various ways: GE technology can be used to remove allergens and/or toxic compounds from certain foods (WHO, 2005). Through GE technology, pest tolerant crops can be grown with lower levels of chemical pesticides, resulting in reduced chemical residues in food, and less exposure to pesticides (Persley, 2003). Plants can potentially be used to produce edible vaccines. Scientists are working on using bananas and other fruits as vehicles to deliver vaccines against animal and human

diseases. For example, the hepatitis B surface antigen has been expressed in tobacco and potatoes, and the feasibility of oral immunization using transgenic potatoes has been demonstrated (Kendall et al., 1997).

Genetic engineering technology can also be utilized to produce crops with improved nutritional value. The best-known example of a GM crop conferring enhanced nutritional properties is rice containing a high level of beta-carotene - a Vitamin A precursor (Persley, 2003). Vitamin A deficiency is a public health problem that contributes to severe illness and childhood mortality (Goklany, 2000). These preventable conditions increase the burden of disease on the health systems of developing countries (WHO, 2005). GE technology can also lead to increased antioxidant content in foods. These phytonutrients are known to prevent disease and improve health. Bioengineered crops can also help battle the so-called diseases of affluence, namely ischemic heart disease, hypertension and cancer (Goklany, 2000).

With regard to environmental benefits, biotechnology products resistant to insect pests require less insecticides (Goklany, 2000). The use of these products also permits farmers to employ conservation tillage techniques that reduce soil erosion and increase carbon sequestration. GM crops are able to absorb Nitrogen and Phosphorus at elevated rates, thus reducing the amount of fertilizer that needs to be applied. This limits environmental damage by reducing reliance on synthetic fertilizers and pesticides that are expensive and damaging to the environment. This would also reduce ground and surface water pollution, risks of chemical spills and atmospheric emissions of Nitrous Oxide, a green house gas (Goklany, 2000). Crops can also be engineered to directly clean up the environment. Crops can be engineered to selectively absorb various metals and metal complexes such as

aluminium, copper and cadmium from contaminated soils (Persley, 2003). Environmental stresses severely affect the sustainability of agriculture. Tolerance to environmental factors through genetic modification is an area that is in the early stages of development. With genetic engineering, it's possible to identify and isolate genes that play a role in the physiological adaptation of plants to environmental stresses (Chet, 1993). A lot has been documented on the benefits accruing from GM foods and there was need to explore stakeholders' perceptions of the benefits of GM foods

Acknowledging the potential and contribution of GM products to world food production is not to ignore their possible risks with regard to food safety and unpredictable environmental hazards. There is indeed an undeniable danger that unexpected negative side effects might come along with the new technology. The past negative experiences with agricultural technologies and pharmaceutical products showed that inappropriate use of a new technology can have serious consequences for people and their environment (FAO, 2001).

## 2.6 Potential Risks of Genetically Modified Foods/Crops

The introduction of a transgene into a recipient organism is not a precisely controlled process and can result in a variety of outcomes with regard to integration, expression and stability of the transgene in the host. Research so far has identified a number of potential harmful effects resulting either from the very process of genetic modification itself (wrong or unstable insertion) or from the successfully modified end product (Barrett and Flora, 2000). Potential harmful effects on human health include allergenicity, toxicity, changes in nutrient composition and antibiotic resistance. Potential harmful effects on the environment include effect on non-target organisms, effects on biodiversity, invasiveness and development of resistance (WHO, 2005).

The impact of GMOs on human health is one of the most frequently cited reasons for opposition to biotechnology (FAO, 2001). A major concern on GM foods is that genes transferred from foods to which people are allergic, could trigger allergies in consumers of such GM products (Batalion, 2000). Through biotechnology, allergens could be transferred from traditional foods into GM foods or allergens could be transferred from foods which people know that they are allergic to foods they think they are safe thus resulting in allergic reactions (FAO, 2001). The problem is unique to genetic engineering because it alone can transfer proteins across species boundaries into completely unrelated organisms (Halloran and Hansen, 1998).

Adverse direct health impacts could stem from the new chemical composition of the genetically modified organism ("toxicity"). Many organisms have the ability to produce toxic substances. In some cases, plants contain inactive pathways leading to toxic substances. Addition of new genetic material through genetic engineering could reactivate these inactive pathways or otherwise increase the levels of toxic substances within plants. Thus, genetic engineering could enhance natural plant toxins by switching on a gene with toxic effects (Barrett and Flora, 2000).

Foreign genes may alter the nutritional value of food in unpredictable ways. The journal of medicinal food reported that concentrations of phytoestrogen were lower in GM soy beans compared to their traditional strains. There are also negative implications of consuming excess nutrients particularly in certain groups of people such as infants, the elderly and pregnant women (Lappe, 1999). Another potential negative effect of GM products on public health is that antibiotic-resistant marker genes used to identify whether a gene has been successfully incorporated into a plant could, through consumption of the antibiotic

gene by humans, accelerate the trend towards antibiotic-resistant diseases (FAO, 2001). Research has shown that DNA in food is not completely broken down by digestion. Small fragments of DNA from food can be found in different parts of the human gastrointestinal tract after eating. Resistance genes could be taken up by human or animal pathogens, making them impervious to antibiotics and effectiveness of existing antibiotics reduced (Barret and Flora, 2000)

Existing studies have so far not yielded scientifically conclusive evidence indicating that GMOs have harmed human health (Masood, 2005). Not enough long-term studies have been conducted on the subject to provide answers yet on the potential future health impacts of GMOs (Barrett and Flora, 2000). Many previous technologies have proved to have adverse effects unexpected by their developers. For example, DDT turned out to accumulate in fish and thin the shells of fish-eating birds. Recent scientific studies have suggested that some GM foods could have serious adverse effects on human health. New GM food products must therefore be assessed for unexpected genetic effects, toxin levels, genes introduced from sources associated with human allergies and marker genes that potentially could transfer antibiotic resistance (Barrett and Flora, 2000).

Public concerns about the risks of GMOs on the environment are based on the fear that when such organisms contain genes introduced from outside their normal range of sexual compatibility, they may present new risks to the environment (Barrett and Flora, 2000). GM crops are harmful to the environment and biodiversity. Laboratory tests have shown that pollen from GM maize in the US damaged the caterpillars of the Monarch butterfly. This experiment demonstrates toxicity of GM products to at least one single species, and it does show that GMOs could have the potential to do unexpected harm to other plants and animals (Batalion, 2000).

There is a potential for crossbreeding between GM crops and surrounding vegetation thus insect resistance and herbicide tolerance traits may be passed on to wild plants including weeds thus creating super weeds (WHO, 2005). Should GM varieties become super weeds, farmers will have to pay for increased crop protection costs. This could on the other hand result in weeds that are resistant to herbicides and thus require greater use of herbicides, leading to soil and water contamination (Barrett and Flora, 2000).

Wide spread use of GM crops may also have adverse socio- economic effects. The major ethical concerns about GM foods include issues surrounding food/seed security, domination of world food production by few multinational companies, religious issues emanating from the mixing of genes among species which are also relevant to vegetarians and the labelling of genetically modified foods to facilitate informed choice for consumers (Wekesa, 2006). About a third of humanity depend on saved seeds for their survival. Household food security especially security in planting materials is the basic building block for community and state food security. This is achieved within decentralized system of food production in which local communities are autonomous in control and management of their resources. Almost all GM crops are owned by private sector corporations and this undermines food security (Shiver and Moser, 1995).

Although WHO, 2005 reported that currently available GM foods are considered safe to eat, this does not guarantee that risks will not be encountered as more foods are being developed with novel characteristics. The hazards and benefits of GM foods remain difficult to predict and measure accurately. This uncertainty is due to several factors including the complexity of genetic code, ecological and social systems in which GE crops are used. Therefore, research programs and regulatory policies must consider the

potentially serious- yet highly complex and uncertain- environmental ethical and public health effects that may result from broad-scale use of GE foods (Barrett and Flora, 2000). Kenya has adopted GE technology and there was therefore need to provide a comprehensive picture of stakeholders' perceptions of genetically modified foods.

## 2.7 Risk Assessment and Regulation of GMOs

In light of the above risks, governments around the world, since the first commercialization of GMOs in the early nineties, started to address the question of how to regulate GMOs. The concept of risk assessment of GMOs was first discussed at the Aslomar Conference in 1975 (WHO, 2005). The discovery of rDNA had raised concerns among researchers regarding the potential creation of recombinant viruses whose escape would threaten public health. Fourteen months after a voluntary moratorium on research involving rDNA techniques, guidelines for the physical and biological containment of riskier experiments were drafted and agreed. These guiding principles were the basis of the US guidelines for research in modern biotechnology developed in 1976. In continuation of this, regulation for contained use and deliberate release of GMOs was developed, e.g. EU regulations in 1990. These guidelines elaborated a pre-market human health and environmental safety assessment requirements for all GMOs on the basis that they are novel and have no history of safe food or environmental use. Many countries have since established specific premarket regulatory systems requiring rigorous assessment of GMOs prior to their release into the environment and/ or use in the food supply (WHO, 2005).

The approval process of GM foods involves an assessment of the risks to human health and the environment. Risk analysis is a process consisting of three components: risk assessment, risk management and risk communication. Risk assessment refers to the

process of gathering diverse data to identify possible risks in research and development involving the use of GMOs. This takes into consideration the properties of GMOs and the environment into which they are introduced. Risk management is the process of weighing policy alternatives in consultations with all interested parties, considering risk assessment and other factors relevant for the protection of consumer' health and for the promotion of fair trade practices as well as selecting appropriate prevention and control options. Risk Communication is the interactive exchange of information and opinions among assessors, risk managers, consumers, industry, the academic community and other interested parties throughout the process of risk analysis (FAO, 2001). This invites for involvement of all stakeholders and therefore calls for an investigation of stakeholders' involvement in the GMOs discourse.

Regulation performs three key and closely related functions in the biotechnology context. These are: risk management, facilitating commercial transactions and generating public trust in the new technologies. However, commercialization of GM products has been allowed to override a fuller consideration of the potential environmental and socio-economic risks associated with GM crops. This has undermined public trust and confidence in the regulation of biotechnology products (Newell and Glover, 2003). Involvement of all key stakeholders in risk assessment for GMOs is vital to win public trust and acceptance of genetically modified foods.

The scope of regulatory activity in relation to crop biotechnology covers diverse areas which include; regulation of laboratory research, intellectual property protection, oversight of field trials, the trade in GMOs, issues of food and safety feed safety, and product labeling (Dunlop, 2000). The United States of America and the European Union have adapted

stringently different approaches to the development of regulatory regimes for GM crops (Newell and Glover, 2003). These two approaches have emerged as predominant models that frame the global debate on regulating GMOs.

The USA has adopted product-based regulation in which case GMOs are assessed according to the characteristics and intended use of the final product, not the process by which they were developed (FAO, 2001). In other words, the techniques of GE are not seen as more hazardous than other techniques such as traditional breeding. According to Food and Drug Administration (FDA), GM foods require regulation and labelling if they contain significantly different structure, function or quantity than substances found in non-GM foods. This utilizes the concept of substantial equivalence which considers many GE organisms to be 'substantially equivalent' to their non-GE conventional counterparts and therefore, pose no special risks and do not require new or different regulatory practices. Pre-market testing is required only when a GE food is deemed to be significantly different from existing foods. According to these principles, most GE foods and crops do not require extensive testing prior to commercialization (Newell and Glover, 2003).

In contrast, the EU has adopted *process-based* policies that require all GMOs to undergo review. Under this approach, the regulatory oversight of a GMO is triggered by the genetic engineering process by which it was developed. This approach regulates all products that have been produced through modern biotechnology techniques (Newell and Glover, 2003). The EU regulation implements this approach by requiring prior consent and risk assessment for every GM product before and after it is released into the environment or market (Dunlop, 2000). This precautionary approach means that controls are put in place even in the absence of definite information about the risks posed.

In democratic societies, public perceptions can both hamper commercial introduction and adoption of new technologies. Public opinion surveys have shown that people's perceptions towards biotechnology vary. Several surveys of the European public's attitudes towards biotechnology have been conducted under the title of Eurobarometer (Euobarometer, 2000). Similarly a study done in South Africa on stakeholders attitudes towards genetically modified foods showed that their attitudes towards biotechnology differ (Aerni, 2002). This study sought to determine whether the debate about genetically modified foods in Kenya has been conducted with the involvement of key groups of stakeholders and to explore their perceptions towards GM foods.

## 2.8 Biosafety Regulation in Kenya

Kenya has been engaging with biotechnologies such as bio-fertilizers and tissue culture for several decades (Odame et al., 2003). Biotechnology research activities in Kenya range from use of tissue culture to production of disease free planting materials, molecular markers for disease diagnosis to biotransformation to produce insect and virus resistant crops (Onsongo, 2005). In June 2004, President Kibaki inaugurated Kenya's first research institution on biotechnology which set to Kenyan scientists to test the environmental impacts of GM crops under controlled conditions (Masood, 2005). Kenya has adopted GE technology as evidenced by contained and confined trials of Bt maize, Bt cotton, transgenic potato and GM cassava (Mugabe, 2003; Onsongo, 2005). The first product of GE technology to be developed in Kenya was a GM virus resistant sweet potato. The project began in 1991 but results of contained field trials showed that the transgenic potato failed to protect against viruses. Several other GM crops have been introduced in the country. However, no GM crops have moved beyond the trial stage and released for commercialization (Odame et al., 2003).

The developments in biotechnology in Kenya increasingly necessitate regulation (Mugabe, 2003). With the potential risks posed by genetic engineering, it is consistent with the precautionary principle to regulate any undertaking for the import, transit, containment, use, release, or placing on the market of GMOs and products of GMOs (FAO, 2001). The increasing application of biotechnology in Kenya has raised the need to formulate appropriate biosafety regulations and guidelines to streamline biotechnology research and development (Kameri-Mbote, 2004). Biosafety and regulatory developments in Kenya have been taking place concurrently with biotechnology development (Mugabe, 2003). The Cartagena Protocol on biosafety aims at comprehensively addressing concerns raised about biotechnology. To provide a suitable framework for the implementation of the biosafety measures, parties to the Biosafety Protocol are required to put in place relevant national legislation (Kameri-Mbote, 2004). Kenya is party to the Cartagena Protocol on biosafety and is subsequently required to put in place legal and administrative measures to comply with various provisions of the protocol (Kameri-Mbote, 2002). There was therefore, need to find out whether Kenya, as party to the Protocol complies with the provision on involvement of all key stakeholders in the regulation of GMOs.

The government started to address biosafety concerns from 1993. The National Council for Science and Technology (NCST) was designated by the government to lead the implementation of biosafety measures (Kameri-Mbote, 2004). In 1998, regulations and guidelines for biosafety in biotechnology for Kenya were produced and published by the NCST (Kameri-Mbote, 200; Onsongo, 2005). The guidelines require that the release of GMOs be preceded by approval by the National Biosafety Committee. Competent authorities have been appointed to deal with matters of biotechnology. They are supposed

to undertake risk assessments before making the decision to approve or deny approval of import (Kameri-Mbote, 2004).

The NCST through the National Biosafety Committee (NBC) is the coordinating office on all issues related to biosafety. Several workshops to deliberate on issues relating to development of an appropriate biosafety framework have been held (Onsongo, 2005). In august 2004, the National council for Science and technology (NCST) drafted a biosafety bill which was then forwarded to the cabinet for discussion before being presented to the parliament. By February 2005, the bill had not been published and groups that oppose GM technology had complained that very few people outside of government and possibly industry had been consulted in drawing up the bill (Masood, 2005). The government finally published a Bio-Safety bill that was tabled in parliament for debate in July 2007. However, parliament was dissolved before the bill was discussed. The bill was later reprinted in June, 2008 and has been tabled in parliament for discussion (Republic of Kenya, 2008). It is uncertain how long the Bill will take before approval and therefore, lack of an effective and enforceable legal framework subjects consumers to the potential risks of GM foods.

A stakeholder-based survey was conducted in Nairobi, Kenya which sought to find out whether all key stakeholders in the biotechnology debate participated in drafting of the biotechnology policy and gives recommendations on tools the government can utilize to enhance public participation in decision- making concerning GMOs.

# CHAPTER THREE METHODOLOGY

## 3.1 Introduction

This chapter contains a detailed discussion of the research methodology employed in the study. In summary, the chapter discusses the following sub topics: research design, study location, target population, sampling techniques and sample size determination, data collection instruments, pilot study and ethical considerations.

## 3.2 Research Design

A descriptive cross-sectional study was conducted. This study design was chosen since it gathers data at a particular point in time with the intention of describing the nature of existing conditions. The investigation of public perceptions in a particular country can be conducted either by means of a representative sample survey of a country's population or by means of a stakeholder-based survey approach, which focuses mainly on those political actors who represent certain public and private interests (Aerni, 2002). This study adopted a stakeholder-based approach due to the technical nature of the subject of study. It was also more appropriate to focus on those stakeholders whose opinion or information serves as a relevant source of information for the public at large. The study adopted a methodology similar to Aerni, 2002 which was used to investigate stakeholders' attitudes towards agricultural biotechnology in South Africa.

## 3.3 Study Location

The research was carried out in Nairobi Province of the republic of Kenya. This is because Nairobi being the country's capital city is home to 10% of Kenya's population. It is cosmopolitan in nature and is host to people from diverse backgrounds i.e. socio-economic, political, professional and educational backgrounds. Also, a cross-section of the key stakeholders in the biotechnology debate live in the city.

### 3.4 Target population

The target population for the study consisted of respondents from five categories of stakeholders. These categories of stakeholders were purposively sampled. This is because these stakeholders were assumed to be well informed about biotechnology and this allowed a survey on public perceptions to be conducted in a country with generally low awareness of agricultural biotechnology. These categories of stakeholders were taken to represent the opinion leaders who are considered instrumental in sensitizing the public and have significant influence on those citizens who are hardly informed about agricultural biotechnology and its environmental, health and socio-economic risks and benefits. Additionally, according to Glover *et al.*, 2003, since resources for consultation and participation are always finite and often scarce, governments tend to rely on a cascade mechanism in which they reach out only to those who claim to be intermediaries or representatives of broader groups and these representatives are expected to do the rest. Based on the Glover et al., 2003, the stakeholder-based survey was found appropriate to investigate stakeholders' participation in the biotechnology policy formulation in the Kenya. The stakeholders were drawn from the following categories.

**University lecturers**: - Selected from the departments of biochemistry and biotechnology, environmental & health sciences, agriculture, nutrition, food science and social sciences.

**NGO Representatives**: - Included representatives of NGOs dealing with agriculture, food security and environmental issues, farmers' organizations and consumer organizations.

**Scientists: -** Sampled from research institutions involved in biotechnology research.

**Industry representatives: -** Selected from food industries, agro-chemical industries and seed companies.

**Government officials**: - Selected from the ministries of agriculture, livestock, health, environment, trade and science and technology and the relevant departments/parastatals.

### 3.5 Sampling Techniques and Sample Size Determination

The first step in a stakeholder-based survey is to select the stakeholder representatives that matter in the public debate on agricultural biotechnology. A sampling frame for each category of stakeholders was identified which was used to obtain the study population (N). The number of lecturers was obtained from university calendars of three public universities i.e. Jomo Kenyatta University of Agriculture and Technology, Kenyatta University and the University of Nairobi. The number of scientists was obtained from different research organizations involved in biotechnology research projects in Nairobi as reported by Odame *et al.*, 2003. A list of NGOs was obtained from the database of the NGOs coordinating board offices in Nairobi. The list of industries was obtained from the Kenya Directory of Manufacturing Industries available at the Kenya National Bureau of Statistics Library. The number of the relevant government ministries and departments was obtained from the draft biotechnology policy, 2005. In addition, stakeholders were identified through searches of reports of meetings and snowballing. Table 3.1 below shows the categories of stakeholders sampled.

**Table 3.1 Stakeholder Groups Involved in the Study**

| **Category** | **Population (N)** | **Sample (n)** |
|---|---|---|
| Lecturers | 300 | 89 |
| NGO representatives | 150 | 45 |
| Scientists | 250 | 74 |
| Industry representatives | 200 | 59 |
| Government officials | 50 | 15 |
| **Total** | 950 | 282 |

The required sample size was determined using the Fisher *et al.*, (1998) formula for determining sample size from a population less than 10,000. Below is the application of the formula.

$$nf = \frac{n}{1+ (n/N)}$$

Where,

nf = the desired sample size (if the target population is less than 10,000).

n= the sample size when population is more than 10,000

N = the target population estimated to have the characteristics being measured.

Therefore,

$$nf = \frac{400}{1+ (400/950)}$$

nf = 282 respondents

On obtaining the study population (N) and using the above Fisher *et al* formula, the desired sample size was calculated as 282. Probability proportionate to sample was then used to obtain the number of respondents to be sampled from category of stakeholders. This was applied as shown below in the case of NGOs representatives.

NGOs Representatives = $\frac{150}{950} \times 282 = 45$ (Table 3.1). This was applied all the categories.

Convenient sampling was then used to reach the required number of respondents.

### 3.6 Data Collection Instruments

The research instrument used to collect data was a pre-tested self-administered semi-structured questionnaire (Appendix 7.3). The structure of the questionnaire consisted of three parts: part one focused on the respondents' demographic information, part two consisted of positively and negatively worded questions on the perceptions of the

respondents towards GM foods (particularly on benefits and risks of GM foods and the issue of labelling of GMOs). Part three sought to investigate stakeholders' participation in the formulation of the national biotechnology policy and also obtain their views on public participation in decision making.

### 3.7 Pilot Study

Pilot testing of the research tool (questionnaire) was carried out by way of administering the questionnaire to 15 stakeholders from the different categories of stakeholders, outside the chosen study area and these were not included in the final study. The respondents chosen for pilot testing were encouraged to seek clarification of any unclear questions. After the questionnaires had been returned, necessary amendments were effected and the questionnaire redesigned before the actual data collection exercise to ensure that the questions in the research tool elicited the information being sought (validity). Two research assistants (enumerators) were thoroughly trained by the principal investigator on the administration of the questionnaire to ensure that they had understood the research instrument well. They were in addition involved in the pilot study of the research tool and their work supervised by the investigator to ensure that the information given by respondents consistently measured the variables in the study (reliability).

### 3.8 Data Analysis and Presentation

Raw data was coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 12. Descriptive statistics were used to present results on the perceptions and participation of respondents using percentages and frequencies. Bar graphs, frequency tables and 2 x 2 contingency tables were used in data presentation. The Chi-square test of independence was used to test for relationships between the dependent variables of

perceptions and participation and the independent variables of age, gender, occupation and educational background of respondents. The level of confidence was taken at $P < 0.05$.

### 3.9 Ethical Considerations

Permission to carry out the research was sought from the then Ministry of Education Science and Technology (MOEST) before starting the work (Appendix 7.4). Further clearance was obtained from the Provincial Administration and relevant institutions like the Kenya Agricultural Research Institute (Appendix 7.5). Consent was further sought from each of the respondents before issuing the questionnaires. In keeping with the usual ethical practices of research involving human subjects, strict confidentiality was observed. Each participant was adequately informed about the purpose, scope and expected outcome of the study. Participants were adequately informed that the information they provided would be reported in such a way that it would not be attributed to them or their organization. Participation was voluntary and willing participants were required to give a written informed consent. Participants were also free to withdraw from the study any time.

# CHAPTER FOUR RESULTS AND DISCUSSION

## 4.1 Socio-demographic Characteristics of Respondents

### 4.1.1 Age and Sex Distribution

A total of 282 respondents participated in the study. Specific age distribution shows that about 60% of the respondents were aged below 40 years. Those aged above 40 years comprised about 40% of the total number of respondents (Table 4.1).

**Table 4.1 Age Distribution of Respondents**

| **Age (Years)** | **Respondents n=282** |
|---|---|
| Below 30 | 13.8% (39) |
| 31- 39 | 46.1% (130) |
| 40- 49 | 36.5% (103) |
| Above 50 | 3.6% (10) |
| **Total** | **100% (282)** |

The results show differences in the distribution of male and female respondents. With regard to gender, the percentage of male respondents was slightly higher (56%) than that of females (44%) as depicted in Figure 4.1 below.

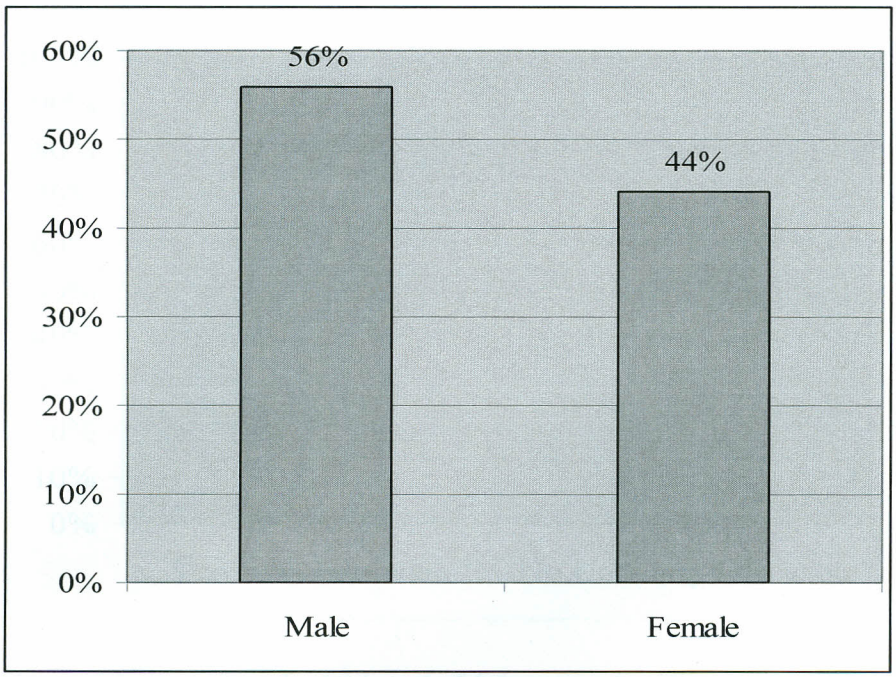


**Figure 4.1 Gender Distribution of Respondents (n=282)**

### 4.1.2 Distribution of Respondents According to their Level of Education and Occupation

The majority of respondents (89.7%) had university education. Only 10% of the total number of respondents had no university education (Figure 4.2) below.

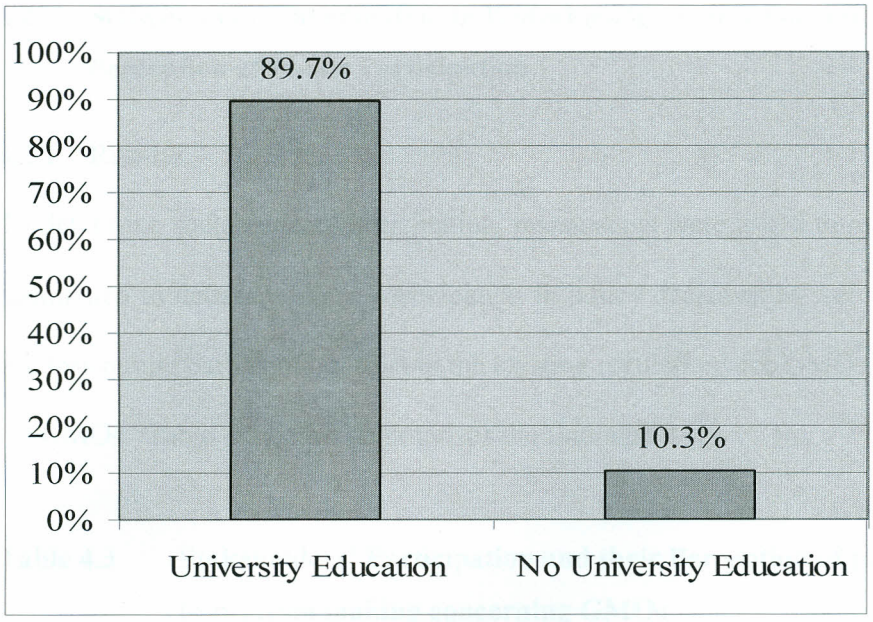


**Figure 4.2 Respondents' Level of Education (n=282)**

Table 4.2 below shows the distribution of respondents with regard to their profession. Lecturers comprised about a third of the total number of respondents. Slightly more than a quarter of the respondents were scientists. Industry representatives comprised about a fifth of the sample and NGO officials accounted for about 1/7 of the sample while government officials comprised 1/20 of the total number of respondents.

**Table 4.2 Respondents' Distribution According to Profession**

| **Respondents' Profession** | **% (No. Of Respondents)** |
|---|---|
| Lecturers | 31.6 % (89) |
| Scientists | 26.2 %(74) |
| Industry representatives | 20.9 % (59) |
| NGO representatives | 16.0 % (45) |
| Government officials | 5.3 % (15) |
| **Total** | **100% (282)** |

## 4.2 Stakeholders' Participation in Biotechnology Policy Formulation and their Perception of Public Participation

### 4.2.1 Results

To determine stakeholders' participation, respondents were asked to respond to statements formulated to determine their participation in policy decisions as well as their perceptions towards public participation, trust in the existing regulations for GMOs and risk assessment for GMOs. Table 4.3 below summarizes the findings.

**Table 4.3 Stakeholders' Participation and their Perception of public participation in decision making concerning GMOs**

| Perception towards participation | Yes (%) | No(%) | D.K(%) |
|---|---|---|---|
| Do you think the public should be involved in decision making concerning GMOs? | 95.4 | 4.6 | 0 |
| Have you participated in policy formulation for GMOs? | 18.8 | 81.2 | 0 |
| Do you think the government has sufficiently promoted public education on GMOs? | 7.8 | 91.5 | 0.7 |
| Do you think decisions about GMOs are made with input from consumers? | 17 | 79.4 | 3.5 |
| Do you think Kenya's regulatory provisions on GMOs are adequate in ensuring public safety? | 19.9 | 78.4 | 2.1 |
| Do you think the existing regulatory provisions adequately address all consumer concerns about GMOs? | 11 | 88.3 | 0.7 |
| Do you think the public is aware of the safety regulations for GM foods? | 0.4 | 97.2 | 2.5 |
| Do you think the public have a direct voice in the risk assessment process? | 12.8 | 85.8 | 1.4 |

**D.K** = Don't Know

Most of the participants (81.2%) indicated that they had not participated in policy formulation for genetically modified foods. The findings of the study indicate that a vast majority of respondents (95.4%) thought that the public should be involved in decision-making concerning genetically modified foods. Respondents, almost exclusively (91.5%) indicated that the Kenyan government has not sufficiently promoted public education on

genetically modified organisms and about 80% of the respondents thought that decisions about GMOs are made without input from consumers. Over three quarters of the respondents (78.4%) thought that the country's regulatory provisions are inadequate in ensuring public safety. Over 80 % of the respondents thought that the public do not have a direct voice in the risk assessment process while an overwhelming majority thought that the public is not aware of the safety regulations for GM foods. Another 88.3% of the respondents thought the existing regulatory provisions did not adequately address all consumer concerns about GMOs (Table 4.3).

**Table 4.4 Stakeholders' Participation in Policy Formulation in Relation to their Profession**

| | | Have You ever Participated in the Formulation of the national Biotechnology Policy Framework for GMOs? | | |
|---|---|---|---|---|
| | | **Yes** | **No** | **Total** |
| **Profession** | **Lecturers** | 16(16.7) | 73(72.3) | 89(89.0) |
| | **Scientists** | 15(13.9) | 59(60.1) | 74(74.0) |
| | **Industry** | 6(11.1) | 53(47.9) | 59(59.0) |
| | **NGOs** | 9(8.5) | 36(36.5) | 45(45.0) |
| | **GoK officials** | 7(2.8) | 8(12.2) | 15(15.0) |
| | **Total** | **53(53.0)** | **229(229.0)** | **282(282.0)** |

The chi square test (Table 4.4) showed a significant statistical association between respondents' profession and their participation in the formulation of the biotechnology policy for GMOs [$\chi^2$= 10.698, d.f = 4, P = 0.03]. Analysis of the chi square test showed that scientists and government officials had participated in formulating the biotechnology policy. On the other hand, lecturers, representatives from NGOs and industry representatives had not participated in formulating the biotechnology policy for GMOs in Kenya. The results of this study indicate that discussions surrounding the biotechnology policy were only deliberated between a section of stakeholders.

### 4.2.2 Discussion

Majority of stakeholders were not involved in the formulation of the national biotechnology policy. On the other hand, majority of the respondents believed that the public should be involved in decisions made concerning GMOs. The results of this study show that not all key stakeholders in the country were involved in policy making which signifies that the public in general was not adequately represented in the policy formulation process. The results of this study also indicate the need for the public to have a say in decisions made about GM foods that may affect their lives. Involvement of all key stakeholders in the biotechnology debate is essential as this would serve to build public confidence and acceptance of GM foods.

Participation of all key stakeholders in decision making is fundamental to achieving long lasting possible solutions. It also improves the quality of decisions made and improves compliance. This also allows government actions to become transparent, effectively avoiding corrupt behaviors. Decisions about GMOs which affect the life of everyone should be done in a consultative and consensual way with the involvement of all stakeholders including the general public (Masood, 2005; Glover *et al.*, 2003). Therefore, consultative and participatory decision making is encouraged. Additionally, in order to build a participatory democracy, it is necessary to provide citizens with an institutional framework that will allow for active participation (Glover *et al.*, 2003).

Similar findings were obtained in a study carried out in Britain in which respondents to the study were asked to what extent they agreed that the public should be involved in decision making about GM foods. A large majority (more than 80%) agreed that different stakeholders and the general public should be involved in making decisions about GM foods (Poortinga &Pidgeon, 2004). The results of these studies emphasize the need for

public participation in decision making with regard to GM foods. Failure to involve all relevant stakeholders breeds suspicion in the regulatory process and undermines public confidence and acceptance of GM foods.

Concerning trust in regulation of GMOs, about 80% of the respondents think that decisions about GMOs are made without input from consumers. Over three quarters of the respondents think that Kenya's regulatory provisions on GMOs are inadequate in ensuring public safety (Table 4.3). The results of this study indicate lack of trust in the government's ability to regulate GMOs and the fear that the government has sidelined consumers in decision making. Similar findings were reported in Britain where more than half of the respondents disagreed with the statement that "government adequately regulates GM foods". In the same study, about 80% agreed that independent regulatory organizations are needed to regulate GM foods separate from the government/industry (Poortinga and Pidgeon, 2004). These reports clearly indicate that people feel that the government alone can not be trusted to regulate GM foods and that there is need to involve all relevant stakeholders in the regulation processes. This will help in winning public confidence and assurance that regulatory processes are transparent and participatory. Failure to this increases chances of the public resisting biotechnology products.

Public understanding of science and technology is the cornerstone of economic development and there is a broad agreement that citizens should be involved in decision making when it is likely to impact on them (Tatiana *et al.*, 2000). The results of this study indicate a broad agreement that citizens should be involved in decision-making concerning GM foods. Although scientific information is normally seen to be complex and forbidding to the general public, experience has shown that citizens are certainly capable of discussing scientific issues using ordinary language and concepts (Glover *et al.*, 2003). Promoting

public participation therefore means involvement of all key stakeholders who would ultimately find ways to make scientific knowledge accessible to the public.

Production and consumption of genetically modified foods is a topical issue and could impact on socio-cultural systems of rural populations in developing countries. Rural people in developing countries are often far removed from many important decision-making processes (Tatiana *et al.*, 2000). Consumers have the right to democratic participation in decision making and they therefore need to be given every opportunity to participate in the debate concerning both the impact of GMOs on their lives and livelihoods and the potential benefits that may arise from the development and use of such products (FAO, 2001). Consumers do not all have the same access to information, for example, the very poor may lack the most basic information to make decisions that may affect their health and capacity to sustain themselves (FAO, 2001). Appropriate methods to reach the least educated, the poorest and the most disadvantaged groups should form part of any strategy to inform the public so that individuals are able to choose according to their needs.

### 4.2.3 Stakeholders' Opinion on How the Government Could Embrace Public Participation

#### 4.2.3.1 Results

The government of Kenya and other stakeholders are obligated to enhance public participation in decisions made concerning GM foods as outlined under Article 23 of the Cartagena Protocol on Biodiversity. This study sought to find out from the respondents, ways in which the government could embrace public participation in decision-making concerning GMOs. Table 4.5 below outlines suggested ways respondents believed the government could utilize to embrace public participation.

**Table 4.5 Respondents' Suggestions on Ways the Government can Embrace Public Participation**

| Public Opinion | Frequency | Percent |
|---|---|---|
| Utilize media to educate public/ organize seminars | 174 | 78.7% |
| Create policies that address public participation in GMOs | 31 | 14% |
| Introduce GMOs in School Curricula | 11 | 5% |
| Launch GMOs projects at the community level | 5 | 2.3% |

The results of the study indicate that more than three quarters of the respondents (78.8%) believed that the government can utilize the media to educate Kenyans about GM foods. The findings show that 14% of respondents suggested that the government should create policies addressing public participation in the debate about GMOs and 5% of the participants suggested that GMOs should be introduced in school curricula. Another 2.3% thought that projects on GMOs should be launched at the community level to educate the rural people about GMOs (Table 4.5).

#### 4.2.3.2 Discussion

Consumption of GM foods could impact on socio-cultural and religious systems of rural populations either positively or negatively. These people have a right to be informed and consulted about decisions that have a direct impact upon their lives, in this case through the food they eat (FAO, 2001). Public awareness at the grassroots level is crucial and should be enhanced to point out clearly and objectively the benefits and risks of adopting genetic engineering technology (Kameri-Mbote, 2002). Educating the public with accurate information about GM foods will promote a balanced view of these GM foods and engender consumer acceptance. Respondents of the study suggest that the media could be an important tool that the government and other stakeholders can use to reach people at the grassroots level. Public awareness and education is essential for ensuring the judicious use

of modern biotechnology applications, practices and products for socio-economic development, without jeopardizing the environment, our biodiversity and human health.

## 4.3 Perceptions of the Potential Benefits of Genetically Modified Foods

### 4.3.1 Results

Respondents' perceptions towards the potential benefits of genetically modified foods were determined using positively worded questions on how they viewed the potential of genetically modified foods. In this case respondents were asked to indicate to what extent they agreed with statements about potential benefits of GM foods/crops. Table 4.6 summarizes respondents' perceptions of the potential benefits of GM foods.

**Table 4.6 Respondents' perceptions towards the potential benefits of Genetically Modified Foods**

| Potential Benefit of GMOs | Perception | Frequency | Percent (%) |
|---|---|---|---|
| 1. GE is Superior to conventional Methods | Agree<br>Disagree | 190<br>92 | 67.4%<br>32.6% |
| 2.GE can improve sustainability of Agriculture | Agree<br>Disagree | 222<br>60 | 78.7%<br>21.3% |
| 3.GE improve food security& eliminate Micro Nutrient deficiencies | Agree<br>Disagree | 261<br>21 | 92.6%<br>7.4% |
| 4.Organic farming is a better solution for poor farmers | Agree<br>Disagree | 166<br>116 | 58.9%<br>41.1% |

From the findings of the study (Table 4.6), a great number of respondents agreed that genetic engineering technology has a high potential to improve food security and eliminate micronutrient deficiencies (92.6%). More than three quarters of the sample (78.7%) agreed that the technology has the potential to improve the sustainability of agriculture in the country while almost 70% agreed that GE technology is powerful compared to conventional methods. The results show that respondents are positive about the potential contribution of GM foods.

Participants to the study were also asked to rank the benefits of genetically modified foods starting with the one they consider most beneficial to the least beneficial. Figure 4.3 shows that improving productivity/ increasing yields was considered the most important benefit of GM foods by 43.3% of the respondents. This was followed closely by the ability of GM foods to alleviate food insecurity (30.5%).

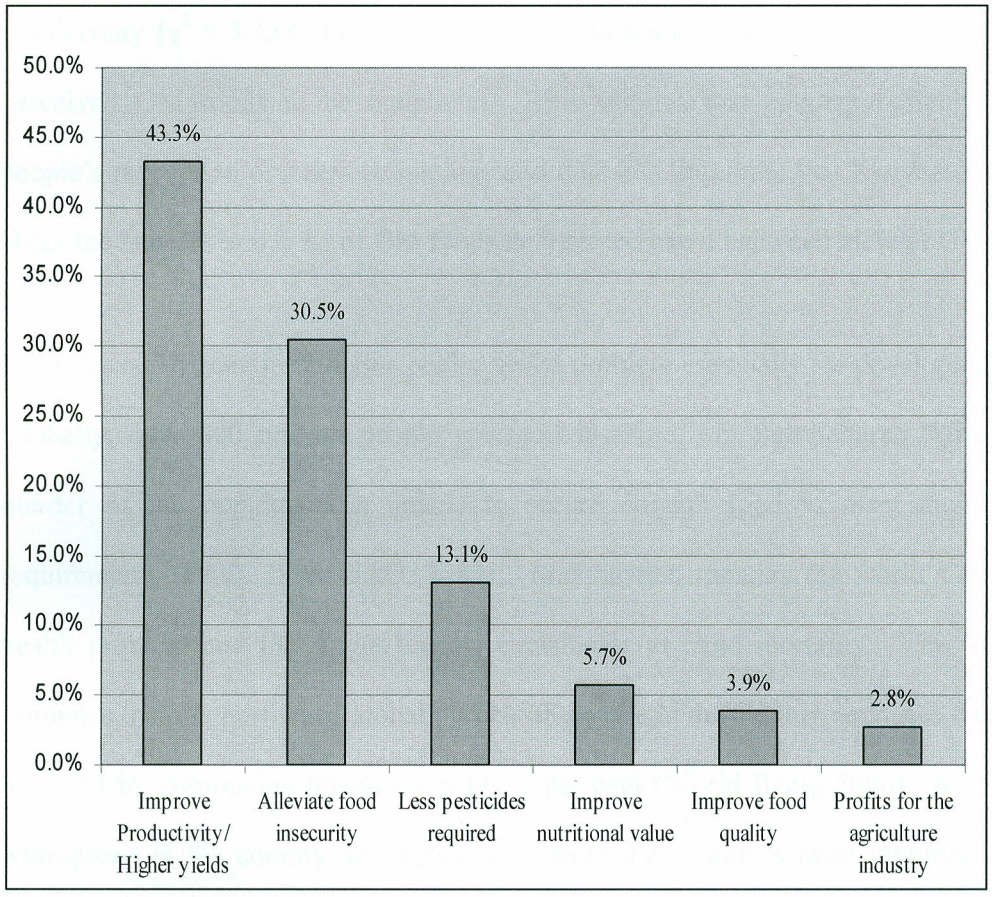


**Figure 4.3 Ranking of the benefits of genetically modified foods**

### 4.3.2. Discussion

The results of this study show that a substantial proportion of the sample appreciates the various potential benefits of GM foods/crops. Respondents thought that GE technology can contribute to food security in that it would increase food production and ultimately ensure food security. Respondents also recognize that GM foods have the potential to battle

micronutrient deficiencies through improved nutritional quality of foods. There was a significant statistical association between respondents' level of education and their perception that GM foods have the potential to alleviate food insecurity and eliminate micronutrient deficiencies [$\chi^2 = 4.499$, d.f = 1, P = 0.034]. There was also a significant statistical association between respondents' level of education and their perception that GM foods have the potential to improve the sustainability of agriculture and conserve biodiversity [$\chi^2 = 5.353$, d.f = 1, P = 0.021]. In both cases highly educated respondents perceived GM foods to be beneficial. This implies that education highly influences people's perception of a new technology and thus it is important that Kenyans are educated about the benefits and risks of GM foods in order to have a balanced view of GM foods.

Food insecurity remains a major public health problem especially for developing countries. Globally, over 800 million people are food insecure. In Sub-Saharan Africa, about a quarter of the population is unable to secure enough food to meet their nutritional requirements (FAO, 1996; FAO, 2002). Malnutrition remains the world's most serious health problem and the single biggest contributor to child mortality. The World Bank estimates that the portion of global burden of disease in developing countries that would be removed by eliminating malnutrition as 32 per cent (World Bank, 2006). Malnutrition is widespread in the country and agriculture being the country's most important economic activity; it implies that GM foods can be considered in the context of the country's need for increased food production and poverty alleviation. Respondents are positive that if GE technology is harnessed properly, it can provide enormous benefits to consumers.

There are however, challenges that need to be addressed if GM foods are to be embraced to achieve food security in the country. Hunger is not caused by scarcity of food, and food security may not be achieved through cheap surplus production of farmers. This is because

sometimes, prices can be high in one region even though the neighbouring region had bumper harvest (Sein, 1981). More than enough food is produced to feed everyone in the world with a basic nutritious diet, but people still go hungry. People simply lack the money to buy food. Of the worlds' six billion people, 2.8 billion live on less than $ 2 a day hence there can be no food security without economic upliftment of household income (Conway, 1997). Lack of purchasing power and high transaction costs may prevent farmers from one region to provide their surplus to consumers who suffer from food shortage in another region (Aerni, 2002). This therefore implies that a sustainable food security strategy must have a strong focus on local food self-sufficiency. Guaranteeing access to food for each individual requires measures to create wealth in poor communities, measures to enhance the control of poor farmers over their land and productive assets, measures to conserve the natural resource base and measures to ensure effective distribution of existing food supplies. GE technology is therefore not the only tool that can alleviate hunger in the country, but is one of the many tools the country needs to solve the food shortage problems.

Intellectual property rights (IPRs) can also be a threat to food security in developing countries that largely rely on subsistence farming (Cullet, 2004). IPRs of inventors lead to high costs of GM seeds and this places them out of reach of developing country farmers. Terminator gene technology produces sterile seeds and this prevents farmers from saving seeds to plant in the following season. This implies that a starving developing country farmer can not re-sow their seed in a famine year. About 1.4 billion people, mainly poor farmers in developing countries depend on saved seeds and this technology combined with the high costs of seeds undermines food security in developing countries. There is therefore a need for a balancing act between the application of IPRs and the protection of farmers' rights and the need to review the use of terminator gene technology in agriculture.

Farmers should retain control over plant varieties so that they may continue to improve and adapt varieties to suit changing needs and conditions.

## 4.4 Perceptions of the Potential Risks of Genetically Modified Foods

### 4.4.1 Results

Central to the debate on genetically modified foods is their safety and their potential environmental effects, and whether mankind, especially in developing countries, can secure the benefits of genetically modified crops while most effectively avoiding any risks they may present. Respondents' perceptions towards the potential risks of genetically modified foods were determined by way of participants responding towards negatively worded questions on the risks of GM foods. Respondents were asked to indicate to what extent they either agreed or disagreed with particular statements about potential risks of genetically modified foods/crops. The results of these perceptions are summarized in the Table 4.7 below.

**Table 4.7 Respondents' Perceptions of the Potential Risks of GM foods**

| Potential Risk of GM foods | Perception | Respondents n=282 |
|---|---|---|
| GM foods have the potential to lead to health hazards to consumers | Agree<br>Disagree | 187 (66.3%)<br>95 (33.7%) |
| GM foods have the potential to lead to loss of biodiversity | Agree<br>Disagree | 243 (86.2%)<br>39 (13.8%) |

The findings of this study indicate that most of the respondents agreed that genetic engineering technology has the potential to pose risks to human health as well as the environment. About 70% of the respondents agree that GM foods have the potential to lead

to serious human health hazards while over 80% are concerned that GM foods have the potential to lead to loss of our country's rich biodiversity (Table 4.7).

Respondents were also asked to rank the risks of GM foods starting with the one they think is more serious according to them. The results are summarized in Figure 4.4 below.

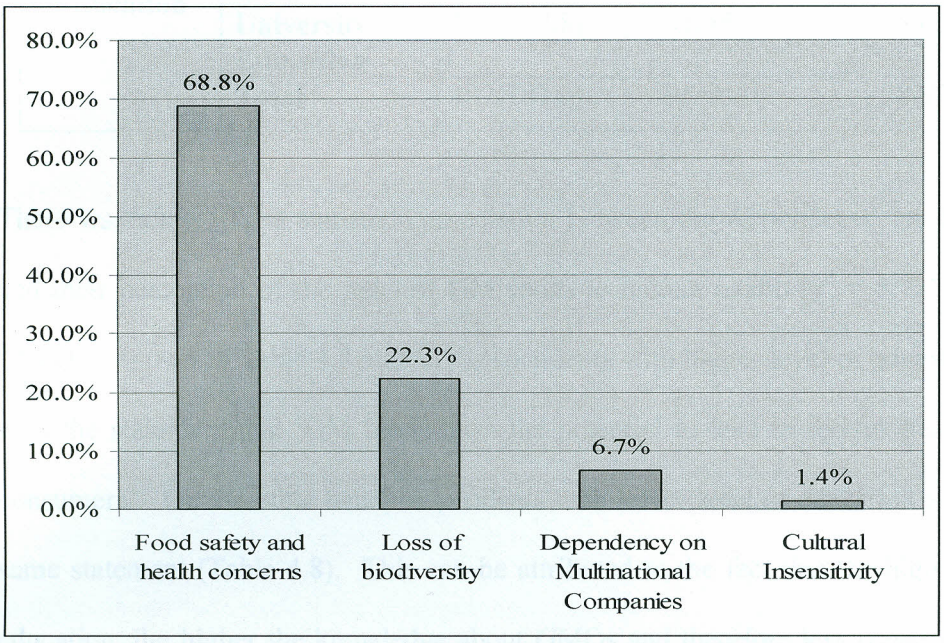


**Figure 4.4 Ranking of the risks of GM foods**

The results indicate a range of specific concerns about the risks of GM foods/ crops. Majority of respondents were concerned about human health and therefore ranked food safety and health concerns as the most important risk (68.8%) as depicted in Figure 4.4 above. Respondents were also concerned about the potential negative impact of GM foods on the environment and ranked loss of biodiversity second (22.3%) whilst dependency on multinationals was ranked third (6.7%). Perceptions like these led to rejection of GM biofuel in South Africa. After yielding to public pressure to label GMOs, the European Union has approved a string of GMOs. France approved new GM trials following public participation (ICTSD, 2007).

**Table 4.8 Respondents' level of education by their perception of risk of GM foods to human health**

| | Genetically modified foods can lead to serious health hazards | | | |
|---|---|---|---|---|
| | | **Agree** | **Disagree** | **Total** |
| **Level of Education** | **No University Education** | 25(19.2) | 4(9.8) | 29(29.0) |
| | **University Education** | 162(167.8) | 91(85.2) | 253(253.0) |
| | **Total** | 187(187.0) | 95(95.0) | 282(282.0) |

There was a significant statistical association between the respondents' level of education and their perception of the risks of GM foods to human health [$\chi^2$ = 5.727, d.f = 1, P = 0.017] as shown in Table 4.8 above. Respondents with higher level of education disagreed with the statement that 'GM foods have the potential to lead to serious health hazards to consumers'. On the other hand, respondents with lower level of education agreed with the same statement (Table 4.8). This can be attributed to the fact that the higher the level of education, the higher the knowledge about GMOs and therefore less concern about health risks of GM foods. On the other hand, the lower the level of education, the higher is the concern about risks of GM foods. This implies that if people are educated, they would appreciate the benefits of GM foods while at the same time address any concerns they may have about the risks of GM foods.

Table 4.9 below shows the perception of respondents on risks of GM foods to human health by their profession. There was a significant statistical association between respondents' profession and their perception that GM foods are potentially harmful to human health.

**Table 4.9 Profession of Respondents in Relation to their Perception of Risks of GM Foods to Human Health**

| | GM foods can pose serious human health hazards to consumers | | | |
|---|---|---|---|---|
| | | **Agree** | **Disagree** | **Total** |
| **Profession** | **Lecturers** | 76(59.0) | 13(30.0) | 89(89.0) |
| | **Scientists** | 19(49.1) | 55(24.9) | 74(74.0) |
| | **Industry** | 45(39.1) | 14(19.9) | 59(59.0) |
| | **NGO** | 39(29.8) | 6(15.2) | 45(45.0) |
| | **GoK officials** | 8(9.9) | 7(5.1) | 15(15.0) |
| | **Total** | **187(187.0)** | **95(95.0)** | **282(282.0)** |

The chi-square tests depict that scientists and government officials disagree with the statement that GM foods could pose health risks to consumers. On the other hand lecturers, industry representatives and NGO representatives are worried that GM foods are hazardous to the health of consumers [$\chi^2$ = 81.303, d.f = 4, P< 0.001]. This clearly shows that scientists and the government emphasize on embracing GM foods without serious consideration of the risks they pose to human health. This is in contrast with lecturers, industry and NGO representatives who recognize that GMOs pose serious health hazards to consumers and advocate for a precautionary approach in embracing GMOs. There is need for thorough and rigorous safety assessment of the risks GM foods may pose to human health before they are released for commercialization.

### 4.4.2 Discussion

The findings of this study indicate that respondents are concerned about the negative impact of GM foods/ crops. Respondents are far more concerned about the risks of GM foods impacting negatively on human health and also the negative impact of GM foods on the environment. Americans also reported concerns about potential risks to human health associated with GM foods in which 45% of the respondents believed it was safe to consume GM foods (Hallman *et al.*, 2003). The findings of these studies confirm that people are generally concerned about the safety of GM foods. Although priorities vary, food safety is

a major concern among consumers. Consumers would like assurance that GM products reaching the market have been adequately tested and that these products are being monitored to ensure safety and to identify problems as soon as they emerge. There is therefore need that regulation of GM foods is done in a transparent manner with the involvement of all relevant stakeholders at every stage. The Kenyan government should also streamline the biosafety policy to ensure that maximum benefits of genetic engineering technology are harnessed while any risks to human health and the environment are controlled.

Food safety is a major public concern both in developed and developing countries (Leeder, 2000). Respondents to this study too express concern about food safety and health risks of GM foods to consumers. GM foods have the potential to be toxic and threaten human health. Although WHO (2005) reported that currently commercialized GM foods are safe for human consumption, the hazards of GM foods remain difficult to predict and measure accurately hence no guarantee that GM foods are 100% safe for human consumption. Furthermore, not enough clinical trials under proper supervision have taken place, as a result, public health can not be guaranteed equivocally. Unlike a drug which when found to have unexpected side effects manufacture can be ceased and the drug withdrawn from the market, as living self-propagating organisms, GM foods cannot be "recalled" in the same manner (Barrett and Flora, 2000). Food safety assessments should be done in a more transparent way to assure the public of the safety of the foods they consume.

Researchers have warned that antibiotic resistance marker genes that help determine if the wanted gene was successfully transferred into the host organism might combine with disease causing bacteria or microbes in human gastro intestinal tract (Batalion, 2000). This

could aggravate the already serious public health problem of antibiotic resistance of infectious diseases that can not be cured with traditional antibiotics for example new strains of *salmonella, e-coli, campylobacter and enterococci* (WHO, 2005). The potential risk of spreading resistance to therapeutic antibiotics could have serious health consequences and therefore should be avoided.

With regard to the environment, over 80% of the respondents are worried that GM foods could lead to the loss of the country's biodiversity (Table 4.7). Africa's wealth of biological resources is a critical element in alleviating poverty and ensuring food security. However, the rate of genetic erosion through loss of species and varieties is alarming (Nnadozie *et al.*, 2003). It is necessary to protect the environment for us to reap the benefits of GE. The environment in which we live greatly affects our lives. Environmental health is an essential component of a sustainable livelihood (Cairncross *et al.*, 2003). Environmental health seeks to reduce people's exposure to environmental factors that cause disease. It is estimated that environmental risk factors account for 21% of the overall burden of disease world wide, and the vast majority of this is in developing countries (WHO, 2000). Majority of the respondents express concerns that GM foods pose risks to the environment which may ultimately affect human health. Scientific research and farmers' reports have identified a number of serious environmental effects related to GM crops (Barrett and Flora, 2000). Many aspects of environmental health depend on improved governance, both in delivery of services and regulation and legislation. In many developing countries, regulation and implementation often of existing legislation is all that is needed to prevent hazardous practices. The Kenyan government should therefore adopt stringent regulations that ensure that GMOs introduced into the country do not harm the environment.

Respondents were also asked to indicate whether they think that the benefits of GM foods were likely to outweigh their risks. The results of the study indicate that more than two thirds (67%) of the total number of respondents were positive to the statement that the benefits of genetically modified foods were likely to outweigh their potential risks (figure 4.5). Slightly more than a third (33%) of the respondents felt that the risks of genetically modified foods can not be ignored.

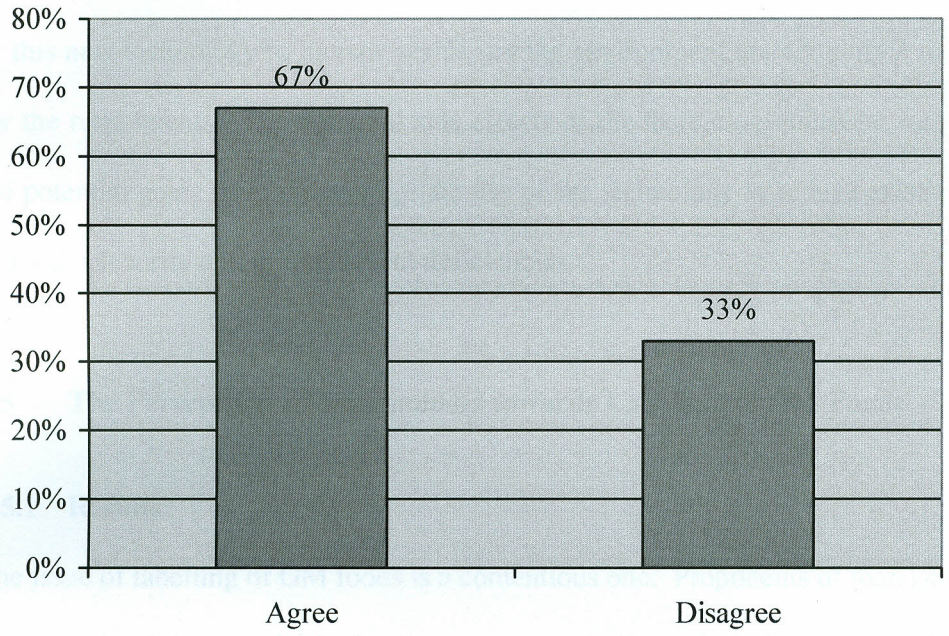


**Figure 4.5 Respondents' Perception to Whether the Potential Benefits of GM foods are Likely to Outweigh Risks (n = 282)**

The results show that even though respondents are worried about the potential risks of GM foods, they are positive that if the risks of GM foods are properly controlled and managed, Kenyans could reap the benefits of this new technology. This therefore calls upon the government to make risk assessment for GMOs more open and participatory to assure the public that GMOs are safe and build their confidence. The results also indicate the need to engage all key stakeholders in the risk assessment processes in order to build public confidence and acceptance of GM foods.

The results of this study differ from those of a study carried out in Britain to investigate public awareness, perceptions and understanding of the GM debate (Poortinga and Pidgeon, 2004). The study showed that 42% of the respondents felt that the risks of GM foods outweigh the benefits while 23% felt that they are about the same and 20% felt that the benefits outweigh the risks. The differences expressed in these studies can be attributed to differences in sampling techniques applied. This study adopted a stakeholder based survey while the British survey adopted a general population survey. The unintended side effects of this new technology to human health and the environment are certainly a major concern for the respondents. The potential side effects of the technology must be weighed against the potential gains from the appropriate use of the technology to reduce existing risks such as food insecurity and micronutrient deficiencies.

## 4.5 The Perceptions of Stakeholders towards Labelling of GM Foods

### 4.5.1 Results

The issue of labelling of GM foods is a contentious one. Proponents of mandatory labelling maintain that it is essential in that consumers retain the right to know about the foods they eat. On the other hand, critics of mandatory labelling argue that such labelling schemes would require difficult and expensive efforts to segregate GM and non-GM ingredients and also argue that it is likely that most consumers would not use the information. As the labelling of genetically modified foods remain highly controversial, this study sought to find out how stakeholders perceive the issue of labelling of GM foods. Table 4.10 below shows the perception of respondents towards labelling of GM foods.

**Table 4.10 Respondents' Perception of Labelling of Genetically Modified Foods Expressed in Percent of Respondents**

| Perception | Yes | No | Not sure |
|---|---|---|---|
| Do you support mandatory labelling? | 95% | 3.9% | 1.1% |
| Is mandatory labelling a necessary choice in democracy where consumers exercise their right to choose the products they want? | 95.7% | 3.2% | 1.1% |
| Is mandatory labelling misleading to consumers? | 5.3% | 94.7% | |

From the findings of this study, majority of respondents (95%) advocate for mandatory labelling of GM foods (Table 4.10). About 96% consider mandatory labelling a necessary choice in democracy where consumers are supposed to have a right to choose the products they prefer. About 95% do not believe that mandatory labelling could be misleading to consumers by giving them the impression that GM products are unsafe compared to their conventional counterparts.

The existence of GMOs raises the issue of the right to informed choice (FAO, 2001). There was an extremely high agreement by respondents that mandatory labelling is a necessary choice in democracy where consumers are supposed to have the right to choose the products they prefer. Labelling of GM foods allows for consumer choice, allows maintenance of dietary observances e.g. vegetarian/ religious and educates and informs the public in making product choices (FAO, 2001; Persley, 2003). Mandatory labelling would therefore work to reassure the public that they are not implicitly required to consume GM foods unknowingly. It would also allow people to choose for themselves whether to consume GM foods or not and vastly increase their acceptance of GM foods. Without labelling, it is true that there is a loss of individual control over what an individual is eating, and that it is appropriate to maintain freedom of choice. GM foods should therefore be

labelled to ensure that consumers make informed choices and to ensure that people who are allergic to certain foods are cautious of the foods that they buy.

The results of this study are similar to those obtained by Aerni (2002). This was a survey carried out in South Africa on stakeholders' perceptions of agricultural biotechnology in which majority of the respondents supported mandatory labelling of genetically modified foods while many of them indicated that mandatory labelling was a necessary choice in democracy where consumers express their right to choose whether to buy GM or non-GM foods. The similarities in study findings could be as a result of similarity in the study methodology adopted in both studies.

Similar results were also reported in the British survey (Poortinga and Pidgeon, 2004) in which there was extremely high agreement (94%) that food containing genetically modified ingredients should be labelled. Similarly, the vast majority of Americans (94%) agreed that genetically modified ingredients should be labelled as such (Hallman *et al.*, 2003). The similarities in these findings indicate that people worry about the safety of GM foods and believe that the only way they can be safe is through provision of information through labels which will enable them to choose whether or not to consume GM foods. There is need to develop an effective labelling strategy and failure to this would eliminate consumer choice and result in more negativity towards GM products since consumers want GM foods labelled. This labelling policy needs to be developed in conjunction with more effective information dissemination practices.

# CHAPTER FIVE CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents a summary of the study findings, conclusions and implications of the findings, recommendations and recommended areas for further research.

## 5.2 Summary of Study Findings

The main objective of the study was to investigate stakeholders' participation in the formulation of the national biotechnology policy in Kenya and to explore their perceptions towards genetically modified foods. In particular, the study sought to establish whether all key stakeholders participated in the formulation of the national biotechnology policy for GMOs and to determine their perceptions towards GM foods. The study sample constituted 282 stakeholders from the Nairobi province of Kenya.

In summary, the findings of the study indicate that majority of the respondents (95.4%) thought that the Kenyan public should participate in decision-making concerning GM foods. In contrast, only about 20% of stakeholders participated in policy making. About 80% thought that decisions about GM foods are made without input from consumers (Table4.3).

Respondents expressed varying perceptions towards GM foods. Respondents of the study appreciate the benefits of genetically modified foods. More than 90% of respondents sampled believed that genetic engineering technology has the potential to improve food security and eliminate micronutrient deficiencies. About 80% of respondents thought that genetic engineering technology holds the potential to improve the sustainability of agriculture in Kenya (Table 4.6). Respondents on the other hand expressed concerns that GM foods could be harmful to human health (66.3%). Another 87.6% were concerned that

GM crops could adversely affect the country's rich biodiversity (Table 4.7). However, 67% of the respondents were optimistic that the potential benefits of GM foods are likely to outweigh their potential risks (Figure 4.5).

Ninety five percent of the respondents support mandatory labelling of genetically modified foods. Most of the respondents (95.7%) agreed that mandatory labelling is a necessary choice in democracy where consumers exercise their right to choose the products they want (Table 4.10). There is therefore need for the government to develop an effective labeling strategy for GMOs.

## 5.3 Conclusions and Implications of the Findings

Only about 20% of stakeholders participated in policy making. There is need to engage all key stakeholders in decision making concerning GMOs. Participation of all key stakeholders will help build public confidence and promote public acceptance of GM foods. Moreover, it is important that all stakeholders participate in deciding on what crops or problems biotechnology research and development should focus on.

Respondents to the study recognize GM foods as having a significant potential to solve problems of food insecurity and micro nutrient deficiencies. Respondents are positive that the GE technology can be tapped to play an important role in solving the problem of food insecurity in the country. On the other hand, respondents are concerned about the risks of GM foods to human health as well as the environment. Public safety can only be assured if risk assessments for GMOs are done in a transparent manner with the involvement of all relevant stakeholders at every stage. Full potential will only be realized if the environmental and health concerns are mitigated and this can only be achieved through

consultative and participatory mechanisms. There is therefore need for reasoned and rational approach to the benefits of GM foods taking into consideration harm to human health and the environment.

The results of the study show a strong support for mandatory labelling of genetically modified foods. Majority of respondents feel that consumers must have a right to choose whether to buy GM foods or stick to non-GM foods. There is therefore need for the government to develop an effective labelling strategy for GMOs. Failure to this would eliminate consumer choice and result in more negativity towards GM products.

### 5.4 Recommendations

Consumers are the final judges of this new emerging technology in agriculture and its success depends on whether they accept its products or not. Public education campaigns should be carried out through established sources of information to educate the general public on the potential benefits of GM foods as well as their side effects. It is therefore recommended that public awareness should be monitored regularly hence the need to extend this survey to cover the general public.

It is important to ensure a more inclusive form of deliberation on issues of GE technology affecting the future of our country's key economic sector- agriculture and the most basic human need- food. GMO policies should be deliberated on by all stakeholders including the public. Therefore, new or revised laws and policies should make provision for public participation in decision making concerning GM foods.

The Kenyan public is largely rural and mainly depends on subsistence agriculture. As a result, biotechnology should give a priority to their needs. There is therefore need for collaboration between researchers and all key stakeholders including the public in goal setting and implementation. Research scientists should strive to cooperate more actively with small scale farmers who are the main technology users/consumers.

## 5.5 Recommended Areas for Further Research

This study investigated participation of Kenyan stakeholders in the formulation of the biosafety framework for GMOs and their perceptions towards GM foods. Engagements need to go beyond the well informed urban consumer in the capital city to the range of potential users of GM technology in the rural areas. There is need to carry out a survey on general public perceptions towards genetically modified foods to find out how farmers and consumers perceive these foods.

Majority of respondents believe GM foods have the potential to alleviate food insecurity and eliminate micronutrient deficiencies. However, no researches have been done to support this. More research is needed to evaluate to what is the scope of alleviating micronutrient malnutrition through breeding and consuming nutritionally enhanced foods.

This study indicates the need for established risk assessment procedures with more public participation in the exercise. These biosafety measures can not be effectively implemented without adequate institutional and human capacity at the national level. Research is needed to investigate whether the Kenyan government has the capacity to carry out effectively risk assessment for GMOs.

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## 7.0 APPENDICES

### 7.1 SELF-INTRODUCTORY LETTER

Winfred Kyalo,
P.O. BOX. 74394,
Nairobi.

Dear Respondent,

**RE: RESEARCH ON GENETICALLY MODIFIED FOODS**

Good morning, I am a Master of Public Health student from Kenyatta University carrying out a research on Genetically Modified foods. I intend to give you a questionnaire which requires you to answer questions concerning genetically modified foods. This is purely for research purposes only and your responses will be taken in confidence. I'm requesting you to answer the questions as freely and objectively as possible. It is hoped that the results of the survey will be used to make recommendations to regulatory authorities to formulate policies that reflect the views of all relevant stakeholders in the biotechnology debate. Thank you for your co-operation.

Yours Faithfully,

Kyalo Winfred.

## APPENDIX 7.2 INFORMED CONSENT FOR PARTICIPANTS

You are invited to participate in the survey about genetically modified foods

**Objectives**

The aim of the study is to investigate stakeholders' participation in the formulation of a national biotechnology policy framework for GMOs and to explore their perceptions towards Genetically Modified foods.

**Procedures**

You are required to fill the questionnaire given as freely and objectively as possible. Due to the fact that you volunteer to take part in the study the information that you provide will be kept confidential and all the information will be destroyed after the completion of the study.

**Benefits of the study**

By participating in this study, you will help determine participation of stakeholders in the formulation of the national biotechnology policy framework for GMOs well as their perceptions towards GM foods.

Your participation in this study is voluntary and you have the right to refuse to participate or answer any questions that you feel uncomfortable with. If you change your mind about participating in the course of the study, you have the right to withdraw any time. The decision to participate or withdraw will not affect you whatsoever. If there is anything that is unclear or need further clarification, we shall be delighted to provide it.

**Declaration of the volunteer**

I have understood that the purpose of this study is to investigate stakeholders' participation in the formulation of the national biotechnology policy framework for GMOs and to explore their perceptions towards Genetically Modified foods. I have read the above information to the best of my understanding. I similarly have had the opportunity to ask questions about it and any questions that I asked were answered to my satisfaction. I therefore consent voluntarily to participate as a subject in this study.

Signature of volunteer .....

Signature of Investigator .....

Date .....

**APPENDIX 7.3 QUESTIONNAIRE.**

**PART 1: Socio-demographic information**

Please tick appropriately.

1. What is your age?
   1. Below 30 ( )
   2. 30 – 39 ( )
   3. 40– 49 ( )
   4. 50+ ( )

2. Gender: 1.Male ( ) 2. Female ( )

3. What is your profession/occupation .....

4. Religion
   1. Christian ( )
   2. Muslim ( )
   3. Hindu ( )
   4. Any other (Specify).....

5. Level of Education.
   1. Secondary Education ( )
   2. Tertiary (College) Education ( )
   3. University Education ( )

**PART 2: Genetically Modified (GM) Foods.**

1. Overall, what would you say are the main benefits or advantages of GM foods? (number 1, 2, 3 etc in order starting with the one you consider most beneficial).
   a). Improves productivity/ higher yields
   b). Improves quality of food/ nutritional value
   c). Less pesticides required
   d). Profits for agriculture industry
   e). Alleviate food insecurity

2. Overall, what would you say are the main risks or disadvantages of GM foods? (Number 1, 2, 3…etc starting with the one you consider to pose a greater risk).
   a). Food safety& Health concerns
   b). Loss of biodiversity
   c). Dependency on multinational companies for seeds
   d). Cultural insensitivity

3. Genetic engineering technology is a new tool that helps solve problems that cannot be solved by conventional breeding.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

4. Genetic engineering has the potential to improve the sustainability of agriculture and conserve biodiversity.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

5. Genetic engineering technology has the potential to improve food security and eliminate macronutrient deficiencies.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

6. Organic farming/integrated pest management is a better solution for resource poor farmers to ensure their food security.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

7. Genetically modified foods have the potential to lead to serious human health hazards to consumers.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

8. Genetically engineered crops have the potential to lead to the loss of our country's biodiversity.
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

9. Health and environmental benefits of genetically modified foods are likely to outweigh the possible risks?
   1. Strongly agree ( )
   2. Agree ( )
   3. Disagree ( )
   4. Strongly disagree ( )

10. Do you support mandatory labeling of genetically modified foods?
    1. Yes ( )
    2. No ( )
    3. I'm not sure ( )

11. Do you think that mandatory labeling is a necessary choice in democracy where consumers are supposed to have a right to choose the products they prefer?
    1. Yes ( )
    2. No ( )
    3. I'm not sure ( )

12. Do you think mandatory labeling is misleading since it will give consumers the impression that GM products are unsafe compared to conventional ones?
    1. Yes ( )
    2. No ( )

13. Have You ever Participated in the Formulation of the national Biotechnology Policy Framework for Genetically Modified Organisms?
    1. Yes ( )
    2. No ( )

14. Do you think many Kenyans are aware of GM foods?
    1. Yes ( )
    2. No ( )
    3. I don't Know ( )

15. Does the general public in your locality know about GM foods?
    1. Yes ( )
    2. No ( )
    3. I'm not sure ( )

16. Has there been any seminar on GM foods in your locality?
    1. Yes ( )
    2. No ( )
    3. I'm not sure ( )

17. In your view, has the Kenyan government sufficiently promoted public education on Genetically Modified foods?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

18. Do you think the public should be involved in the policy formulation for GMOs?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

19. Do you think decisions about the use of biotechnology products are made with input from consumers?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

20. Do you think the existing regulatory provisions in Kenya are adequate for ensuring public safety?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

21. Do you think the public have a direct voice in the risk assessment process?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

22. Do you think the existing regulatory provisions adequately address all consumer concerns about GMOs?
    1. Yes ( )
    2. No ( )

23. Do you think the general public is aware of the safety regulations for GM foods?
    1. Yes ( )
    2. No ( )
    3. I don't know ( )

24. Suggest ways in which you think the government can embrace participation of the public in the debate on GMOs.
    .....
    .....

**Thank you for your participation**

**APPENDIX 7.4 RESEARCH AUTHORISATION**

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

Telegrams: "Education", Nairobi
Telephone: Nairobi 336411
When replying please quote

Ref. No. ... .....
and date

JOGOO HOUSE "B"
HARAMBEE AVENUE
P.O. Box 30040-00100
NAIROBI

....., 20.....

MOEST 13/001/35c 109/2

29th March, 2005

Winfred Muchini Kyalo
Kenyatta University
P.O. BOX 43844
NAIROBI

Dear Madam

**RE: RESEARCH AUTHORISATION**

Following your application for authority to research on "Public participation as a means of mitigating Public Health issues associated with genetically modified foods" I am pleased to inform you that you have been authorised to carry out research in Nairobi for a period ending 30th March, 2006.

You are advised to report to the Provincial Commissioner and the Provincial Medical Officer of health Nairobi before embarking on your research project.

Upon completion of your research project, you are expected to submit two copies of your research report to this Office.

Yours faithfully

B. O. ADEWA
FOR: PERMANENT SECRETARY

RECEIVED
NAIROBI AREA

Cc
The Provincial Commissioner
Nairobi

The Provincial Medical Officer of Health
Nairobi

**APPENDIX 7.5 RESEARCH PERMIT KARI**

KENYA AGRICULTURAL RESEARCH INSTITUTE
HEADQUARTERS:
P. O. BOX 57811 TEL: 4183301/20
FAX: 4183344
e-mail:resource.centre@kari.org
NAIROBI

When replying please quote:

Our Ref: KARI/3/041/VOL.VI/ Date: 7th July 2005

Your Ref: _____

**TO WHOM IT MAY CONCERN**

**RE: Data Collection – Winfred Kyalo - P.O box 74394, NAIROBI**

The above named is a student at Kenyatta University currently pursuing a Masters Degree Course in Public Health.

She is currently undertaking data collection for her Masters thesis entitled: Public Participation as a Means of Mitigating Public Health Issues Associated with Genetically Modified Foods.

The student requires information from our Biotechnology Center at NARL Kabete.

We have no objection with the student making appointments with scientists for interviews for the purpose of her academic research at Biotechnology Centre, NARL, Kabete

By a copy of this letter, Dr. Ateka would be requested to act as the lead scientist in this exercise

Any assistance given to her will be appreciated

**Elizabeth Munyori (Mrs)**
**For: DIRECTOR – KARI**

CC. Centre Director, NARL Kabete
Head Biotechnology Centre

## APPENDIX 7.6 A MAP OF NAIROBI PROVINCE