

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

**CONSUMERS' AWARENESS, PERCEPTIONS AND WILLINGNESS
TO PAY FOR GENETICALLY MODIFIED FOODS: THE CASE OF
RICE IN TAMALE, NORTHERN GHANA**

ZAKARI ADAM



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RICE IN TAMALE, NORTHERN GHANA**

BY

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(UDS/MEC/0037/14)

**THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL
AND RESOURCE ECONOMICS, FACULTY OF AGRIBUSINESS AND
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REQUIREMENTS FOR THE AWARD OF MASTER OF
PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS**

JUNE, 2017



DECLARATION

Student

I hereby declare that this thesis is my own original work except for related works of other authors in the thesis which have been dully acknowledged. There has been no previous submission of this work for another degree in this university or any other institution.

Signature: _____ **Date:** _____

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Supervisors

We hereby declare that the writing of this thesis was solely carried out by Zakari Adam in partial fulfillment of the requirements for the award of Master of Philosophy (MPhil) Degree in Agricultural and Resource Economics under our supervision in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

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ABSTRACT

A survey of 300 consumers was conducted in Tamale in northern Ghana to determine consumers' awareness, perceptions and willingness to pay (WTP) for GM foods. Both the double-bounded contingent valuation method (CVM) and choice experiment (CE) were used to elicit WTP. Also, ordered probit model was used to analyze factors influencing WTP. Descriptive results indicate that GM foods do not exist in Tamale. Most consumers have heard or read about GM foods; however, the knowledge level is low on specific GM products. Also, majority of consumers in urban Tamale (56.5%) are not willing to pay more for and (30.43%) require a 20% discount to be willing to buy GM foods regardless of the benefits it seeks to offer. The conometric results showed that age, education and perceived allergies to GM positively affected WTP while religion, awareness, information from the radio, perceived nutritional benefits and perceptions of GM foods as unnatural negatively affected WTP for GM foods.

Again, consumers' are much conscious about health, nutrition and food safety and this has a direct influence on their WTP for GM foods, especially for the higher bids, hence there should be keen efforts by GM technologists to make GM foods as safe and nutritious as possible to influence consumers' WTP for higher bids.

Biotechnologists and the whole scientific community in collaboration with government and the media should endeavor to provide the public with unbiased information that will change consumers' negative perception about GM rice.



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DEDICATION

I dedicate this work to my beloved mother, Mrs. Ayishatu Adam for her invaluable love and care.



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LIST OF ACRONYMS

Acronym	Meaning
BT	Bacillus thuringensis
CDF	Cumulative Distributive Function
CE	Choice Experiment
CVM	Contingent Valuation
EU	European Union
DNA	
WTA	Willingness to Accept
WHO	World Health Organization
WTP	Willingness to Pay
UNDP	United Nations Development Programme
GSS	Ghana Statistical Service
MoFA	Ministry of Food and Agriculture
VAD	Vitamin A Deficiency
SEM	Structural Equation Model
RP	Revealed Preference
SP	Stated Preference
MPM	Market Price Method
TCM	Travel Cost Method
HPM	Hedonic Pricing Method
DALY	Disability _Adjusted Life Years
MoFA	Ministry of Food and Agriculture
UNEP	United Nation Environment Programme
DNA	Deoxyribonucleic acid
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
EU	European Union
KG	Kilogram
CV	Contingent Valuation or Compensating Variation





WTA	Willingness to Accept
CVM	Contingent Valuation Method
CE	Choice Experiments
GMO	Genetically Modified Organisms
GM	Genetically Modified
GE	Genetic Engineering
USDA	United States Department of Agriculture
GMT	Genetically Modified Technology
PFM	Production Function Method
GPHC	Ghana Population and Housing Census
JHS	Junior High School
SHS	Senior High School
GLSS	Ghana Living Standards Survey
MSLC	Middle School Leaving Certificate
BECE	Basic Education Certificate Examination
FAO	Food and Agricultural Organization
CARD	Coalition for African Rice Development
DBDC	Double Bounded Dichotomous Choice
SBDC	Single Bounded Dichotomous Choice
UDS	University for Development Studies
APHIS	Animal and Plant Health Inspection Service
USA	United State of America
US	United State

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Biotechnology is a technique that involves using living organisms or substances to modify a product in order to improve plants or animals, or to develop microorganisms for specific uses. For this reason, plant and crop breeders have used biotechnology to adapt the genetic makeup of crops for several years (McHughen, 2008). Contemporary biotechnology has been allied with Genetic Modification (GM). It is a modern biotechnology that entails transferring a gene from one species (plant) to another in order to produce a new desirable trait (Skogstad, 2011). GM foods were first put on the market in the early 1990s. The first GM foods were manufactured from plant species (e.g. corn, soybean, canola and cotton seed) (Uzogara,2000).

The reasons for developing GM crops was to increase farmers' profitability through cost reductions or higher yields. It was later modified to satisfy the needs of the consumers. For instance, rice, maize and other crop gene codes were modified to resolve an acute nutritional problem. This began with 'golden rice', which was genetically engineered to contain an increased level of vitamin A to help boost the health of malnourished people in developing countries. It also included some pharmaceutical products (Yonekura-Sakakibara and Saito, 2006). Recently, genetic modification is being used to augment the protein content and levels of essential amino acids in food crops. For example, maize has been genetically modified to produce high lysine content and has already been approved for environmental release in Australia, Canada, Japan and the USA (Aldemita, *et al.*,2015).



Many proponents of the GM technology consider that people in developing countries will gain from the GM improvement of amino acid content in crops, since their diets are largely grain-based (Newell-McGloughlin, 2008). Many GM foods are now in the world market and their products can help meet the basic needs as well as provide economic, environmental and health benefits to humans (James, 2008; Langtree, 2009; Suzie *et al.*, 2008). Biotechnologists have the conviction that the technology has the potential of benefiting society through reduction of hunger and malnutrition, prevention and cure of diseases, and promotion of health and general wellbeing (Isserman, 2001). Again, early research has reported that GM crop varieties have shown superiority over conventionally grown crops in terms of yield, pest and disease resistance, nutritional improvement and longer shelf life (Devoset *al.*, 2014).

Despite these superior characteristics, GM crops are received with varying emotions worldwide. Nevertheless, GM application is gradually finding its place across the world. Statistics indicate that after the introduction of GM seeds, its production has grown about 125 million ha globally (GMO Compass, 2009) with the US accounting for close to 50% of the global area under GM crop production.



In Africa, biotechnology has been adopted on an extremely cautious basis, even though per capita food production has been decreasing against a rapidly expanding population. As at 2007, only the Republic of South Africa had benefited from the commercialization of GM crops. GM created its way into South Africa through the BT maize, which reduce yield losses from damage by stem borers (Gouseet *al.*, 2004). In Egypt, South Africa and Burkina Faso, there is commercial production of GM foods(e.g. BT cotton, BT maize) (Vital *et al.*, 2011).



In December, 2011, the president of Ghana signed the Biosafety Act, 2011 (Act 831) following the passage of the Biosafety Bill. Consequently, scientists have been given the go-ahead to develop and commercialize biotech seeds and crops such as sweet potato, cassava, cowpea, maize, soybeans and rice. By implication, Ghana is on its journey to adopting the production and consumption of the GM food crops. The Ministry of Food and Agriculture (MoFA) indicated experts have testified to the safety of GM products. What is needed now is to put in place the necessary structures to begin its commercialization in the country (Ashitey, 2013).

1.2 Problem Statement

The role of biotechnology in the development of food production and agriculture in general cannot be underestimated (Shetty, 2006). Biotechnology has become important as huge sums of money are being spent to develop new and improved foods, fuel, feeds, fibers and pharmaceuticals. The technology was developed to help reduce production costs, enhance yields, and also to increase the potential profits of farmers through reductions in pesticide and herbicide use, as well as the potential for enhanced nutritional value, flavor and shelf life of any food. Despite the stated advantages, the introduction of GM has been met with mixed reactions from consumers and the general public. While these issues are location and country specific, there are major highlighting points that reflect across the globe. These common concerns include health risks, ethical issues, environmental issues and conservation issues (Galveo, 2013).

For instance, many people, including consumers and producers, argue that GM food benefits come with risks ranging from exposure to possible allergens and toxins, harm to the environment, antibiotic resistance, and the spread of introduced genes to non-target

plants by out crossing and pollen drift (Obrycki, 2001). GMO technologies are viewed by some opponents as a needless interference with nature that may lead to unknown and potentially disastrous consequences (Rohrmann and Renn, 2000). On the other hand, biotechnologists are of the view that the issue is not about the environment or the health of the consumer, but a deliberate fight against bio-technology for political success (Pollack, 2001). The harmful nature of GMOs has been questioned because no scientific evidence has been provided (Bansal *et al.*, 2007).

Perceptions play an important role in the acceptability and utilization of any new product. But, consumers' perspectives on the introduction of a new product also depend largely on the awareness and existing information about the product. Consumers' level of awareness also influences their perceptions and intentions (purchasing decision) towards a new product. In other words, consumers' perception of risks and benefits about products (GM food) depends on their level of awareness or availability of information (Slovic *et al.*, 2004). Again, consumers' knowledge on GM food also depends on their trust in information received, which is directly related to the sources from which the information is disseminated (Siegrist *et al.*, 2000).



While many studies (Curtis *et al.*, 2004; Hung *et al.*, 2006; Gonzalez, 2009; and Buah, 2011) have analyzed consumer acceptance of GM foods in the developed and developing countries, there is limited knowledge in Ghana on consumers' preparedness to purchase GM foods. Since producers will only embrace the production of a crop if there is a demand for it, it is also important to study consumer WTP for GM foods. To the best of the author's knowledge, consumer WTP for GM foods in Ghana is less understood, particularly in relation to one of the most important staple food crop (rice). The success of the GM concept

depends on consumers' WTP and use GM foods (Springer *et al.*, 2002), which is very essential in food markets (Hossain *et al.*, 2003).

The purpose of this study is to examine the knowledge level in relation to GM foods. Effort will be extended to examine their general perceptions and whether they will be prepared to purchase GM foods. This will help us to know whether it is worth investing in GM products in the Ghanaian context. The study is guided by the following research questions.

1.3 Research Questions

- i. What are consumers' level of awareness and source of information about GM food in Tamale?
- ii. What are consumers' perceptions about GM foods in Tamale?
- iii. How much are consumers' willing to pay for GM foods?
- iv. What factors influence consumers' willingness to pay for GM foods in Tamale?

1.4 Research Objectives

The objectives of the study are as follows:

1.4.1 Main Objective

To determine the consumers' level of awareness, perception and willingness to pay for GM foods in Tamale.

1.4.2 Specific Objectives of the Study

The specific objectives are to:

- i. Examine consumers' source of information and level of awareness of GM foods.
- ii. Investigate consumers' perception of GM foods.
- iii. Determine amount consumers' are willing to pay for GM foods.



- iv. Identify the factors that influence consumers' willingness to pay for GM foods.

1.5 Justification of the Study

A better understanding of consumer awareness, perceptions and willingness to pay for GM food such as rice and maize is needed to promote and facilitate the production of such crops in Ghana. Studies have shown that consumers are the beginning of the value chain whereby the flow of information about food preference moves back to retailers, manufacturers, farmers, and scientific laboratories (Kinsey, 2001). Consumer information such as their perceptions and willingness to pay for a product is the source that can be used to better understand the market. Good market information from consumers will assist rice and maize producers in making better decisions regarding the production GM food. For these reasons, the empirical findings of the study would provide quantitative WTP estimates as well as qualitative information on people's awareness level and perception on GM foods.

The availability of this comprehensive monetary estimate on the individuals WTP for GM rice and maize would help in the planning and execution of a suitable national incentive programme for the dissemination and adoption of more environmentally friendly agricultural practices. Again, the results of this study can help policymakers and marketers to make more informed decisions based on consumer perceptions and willingness to pay for GM food in Tamale which is one of the fastest growing cities in West Africa. This will help guide promotions, investment decisions and efficient fund allocation.

Academically, this study will add to the body of knowledge on people's awareness, perception and willingness to pay for GM foods such as rice and maize, and its related areas in Tamale, Ghana or it can serve as a source of reference materials for students and



researchers. This calls for the understanding of consumers' awareness, perceptions and WTP for GM rice and maize and thus, justifies undertaking this study.

1.6 Challenges and Limitations

The successful completion of a research work fundamentally depends on the collection of valid and reliable data. Collecting reliable data is not always an easy task and it entails some challenges. The challenges and limitations faced by the researcher during the data collection period are as follows:

- I. Some of the respondents in the beginning were not willing to answer the questions about income, but the researcher has to guarantee them of confidentiality of their information and made them aware that the research is purely done for academic purpose, and then the circumstances turn out to be better.
- II. GM products are not yet on the market and as a result, many people do not have much information about it and hence it was quite difficult to proceed with a respondent who have no knowledge or not heard of GMO before. However, the researcher has to spend more time with the respondent to explain what GMO is about and give examples before proceeding. This took more time and made the data collection period long and expensive.
- III. GMT and its products are a controversial issue as a result, many of the respondents were not so comfortable to give their answers. However a brief introduction to the purpose of the research improved the situation and facilitated the work to a great extent.



1.7 Organization of the Study

This study is structured into five chapters:

Chapter one consists of the background of the study, the problem statement, the research questions and the objectives of the study as well as the justification of the study.

Chapter two provides a broad literature review on the concept of GM, the awareness and consumers' source of information on GM foods, the concept of GM rice and maize, socioeconomic variables and factors influencing WTP, consumer behavior, empirical studies on consumers' WTP, and consumers' attitudes and perceptions of GM, as well as a review of the methodology of the study.

Chapter three gives a detailed description of the study area, the sample size and sampling procedure, hypotheses, descriptions of variables and *a priori* expectation, the conceptual framework on WTP, which comprises consumers' utility and willingness to pay, the contingent valuation method, as well as the estimation of mean on WTP.

Chapter four gives a descriptive analysis of the survey data and also discusses the empirical findings.

Chapter five entails summary of the research findings, conclusions and some policy recommendations.



CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter comprises a review of relevant theoretical and empirical literature. This includes studies on consumers' WTP and other related studies globally.

2.2 Evolution of Genetically Modified Organisms

A genetically modified organism (GMO) is one that has had its genetic material altered through one of several methods. Although traditional animal breeding and genetic modification through plant hybridization techniques are technically genetic modifications, these techniques pre-date recombinant techniques and typically are not considered GM. A genetically engineered (GE) organism is one where its DNA is modified using techniques that permit the direct transfer or removal of genes in that organism. Organisms that undergo genetic engineering are sometimes referred to as transgenic (Schneider, 2009). Originally, transgenic referred to an organism that had a gene from another (different) organism inserted into its genetic material. The term GM foods or GMOs as defined by Bartel (2016), is most usually used to refer to crop plants created for human or animal consumption using the hereditary engineering techniques.

GMOs have been the source of hope for man in the world of today. This is supported by an ever increasing demand for food due to exponential increases in the human population. For instance, rice, maize, soybeans, tomatoes, potatoes, meat, and many other crops are being genetically modified. This application of biotechnology has improved qualities of crops for





use by man. These qualities may include increased yield, better appearance, disease resistance, fragrant aroma and decreased height depending on the objectives of the modification. An example of a transgenic GMO is BT maize, a variety that contains a gene from the bacteria *Bacillus thuringiensis* (EPA, 2002). The maize species has the natural insecticidal ability to resist pest (Craig, 2017). They are highly effective at combating pests such as European corn borer, rootworm and corn earworm (Ostry *et al.*, 2010). GM crops are cultivated in most parts of the world, particularly in countries from South America, Europe, Asia, Australia, South Africa and North America (James, 2008). GM foods are classified into one of three generations. First-generation crops have enhanced input traits, such as herbicide tolerance, better insect resistance, and better tolerance to environmental stress. Second-generation crops include those with added-value output traits, such as nutrient enhancement for animal feed. Third-generation crops include those that produce pharmaceuticals, improve the processing of bio-based fuels, or produce products beyond food and fiber (Fernandez-Cornejo and Caswell, 2014).

Since 1987, seed producers have submitted nearly 11,600 applications to the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA APHIS) for field-testing. Applications peaked in 2002 with 1,190 approvals (Fernandez-Cornejo and Caswell, 2014). More than 92 percent of the crops that were submitted have been approved for trials. Most applications involve major crops, with more than 5,000 approvals for maize, the most commonly modified crop. The next most modified crops are soybeans, potatoes, and cotton. More than 6,600 of the approved applications include GE varieties with herbicide tolerance or insect resistance. If a GM product is deemed to be successful after trials and thought to be commercially viable, a company can petition for deregulation (i.e.,

allowing GE seeds to be sold). To date, APHIS has received 145 petitions for deregulation, but only 96 of these petitions have been approved. These include maize (30), cotton (15), tomatoes (11), soybeans (12), rapeseed/canola (8), potatoes (5), sugar beets (3), papaya (2), rice (2), squash (2), and 1 petition each for alfalfa, plum, rose, tobacco, flax, and chicory (Fernandez-Cornejo and Caswell, 2014).

It has been estimated that more than 60% of food products in retail stores already contain genetically modified ingredients (Ahmed, 2002). Commonly planted GM foods include many major agricultural commodities, with genetically modified plants accounting for 88% of the maize acreage, 93% of the soybean acreage, and 94% of the cotton acreage grown today. Globally, over 148 million hectares of GM crops was cultivated in 2010 (ISAAA, 2010)

In 2006, 252 million acres of transgenic crops were planted in 22 countries by 10.3 million farmers. The majority of these crops were herbicide- and insect-resistant soybeans, maize, cotton, canola, and alfalfa. Other crops grown commercially or field-tested are sweet potato resistant to a virus that could decimate most of the African harvest, rice with increased iron and vitamins that may alleviate chronic malnutrition in Asian countries, and a variety of plants able to survive weather extremes. On the horizon are bananas that produce human vaccines against infectious diseases such as hepatitis B; fruit and nut trees that yield very early, and plants that produce new plastics with unique properties. However, the need to produce GM foods and the justification of its commercialization does not confer its acceptance and consumption by the consumers. This is evident in the public reaction of the EU regarding the commercialization of GM foods.



2.3 Global Growth in Commercialization of GM Crops

Despite a steady increase in global plantings of transgenic crops from 1996, when they were first introduced, the global percentage of land under GM crops remains relatively small. From the year 1996 to 2015, the total areas under cultivation of transgenic crops have increased from 1.7 million to 179.7 million hectare (ISAAA, 2015) (Table 1).

Table 1: Global Area of Transgenic crops under cultivation, 1996 to 2015

Year	Hectares (Millions)	Acres (Millions)
1996	1.7	4.3
1997	11.0	27.5
1998	27.8	69.5
1999	39.9	98.6
2000	44.2	109.2
2001	52.6	130.0
2002	58.7	145.0
2003	67.7	167.2
2004	81.0	200.0
2005	90.0	222.0
2006	102.0	250.0
2007	114.3	282.0
2008	125.0	308.8
2009	134.0	335.0
2010	148.0	365.0
2011	160.0	395.0
2012	170.3	420.8
2013	175.2	433.2
2014	181.5	448.0
2015	179.7	444.0
Total	1,964.6	4854.6

Source: James 2015

Global plantings of GM crops jumped by 20 per cent in 2004; this was the second largest yearly increase since commercial plantings began in 1996. During that year, the land under



GM crops rose to 81 million ha. For the first time, the number of hectares increased. Growth in GM crop areas was higher in developing countries than in developed countries, which accounted for slightly more than one-third of the world's GM crop area. Land under GM crops is expected to continue increasing as the sector grows in India and China and new countries introduce GM crops. In 2004, soybean accounted for 60 percent of all GM crops, maize for 23 percent and cotton for 11 percent. In the near future, GM maize is projected to have the highest growth rate as more beneficial traits become available and is approved. In 2004, there were 8.25 million farmers involved in GM crop production in 17 countries. Although 90 percent of these farmers were from developing countries, only one of these countries, South Africa, was in Africa. There are 14 countries growing over 50,000 ha of GM crops. In 2004, Paraguay, Spain, Mexico and the Philippines joined this group. However, global production is dominated by five countries. The USA with 59 percent of global sowings has the largest share of total land under GMO production. This is followed by Argentina with 20 percent, Canada and Brazil with 6 percent each, and China with 5 percent of land under GM crops globally. In Africa, the use of GMO technology and its products is still in its infancy.



In South Africa, under the GMO Act of 1997, three transgenic crops – insect or herbicide resistant cotton, maize and soybean have been approved for commercialization (James, 2008). Supporting legislation and policy to regulate research and commercialization processes have not kept pace with these developments. Also, private sector dominance has meant that most agricultural biotechnology research focuses on developing country concerns such as improved crop quality or management rather than drought tolerance or

yield enhancement, and innovations that save labor costs (such as herbicide tolerance) rather than those that create employment (UNEP, 2005).

2.4 Genetically Modified (GM) Maize

Maize is one of the world's major commercial food crops and is grown in many countries around the world. It contains the highest amount of energy (ME 3350 Kcal/kg) among cereal grains and is highly palatable. Maize is also an excellent source of linoleic acid. The seed is high in starch (65-70%), but low in protein (8.8%), fiber and minerals. Maize protein is mainly deficient in tryptophan and lysine. Therefore, maize is used on a large scale and in many cases consumed in most households in the world. However, European maize borer (*Ostrinia nubilalis*) and Southwestern maize borer (*Diatraea grandiosella*) have caused momentous yield losses in maize production, resulting in food insecurity in most households (McKenzie *et al.*, 2015). Farmers have to purchase insecticidal spray that includes a mixture of spores and associated protein crystals belonging to a Gram bacterium (*Bacillus thuringiensis* (Bt) which has been used worldwide (Nester *et al.*, 2002). This could increase the production cost of farmers as well as reduce their farm profit. Biotechnologists therefore developed recombinant DNA technology and other direct and controlled methods to fight these pests. MON810 was one of the first DNA introduced into maize and authorized by the US in 1998 (Kania *et al.*, 1995). Independent studies (Holck *et al.*, 2002; Hernandez *et al.*, 2003; Rosati *et al.*, 2008; Eede, 2008) revealed a more detailed molecular characterization, but confirmed the structure and stability of transforming DNA inserted into the genome of maize was MON810.

Several studies have been conducted to examine the nutritional and possible effects of GM Bt maize on human and animal health. For instance, a study conducted by the Hutchison *et*





al., (2011) to examine the environment and health impacts of GM crops (BT maize) revealed that the crops are toxins to harmless non-target species, toxin to beneficial insects, threat to soil ecosystems, risk for aquatic life and swapping one pest for another. On the aspect of human health, CryIAb BT toxin in the blood of pregnant women could cross the placenta boundary. This calls for health concerns, even though its consequences and transference across the placenta are not yet known (Paganelli *et al*, 2010). GM maize is the second most important transgenic crop, globally planted in 2005, on 21.2 hectares and about 14% of the total maize grown globally (James, 2005). Clancy, (2016) stated emphatically that GM maize is an unnecessary, outdated and risky technology that positions severe fears to human health and the environment. It is also a risky business from an economic point of view. The best option for farmers, beekeepers, governments, global markets and consumers is to reject it to defend the world's most important food crops. There are many viable substitutes for GM. Maize, such as organic agriculture and other forms of sustainable agriculture that can ensure food safety and food security for all, while at the same protecting the environment. A study conducted by Séralini *et al.* (2014) on long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize through Biochemical analyses confirmed that there were significant chronic kidney deficiencies, for all treatments and both sexes; 76% of the altered parameters were kidney-related.

2.5 Genetically Modified (GM) Rice

Rice is the major staple grain for virtually half of humanity. However, rice is usually milled to remove the oil-rich aleurone layer, and the remaining endosperm lacks several essential nutrients including provitamin A, or β -carotene (Hallerman and Grabau, 2016).

High consumption of rice could lead to vitamin A deficiency, which is a serious health problem in at least 26 countries in Asia, Africa, and Latin America (WHO, 2005) and is accountable for 1.9–2.8 million avoidable deaths per year (Mayo-Wilson *et al.* 2011).

WHO (2007) again indicated that between a quarter and a half million children go blind each year due to Vitamin A Deficiency (VAD) syndrome. Also, golden rice could decrease the number of Disability-Adjusted Life Years (DALYs) lost per year.

It was against this background that Golden rice, a variety of rice that has been genetically modified to yield beta-carotene which has the potential of improving health in developing countries where rice is dietary staple (Dawe *et al.*, 2002).

The development of GM rice (Golden Rice) came up during an international conference in the Philippines in 1984 (Stone, 2016). This was to resolve an acute nutritional problem facing developing countries.

As of the year 2000, the first two GM rice varieties, both with herbicide-resistance, were permitted in the United States, Canada, Australia, Mexico and Colombia. It was also reported in 2009 that China had granted Biosafety approval to GM rice with pest resistance, however there is still anxiety in its commercialization to its component of vitamin A.





Anderson and Yao (2004) conducted a study in China to assess the adoption of GM rice and cotton. The outcome of the study shows that the global benefits with GM rice would double if China adopts it, with China's gains going beyond \$1.1 billion per year. In the same manner, Anderson and Jackson (2005) studied the effect of GM food crop adoption in SSA, including rice, but they also included the effect of GM rice adoption in India and China. The findings of the study showed that countries adopting GM production and consumption can most benefit from GM rice and that trade restrictions are not significant compared to the potential gains for SSA. However, in India and China, the evaluated advantages of GM crop adoption would surpass \$650 and \$830 million, respectively, and they found that trade restrictions would not make any great difference.

The assumed nutritional benefit arguably has been the focal controversy regarding golden rice. Golden rice was shown to be an effective source of vitamin A to adults in the United States (Tang *et al.* 2009).

However, GM rice is faced with intense controversy. For instance, Dubock, (2014) claimed that an adult would have to consume at least 12 times the normal intake of 300 grams of rice in order to take in the daily recommended amount of pro-vitamin.

2.6 Awareness and Source of Information towards GM Foods

There are many ways of getting consumer awareness on GM foods; through labeling, mass media, and government information. Ghanaian consumers' understanding of GM foods is still not clear. We expect consumers' awareness, availability of information, perceptions to have relationship with WTP for GM foods.



Deffor (2014) investigated consumers' acceptance of GM foods in the Greater Accra Region of Ghana. He found that about 90% of the respondents had heard or read something about GM food and 85% were willing to accept it. However, Buah's (2011) survey on public perceptions of GM food in Ghana found that about 50% to 60% of the respondents coming from academic and research institutions heard about GM foods from workshops and friends. Furthermore, more than 80% of the respondents were unwilling to accept GM food for fear of unidentified side-effects and ethical thought. Similarly, Quaye *et al.* (2009) reported in a study that close to 50% of respondents in Ghana were not in favour of accepting GM foods.

Although South Africa adopted the GM technology, some people do not know what GM foods are, and those who know do not know which products contained GM ingredients and which one's do not (James, 2008). A survey conducted by Peter and Karodia (2014) of 60 individual respondents (consumers) and 6 focus groups were conducted in Queenstown in South –Africa in August and September 2013 to determine consumer acceptance towards genetically modified (GM) foods. The outcome of the study revealed that beyond a third (38%) of the respondents were aware of GM foods, mostly from newspapers, television and radio. Others had learned about GM crops at school, newspapers and television that were more important to more educated consumers. In a similar manner, a study discovered that consumers, and for that matter individuals, have a low level of awareness and understanding of the GMO and therefore make decisions of risk and benefit without fully understanding (Knight, 2009). The Media have the ability to structure stories and reinforce ideas and perceptions of consumers. For instance, a study reported that consumers learn about biotechnology primarily from the media (Botelho and Kurtz, 2008). Therefore, the



media has the ability of reaching large numbers of people from different backgrounds. The media sometimes changes the information by framing the issues in different ways through choice of words and images which influences the minds (Vilella-Vila and Costa-Font, 2008). Many a time, consumers' reactions towards GM is often based on what they hear and see on the media. A research conducted by Klerck and Sweeney (2007) to examine the awareness and understanding on GMO indicated that a person's understanding of a product is based on the amount of information he/she has about that product stored in the mind. Workshops and other agricultural education can help inform the public with regards to the benefits of biotechnology (Aerni, 2006).

Many researches have discussed the role of the media in influencing consumers' decisions when purchasing food (Kalaitzandonakes *et al.*, 2004; Villella-Vila and Costa-Font, 2008). Vestal and Briers (2000) articulated the need for an educational environment accessible and eye-catching to journalists that gives objective information on GMOs. The influence such programme would have on journalists could eliminate bias and promote objective knowledge among the public. The media is often used as a main source disseminating information. Media sources can be incredibly effective at reaching massive amounts of people who may not otherwise seek out scientific information, but the accuracy of the final message may be less than desired. Knowledge of GMOs is an area of interest because it may affect consumer opinions, attitudes, and behaviors. For example, a 2001 survey of US citizens revealed that only 44% of the respondents had at least some information about GMOs with 9% receiving a great deal of information, but 54% had heard not much or even nothing about biotechnology and food (McInerney *et al.*, 2004). This could lead to lack of information, hence, denying the people from knowing what to think about GM foods and

their degree of safety. The lack of appropriate information could lead to formation of bad attitude towards a product.

According to the Hartman (2014), among anti-GMO respondents, 57% are not well conversant with even products that do not contain GMO, 12% had seen it but did not know what it represented, and 16% knew its purpose but are indifferent. However, only 15% stated vigorously they seek out the cover in order to choose non-GM foods. Likewise, only 49% of those who oppose GM foods are more likely to use the organic seal.

2.7 Consumers' Perceptions about GM Foods

Consumers' perceptions of GMOs have been studied in most developed countries including the U.S. and France. Consumers from different areas of the world have quite diverse perceptions about biotechnology and GMOs (Frewer *et al.*, 2013). It was discovered that consumer perceptions about GM products are very diverse depending on the type of information provided and government trustworthiness, and cultural preferences. For instance, the United States demonstrated high public backing for biotechnology applications in comparison to other European countries. In the United States, consumers articulated a prudent confidence about the benefits of biotechnology, and are ready to accept GM products if the price is suitable and benefit society.

A survey conducted by Zakaria *et al.* (2014) to assess farmers' knowledge and perceptions of GM crops among leaders of Farmer Based Organizations (FBOs) in Northern Ghana revealed that majority of the respondents (64%) were aware of GM crops. They were of the opinion that commercial application of agro biotechnology could help boost the food security situations in the country. However, concerns were raised with regards to possible





policy failures, environmental, health and market risks. Stein (2008) undertook a study to assess the potential impact of Golden Rice in India, and found that consumers perceived extensive consumption of Golden Rice could reduce the incidence of VAD in India by almost 60 percent. On the other hand, those consumers who doubted this perception still believed that GM foods could reduce VAD by almost 10 percent. The results also showed that Golden Rice could prevent the loss of one DALY for less than \$20, even under pessimistic assumptions. However, other vitamin A interventions cost between \$80 and \$600 per DALY saved.

Studies conducted by Carpenter (2010) from 12 countries pointed out that farmers received direct benefits from growing GM crops. GM technology benefits small holder farmers in developing countries in terms of better yields. Again, Moon and Balasubramanian (2004) examined public attitude towards biotechnology, and confirmed that consumer acceptance of biotechnology is determined by their thought assessment of its risky and beneficial qualities.

Wynne, (2001) compared consumer and expert perceptions regarding several dimensions applicable to GMOs, and found considerably opposing opinions and attitudes. The study showed that consumers are not self-assured about risk management urgencies or efficiency as experts do, and give much more credibility to information coming from the media. There are also robust differences of outlook about the quality of the information that is available. However, some consumers are mixed up about GM products and uncertain about purchasing these products as they are ignorant of the effects that the products might have if consumed (Knight, 2008).



In Malaysia, a study was conducted by Amin *et al.* (2014) in Klang Valley to determine the acceptance level of the consumers towards GM food. It was realized that 56% of them had negative perceptions and were totally reluctant to buy GM foods and were notWillingness to Accept (WTA) GM food. In addition, many researchers believe, GM crops and food producing animals can produce toxic and allergic reactions to humans (Batalion, 2000).Furthermore, Boccaletti and Moro (2000) concluded from a study that even though consumers in Hoban perceived GM foods to be risky to human health, only 57% of them totally rejected it. A similar study in Italy by Boccaletti and Moro (2000) observed that 51.5% of the respondents knew of the existence of GM food in the market and 46% accepted itwhile 27.5% rejected it. In Poland, similar studies indicated that a considerable number of the respondents disbelieved GM, especially in food products (Szczurowska, 2005).Consumers make food choices based on ethical beliefs; when consumers make food choices, they base the choice on moral and ethical beliefs and how those beliefs match environmental concerns (Botelho and Kurtz, 2008).Also, in an article published in Lancet journalsurveyed the effects of GM potatoes on the digestive tract in rats. The study results indicated that there were appreciable differences in0 the intestines of rats fed with GM potatoes and rats fed with unmodified potatoes (Lack,2002).On the aspects of economic benefits, consumer campaigners are anxious that patenting GM plant varieties will raise the price of seeds so high that poor farmers and developing countries will not be able to afford seeds for GM crops, thereby increasing poverty (Hug, 2008).However, one factor that could raise the price is the improvement in seed genetics (germ-plasm) (NRC, 2010). Numerous studies have seen GM seed varieties to have lower prices than the sum of their component values (Stiegert *et al.*, 2010).



A study conducted by Font and Gil (2009) to assess the influence of risk perception and risk attitudes in the process of accepting GM foods using the Structural Equation Model (SEM) in Spain. The results suggest that the conceptualized model captures the decision making process, and that both perceptions and attitudes toward risk have independent effects on consumer acceptance. Though, the effect from risk perception is larger in intensity.

A study conducted by Han(2006) through a random, national and a mail survey to investigate the effects of risk/benefit beliefs on consumer purchase intentions for genetically modified (GM) foods. The survey result indicates that cognitive factors associated with risk/benefit tradeoffs turn out to have significant impacts on consumer acceptance of GM foods, and that consumers living in the Northeast region of the U.S. show a negative attitude about willingness to buy GM meat products. Benefits of GM foods on health and the environment have positive, significant impacts on the premium levels for GM potatoes.

2.8 Factors that Influence Consumers' WTP for GM foods

According to Font (2009), acceptance of new science improvement such as new food uses is a matter of substantial attention worldwide for a diversity of reasons. Public appreciation, awareness and knowledge of modern biotechnology, the possible benefits to the mankind from the technology could be exploited (Smith, 2004).

Several attempts have been made to classify the factors influencing the consumers' behavior. Usually, factors have been classified into three, namely:

- product-related factors (suitability, accessibility, packaging, price, durability, nutrient contents, physical attributes, and functionality),

- consumer-related factors (demographic factors, hunger, thirst, intentions, personality and attitudes) and
- Environmental factors (economic factors and social factors) (Zielińska, 2006).

2.8.1 Price factor

Additionally, there are other factors such as price, brand, price, risk and location that influence a buyer's purchasing decisions.

Price is the amount of money that the purchaser needs to pay to the seller for receiving rights to their desirable product (Wu *et al.*, 2011). There are many ways in which the price can affect a customer's behavior because prices can imply more to consumers than just a monetary exchange of value (Campbell, 1999). For instance, when the product price is high, the purchaser will attempt to search more information about the product (Wu *et al.*, 2011).

2.8.2 Socio-Economic Factors That Influence WTP

A significant association among the diverse stages of a consumer's attitudinal development is their association with socio-economic and demographic attributes such as age, ethnicity, residence and income level, which are found to openly relate to consumers' attitudes towards GM food. This relative is maintained by Costa-Font and Mossialos (2005), Hossain *et al.* (2003), Veeman *et al.* (2005), and Noomene and Gil (2004) using mainly logit and probit models.

Moreover, an individual consumer intention to purchase food commodity is influenced by his/her background, age and life stages. (Kardes *et al.*, 2011).



A study also revealed that age is an influencing factor when it comes to WTA/WTP for GM food, for instance, younger individuals are more tolerant of GM technology and its products (food) while older generations are more concerned of risks and safety of the products (Knight, 2007).

In addition, Sumukwo *et al.* (2012) found that age, sex, level of education and income are significant factors determining consumers' WTP while Acquah (2011) also argued that age, years of experience and household size have positive effect on consumers' WTP.

A study conducted by Irani *et al.* (2001) established that respondents' decision to purchase GMOs depends on their gender, ethnic background, and geographic location. This study also brings to the fore the fact that respondents living in rural areas were more likely to consider buying GMOs than respondents in urban areas. Huffman *et al.* (2004) disclosed that an individual's demographic characteristics such as schooling, age, religion, and social capital can significantly affect the preference for GM information sources.

Also, Frewer *et al.* (1998) revealed no significant difference between sexes of respondents with high level of environmental concern. In a similar case, Hossain and Onyango (2004) and Baker and Burnham (2001) disclose in their studies that economic and demographic attributes are not important in defining consumers' attitudes towards GM technology. Conversely, Baker and Burnham (2001) and Hwang *et al.* (2005) propose that economic and demographic factors concern might influence consumers decisions to purchase GM products.



2.8.3 Knowledge and Perceptions Factors

Again, a study conducted by Baker and Burnham (2001) to estimate diverse factors influencing consumer perception and valuation of GM corn flakes, brought to light that opinions and risk aversions to GM foods were strong signs of consumer acceptance or rejection for GM maize flakes in relation to socioeconomic variables such as income, education, and race. They asserted that consumer behavior is indomitable by what consumers trust, and to a lesser extent by how much they know about GM food products. Bower *et al.* (2003) have assessed the effects of liking, information and product features on the purchase decisions and respondents were willing to pay more for fats of proved health value. Labeling characteristics, price and health concerns all influenced the purchasing consumers' purchasing decisions.

Food insecurity changes beliefs, attitudes and behavior towards some specific foods. For example, consumers developed negative attitude towards GM foods when they suspected meat be poisoned with dioxin. Verbeke and Viaene (2001) and Verbeke (2001) have noted an outstanding increase in consumers' needs on safety and content of hormones at the phase of production, delivery and securities.

The factors determining purchase intentions and feelings towards GM food have been studied in Argentina (Mucci *et al.*, 2003). Generally, purchase intention has been low, and the most motivated issue was that, the young and less educated people were less informed about GM foods and those who liked to buy new sorts of food established some kind of attitudes. In an earlier report (Mucci and Hough, 2003), the subjects of a small 45 person group have demonstrated a number of negative attitudes towards GM foods: it is risky for



health and can change the environment; and some positive attitudes: it is beneficial and can improve nutrition.

2.8.4 Theoretical literature on WTP

From literature, methods for valuing non market resources may be generally classified into two frameworks- Revealed Preference (RP) or Stated Preference (SP) approaches. The Revealed Preference approach (also known as the Revealed Willingness to Pay) is based on the market price of goods. This is advance in economic intuition that if the good at hand or being valued has an established market, then individuals' will reveal their preference or value it by paying for it at the market price. Here, individuals use existing market price to assess the value of the good. Under, this approach, economic valuation methods such as Travel Cost Method (TCM), Market Price Method (MPM), Hedonic Pricing Method (HPM), and Production Function Method (PFM) are used.

Stated-preference methods on the other hand consist of a range of survey methods used in economics and psychology to study peoples' priorities and preferences. It makes use of qualitative and quantitative approaches to identify and evaluate people's choices.

The stated preference approach is used to elicit consumers' willingness to pay for a given commodities from survey respondents (Mitchell and Carson, 1989; Bateman *et al.*, 2003).

Stated preference (SP) methods allow analysis of hypothetical situations, which are made by some systematic and planned design process (Louviere *et al.*, 2000).

It is classified into two main categories; that is, the Contingent Valuation Methods (CVM) and choice modeling techniques (Discrete Choice Experiments) which is reviewed in the subsequent pages. These are methods used for Eliciting Consumers' WTP.



WTP is the maximum amount of money a consumer is willing to pay for new or value-added products. According to Mubyazi *et al.* (2004), WTP is the maximum price an individual is willing to give in order to obtain a product or service. It is also the highest amount an individual (consumer) is ready to give to acquire more of a good or service. However, formally, WTP is defined as the amount that must be taken away from the person's income while keeping his utility constant.

Mathematically it can be represented as:

$$V(y - WTP, p, q_1; z) = V(y, p, q_0; z) \quad [1]$$

Where V indicates the indirect utility function, y is income, p is a vector of price confronted by the individual, and q_0 and q_1 are options levels of the good or quality index (with $q_1 > q_0$) indicating that q_1 , is the value – added product.

Willingness to Accept (WTA) on the other hand indicates the amount that must be given to an individual experiencing deterioration in environmental quality to keep his utility constant. It can also be defined as the lowest amount of money an individual is prepared to take to obtain less of a good or service. The two are common approaches used by various economists to determine the value of resources. Allocating monetary value to goods and services has the basic objective of stimulating the acceptance of the two methods (WTP and WTA) for goods and services people enjoy (Hecht, 1999).

It can also be represented as:



$$V(y + WTA, p, q_0; z) = V(y, p, q_1; z) \quad [2]$$

Where the variables are as defined above.

Though we expect WTP and WTA for a given food commodity to be nearly equal, however, a number of CV studies have revealed that WTA is often much larger than WTP for the same commodity. Several reasons are possible for this finding. One reason is that the difference between WTP and WTA rests on the elasticity of substitution between the commodities to be estimated. The lower the elasticity the fewer the available substitutes, hence the greater the difference between WTP and WTA methods (Hanemann, 1991).

A number of researchers have used various methods to discover consumer WTP worldwide including CVM (Campbell *et al.*, 2014; Gil *et al.*, 2000; Boccaletti and Nardella 2000; Majumdar *et al.*, 2011; Krystallis and Chryssohoidis, 2005; Misra *et al.*, 1991).

2.9 WTP Measurement Techniques

There are a huge variety of analytical techniques for measuring WTP. That is the open-ended format, discrete choice, payment cards, bidding game. Bishop and Heberlein (1979) introduced the single-bounded dichotomous choice CV that is not so burdensome for respondents, simulates the market situation and is not prone to anchoring. This question format has dominated CV applications since the strong recommendations issued by the NOAA panel (Arrow *et al.* 1993; Smith 2006; Carson 2011). It has been connected to several desirable features, e.g. the familiar context of take-it-or-leave-it purchasing decisions (market similarity) (Freeman, 1999), which is a relatively simple decision problem. It additionally contains no starting point bias (Arrow *et al.* 1993) and resembles a referendum situation when taxes are used as a payment method. One of the most important





claims has been the assumption of its incentive compatibility (Hoehn and Randall 1987; Arrow *et al.* 1993). The findings concerning incentive compatibility have been more ambiguous in recent years (Bateman *et al.* 2008). The most common variant of the dichotomous choice question format is the double bounded question format (Hanemann *et al.* 1991). It collects more information concerning respondents' preferences compared to the single-bounded question format, but may suffer from the starting point bias and incentive incompatibility that may distort results. In addition to the dichotomous choice format, preferences have been elicited using the open-ended question format and payment card (Bateman *et al.* 2002), and more recently e.g. the payment ladder (Håkansson 2008). In dichotomous choice CV, as well as CE, the choice of a bid vector is a crucial point in the questionnaire design (Cooper and Loomis 1992; Kanninen and Kriström 1993). Optimal designs require information concerning WTP distribution prior to the study that is usually non-existent (Alberini 1995; Kanninen 1995). A practical approach has been to conduct a pilot study and based on that, place some bid levels around the expected mean WTP and some bid levels to both tails of the WTP distribution.

The discovered preference hypothesis suggests that the choice faced by a respondent in the first valuation choice task is not produced through stable and consistent preferences (Bateman *et al.* 2008), because goods may be unfamiliar and the respondent may also lack experience regarding the choice situation. A drawback of binary choice CV thus, is that it does not give respondents the possibility for either value or institutional learning. In CV, it must be assumed that the information provided by the survey suffices for the respondent to gain knowledge of her underlying preferences. The CE method has been suggested to overcome most problems inherent in the CV approach (Adamowich *et al.* 1998; Louviere *et*

al. 2000; Bennett and Blamey 2001). For example, it has been claimed to be so complicated that respondents cannot behave strategically. The proposed scenario in the CE is described using the attributes and their levels, which vary according to certain design. The choice set usually contains several alternatives and a respondent chooses the most preferable alternative that is supposed to yield the highest utility. Respondents also face a sequence of choice tasks, which are defined by the attributes and their levels. Choice experiment data can be analyzed using the conventional multinomial logit model. However, it makes strong assumptions concerning the independence of the choice task alternatives and the independence of each choice task in a sequence faced by an individual. Econometric modelling developments have solved many of these problems (Layton 2000; Carrasco and Ortúzar 2002) and CE has been suggested to overcome most of the potential biases that complicate the CV applications (Boxall *et al.* 1996; Adamowich *et al.* 1998; Smith 2006).

2.10 Methods for Eliciting Consumers' WTP for GM Products

2.10.1 Choice Experiment (CE) Methods for Eliciting Consumers' WTP for GM Products

The choice experiment was first established in transport and marketing research (Louviere *et al.*, 2001). It chooses among alternative options, where each option is characterized by a number of characteristics with different levels (Burton *et al.*, 2001). The CE model and the random utility theory work hand in hand. CE involves providing the individual with a hypothetical setting and then asking them to make a choice from the alternatives. Various characteristics or attributes are used to describe each alternative which includes a monetary



value. The Random utility theory states that an individual consumer will select among a set of alternatives if he/she derives higher satisfaction from it than the other alternatives options (Mac Fadden, 1974).

Again, Hensher *et al.* (2005) indicated that utility level relates to one another in the choice set. CE has a number of advantages in the sense that it makes WTP and WTA estimates much simpler and also reduces the danger of strategic answers (Ahlheim and Neef, 2006; Yabe and Yoshida, 2006). The CE is based on Lancaster's method to consumer theory (Lusk and Schroeder, 2004; Carlsson *et al.*, 2007) which shows that a good has features that give rise to utility but the good does not give utility to the consumer.

2.10.2 Contingent Valuation (CV) Methods for Eliciting Consumers' WTP for GM Product

Nearly every study on consumers' behaviour with a stated preference for non-market goods employs Contingent Valuation Method (CVM) (Boccaletti and Nardella, 2000; Haghiri *et al.*, 2009; Misra *et al.*, 1991; Gil *et al.*, 2000; Krystallis and Chryssohoidis, 2005; Wang and Sun, 2003; Stolz *et al.*, 2011; Mitchell and Carson, 1989). When estimating the feasibility and sustainability of a new venture (or improvement of an existing method), it is very important to consider the cost of production (or the extra cost) and consumer demand for the new product.

This study employed the CVM because it is more adaptable for measuring the value of non-market goods and does not impose restrictive assumptions on an individual's preference. CVM allows a direct or indirect estimation of WTP by means of direct elicitation technique. In CVM, consumers indicate their WTP for a hypothetical product (non-market)





without actually paying for it. The CVM involves the construction of hypothetical scenarios in which consumers are asked directly or indirectly to state how much they would be willing to pay for safer vegetables (Mitchell and Carlson, 1989). These values are obtained by asking the respondent, how much he/she is willing to pay for some environmental good (in this context labeled GM foods). CVM relies on two basic assumptions; first, the concerns of the respondent are evaluated based on their preference for GM foods. Second, consumers draw out values, and these are the maximum amounts they are willing to pay for GM foods.

There are several forms (open-ended, single bounded dichotomous choice, double bounded dichotomous choice, iterative bidding) of the CVM elicitation techniques. The dichotomous choice and open-ended CVM are commonly used. Open ended willingness to pay questions elicit a single amount from the respondent by asking "what is the maximum amount you would be willing to pay" for the described situation. The outcome of the survey will be examined with the standard double-bounded logit model (Hanemann *et al.*, 1991). The double-bounded model will be used instead of the single-bounded model due to the fact that it provides efficient assessment than the open ended in the following ways (Haab and McConnell, 2002). Firstly, the number of responses is increased so that a given function is fitted with more data points. Second, the chronological bid offers for yes-no and no-yes responses yields clear bounds on WTP. Finally, for the no-no and yes-yes combinations, efficiency gain comes from the fact that they shorten the distributions where the respondent's WTP are likely to reside. For instance, Hanneman *et al.* (1991) used a double-bounded logit model to compare the DBDC and SBDC estimates of WTP. They found that

the DBDC reduces the variance, is asymptotically more efficient, and lead to higher t and R^2 statistics.

In the double bound dichotomous choice, the CVM question is framed first as dichotomous: for instance “are you willing to buy GM foods if there is a 5% increase in its current price considering the fact that it contains vitamin A and is pesticide-free?” Two follow-up questions are stimulated depending on the answer given by the consumer to the first question. If the consumer says “no” to the first bid, it means that a negative response is triggered which allows the researcher to present a lower bid to the consumer. Two outcomes are expected from the follow-up question triggered by the negative response: (1) if the consumer again says no to the lower bid, then it provides a final outcome for the bid as “no-no” and (2) if the consumer again says “yes” to the lower bid, then it provides a final outcome for the bid as “no-yes”. In this scenario, the outcome given as “no-yes” is certainly better than the outcome “no-no”. Similarly, if the consumer says “yes” to the first bid, means that a positive response is triggered which allows the researcher to present a higher bid to the consumer. Two responses are expected from the follow-up question triggered by the positive response: (1) if the consumer again says “no” to the higher bid, then it provides a final outcome for the bid as “yes-no” and (2) if the consumer again says “yes” the higher bid, then it provides a final outcome for the bid as “yes-yes”. It must be noted that, the “yes-yes” response is certainly better than “yes-no” response.

2.10.3 Consumers’ Utility and Willingness to Pay

Modeling choices that an individual makes has become an important economic phenomenon in consumer demand analysis to measure willingness to pay for an



environmental or private good. These choices are discrete or limited in nature and often based on economic decision of random utility theory. The decision to buy or not to buy GM can be explained by the random utility framework. In random utility theory, it is assumed that, if consumers encounter same commodities in the market, say GM food and non GM food; and if the consumer decides to purchase the GM food instead of the non GM food, it is assumed that he/she derives higher satisfaction from GM food than the non GM food (Magnusson *et al.*, 2005). The consumer is rational, and will only be willing to pay if his/her utility increases. If an increase in price decreases a consumer's utility compared to old level of utility, then the consumer will not change. Also if the utility increases, then the consumer may be willing to pay more for GM food, on the basis that the price increase does not lower the utility beyond the base level (Cranfield *et al.*, 2003). The individual will only choose alternative i , if and only if the utility he/she derives from this alternative is greater than all the other alternatives in the choice set. This is represented in the

$U_i > U_j \forall j \neq i$ equation below:

[3]

From this premise, we can say that WTP is a function of change in utility;

$$WTP = f(\Delta U) \quad [4]$$

where ΔU is the change in utility and $f'' > 0$

Therefore, the random utility model is outlined in the equation below:

$$U_i = V_i + \varepsilon_i \quad [5]$$



Where, V_i is deterministic component and ε_i is the random component. The random component cannot be measured, therefore, the probability that individual n will choose alternative i can be expressed as in the equation below:

$$\Pr(U_i > U_j) \forall j \neq i \quad [6]$$

Hence, the probability that a consumer will choose alternative i is the probability that the utility of that alternative is greater than any of the other alternatives in the choice set. Now, let us examine a simple case where the choice set consists of only two products, in this case GM food products and non GM food products. Then, it can be represented as:

$$P_i = \Pr[v_i + \varepsilon_i > v_j + \varepsilon_j] = \Pr[\varepsilon_j' < v_i - v_j + \varepsilon_i] \quad [7]$$

By integration ε_i we can calculate the Cumulative Distribution Function (CDF) at each point to find P_i

$$\int_{\varepsilon_i=-\infty}^{\infty} \left(\int_{\varepsilon_j=-\infty}^{v_i - v_j + \varepsilon_i} f_{\varepsilon}(\varepsilon_i, \varepsilon_j) d\varepsilon_j \right) d\varepsilon_i \quad [8]$$

2.11 Empirical studies on Consumers' WTP for GM Foods

A number of studies have investigated consumer willingness to pay (WTP) for and willingness to accept (WTA) GM foods in diverse regions. For instance, Asia, Japan and Korea stand out as the countries with low consumer acceptance for GM food in comparison with others like China and Taiwan that show greater acceptance. In Korea, Kim and Kim (2004) found that a large number of consumers would be ready to purchase GM products if they were offered lower prices. Similarly, a study conducted by Senturk (2009) on



willingness to pay for GM food in Turkey established that years of education, risk perceptions, and opinions concerning GM products have a significant influence on the price that consumers were willing to pay. Again, consumers in Johor Bharu had negative attitude and they were concerned about potential risks associated with GM foods (Ismail *et al.*, 2012).

Li *et al.* (2002) conducted a study to assess willingness to pay for GM foods in Asia, and discovered that consumers in Beijing were willing to pay a 38% premium for GM rice and a 16.3% premium for GM soybean more than the non GM product. In Japan, consumers are skeptical about GM products and will only choose GM food products when they are offered more discounts on GM foods. They were less worried about food safety, their understanding of GM was also low, more optimistic about the use of biotechnology in food production, and did not demand much about labeling of GM foods but were more willing to choose GM food products when they were offered more discounts on GM foods (McCluskey *et al.*, 2001).

Jin *et al.* (2014) conducted a study in 2013 to evaluate urban China consumers' acceptance and willingness to pay (WTP) for GM rice. The survey was conducted using the double bounded dichotomous choice contingent valuation method to estimate consumers' WTP for GM rice products and used a reference question to create sub-samples of respondents according to their preference for GM rice relative to non-GM rice at a reference price of 5 Yuan/kg. The result indicated that majority (73%) of the respondents' preferred non-GM rice to GM rice. The mean WTP estimate for GM rice by this sub-group suggested that a discount of 68% was required to make GM rice competitive. The mean WTP for those who preferred or were indifferent to GM rice suggested a WTP premium for GM rice of 14.4%.



In a similar study, Huang *et al.* (2006) stated that 60% of respondents or more are of the view that GM and non-GM foods are perfectly substitutable, 20% of the respondents would not buy any GM food and only 20% would buy it at a price discount.

On the contrary, Sharifuddin (2013) identified that Chinese consumers have positive attitude towards GM foods even though they have low knowledge about it. However, Japanese consumers also required GM discounts which is in relation to cognitive and demographic variables. The consumers required 40% discount on the GM foods (Kaneko *et al.*, 2005).

Again, a study conducted by Huang *et al.* (2006) in China discovered that information on GM foods is not much but awareness is high among urban consumers than the rural consumers. Information and prices of GM foods were two essential factors influencing consumers' attitudes toward GM foods. It concluded that the commercialization of GM foods is not likely to have great resistance from consumers in China.

A study conducted by Udomroekchai and Chiaravutthi (2012) in Thai to quantify consumers' WTP for GM rice, revealed that Thai consumers opposed GM rice. They were however WTA a discount of 18.73% for GM rice.

Moreover, De Steur *et al.* (2014) did a hypothetical experimental auction about foliate improved rice in Shanxi area, and established that female consumers are willing to pay a premium of 33.7% for foliate nutrient improved GM rice. Nevertheless, the literature over time has separated less favorable acceptance and increased knowledge on GM rice. Fu *et al.*, (2012) also revealed from his studies that consumer acceptance of GM food has declined from 80% of 2005 to 40% in 2010.





Consumers' willingness to accept and pay for GM food in the United State (US) is usually high, but consumers' concern about the potential risks of GM crops on human health still exists (Chern and Ganiere, 2004). Earlier studies by Zhang *et al.* (2004) also revealed that majority of consumers from China and American are generally supportive of the new technology, though consumers in both countries were undoubtedly more willing to accept GM plant products than GM animal products. Conversely, consumers in Europe are less grateful to GM technology and its products. This is because UK consumers were willing to pay much higher price for non GM foods to avoid GM foods than US consumers (Moon *et al.*, 2002).

Hossain *et al.* (2003) also used the discrete choice model for GM fresh fruits and vegetables and disclosed that some of the respondents were against GM technology and its products, while others were undecided. In a similar study, Swedish consumers did not see GM food as the same as conventional food. So, the consumers proposed compulsory labeling and were willing to pay higher prices to ensure GM products are not allowed in the market (Carlsson *et al.*, 2004). Generally, UK consumers also showed high demand for non-GM foods, except a few who were willing to substitute it with the GM products, either without discount (12 %) or with discounts of 34 % (Moon *et al.*, 2004).

Moreover, a study conducted by Brookes and Barfoot (2013) in UK discovered that GM technology has had a significant positive impact on farm income derived from a combination of enhanced productivity and efficiency gains.

In Africa, a study was conducted by Kimenju and Groote (2008) with 604 respondents in Nairobi, Kenya, in 2003 to measure consumers' awareness and WTP for GM foods, and the

factors that determined their WTP. They established that consumers' knowledge of GM crops was low and only 38% of the respondents were aware of GM crops. Awareness level however varied across socio-economic groups; for instance people in higher education and income groups were more aware than others. Nonetheless, people were generally appreciative of the technology, and majority (68%) would be willing to buy GM maize meal at the same price as their favorite brand. Consumers were, however, anxious about the likely side effects, particularly on the environment and biodiversity. Using a double-bounded dichotomous choice model, the mean WTP was found to be 13.8% higher than the mean price of non-GM maize meal.

A recent study in Ghana in the Greater Accra Region by Deffor(2014)indicated that 85% of the respondents were willing to accept GM foods. From the logit model results, consumers within the age brackets of 31-40 and above 50 years had high probabilities of accepting GM foods. Sex of the respondents was also an influencing factor on WTA foods, where male respondents were more likely to accept GM foods than females. Respondents with secondary and tertiary levels of education, and average household size of one (1) to five (5) were likely to accept GM foods.

2.11.1 Perceptions on Potential Adverse Health Effects of Genetically Modified Foods

Along with the potential benefits of genetically modified foods, concerns about the adverse human health consequences of consumption of those products have been raised. Genetically modified crops raise fear and concern in many people's minds about the safety or adverse health effects (Godfrey, 2000). Some of the adverse effects attributed to genetically modified crops in humans include new allergens in the food supply, antibiotic resistance, production of new toxins, concentration of toxic metals, enhancement of the environment



for toxic fungi to grow, increased cancer risks, degradation of the nutritional food value, and other unknown risks that may arise later (Acosta, 2000). According to WHO(1995), the safety of whole genetically modified foods can be assessed by comparing the toxicity/safety of whole genetically modified food to the food or food constituent from which it is derived.

Many environmentalists are concerned that the pesticidal gene product of the genetically modified crops might be toxic to non-target organisms that consume it; for example, the incorporation of Bt genes into crop plants for insect control. The adverse health effects of Bt endotoxins in non-target species have been reported (Betz *et al.*, 2000). They show a narrow range of toxicity that is limited to specific groups of insects, Lepidoptera, Coleoptera, or Diptera depending on the Bt strain. Plant species containing Bt genes have been tested to determine whether any alterations in this limited spectrum of toxicity occurs and no unexpected results were reported (Orr and Landis, 1997; Pilcher *et al.*, 1997; Lozzia *et al.*, 1998). Concern has been expressed about the potential toxicity of the Bt toxin in maize pollen to the monarch butterfly because initial laboratory studies showed increased mortality in larvae (Losey *et al.*, 1999). However, Sears *et al.* (2001) believe that it is unlikely that a significant risk to those butterflies exists in the field.

Again, a study was conducted in Ghana by Buah(2011) using 1,200 respondents to discover the perceptions of the Ghanaian public on GM foods. It was discovered that more than 80% of the respondents from government ministries and the ordinary Ghanaians were unenthusiastic to accept GM foods and their refusal was based on the fear of unidentified side effects and on ethical thoughts.



2.12 Benefits of Genetically Modified Foods

Genetically modified food does have potential risks but also has benefits. The new food biotechnology will produce grains, fruits, and vegetables that contain more nutrients, such as proteins, vitamins, and minerals, and have reduced fatty acid profiles. Biotechnology will also make better-tasting food crops that will ripen less quickly after picking so that there is an improved flavor and the foods remain fresh longer. The crops will be disease and insect resistant and have increased tolerance to herbicides and drought. The use of pesticides will decrease and there will be faster growing crops (Paarlberg, 2000). There is a need to double food supply by 2025 due to expected population increases. Less arable land will be available and there will be a need to destroy more primary habitat unless genetic engineering is utilized. In addition, genes that produce vaccines are being inserted into crops so that those people who eat them would be healthier, because they would be protected from infectious organisms. For example, researchers at Cornell University have genetically altered a potato to contain a vaccine for viral diseases (Griffith and Cookson, 2000). Rice has also been genetically modified so that it is enriched with vitamin A, preventing blindness for those who eat it, especially in famine-stricken countries in Africa and Asia. Therefore, genetically engineered food can be a potential lifesaver and its benefits should not be overlooked.



CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the measures and approaches used for the study in order to answer the research questions. These comprise study area, research design, source of data, sampling technique, and model used for data analysis (ordered probit model). Moreover, the double bounded CVM was used for data collection is discussed.

3.2 Research Design

A research design is a plan that describes what, how, when and where data are to be collected and analysed (Parahoo, 1997). In other words, it defines the researchers overall plan for measuring the research questions. A research design can be quantitative or qualitative.

Qualitative research is a form of social research that focuses on the way people interpret and make sense of their experience and the world in which they live (Holloway and Wheeler, 2002). Quantitative research on the other hand is the systematic, controlled, empirical and critical investigation of natural phenomena guided by theory and hypothesis about the accepted relationship among such phenomena (Strauss and Corbin, 1990).

Quantitative data are collected numerically. Qualitative and quantitative both have their strengths and weaknesses. They also complement each other. For instance, quantitative method aids in conducting research with ease and quickly. It covers a wide range of situations while after the analysis are presented in quantitative data, the final results are based on actual quantities other than interpretations (Amarantunga *et al.*, 2002). On the other hand, qualitative method has the potential of controlling for end points and pace of the



research process. It also prevents problems related to rigour and objectivity. It is however expensive and time consuming. The study therefore employed both quantitative and qualitative approaches to achieve the research objectives. The CVM was used to elicit consumers' willingness to pay for GM foods using a semi-structure questionnaire. Descriptive analyses and econometric models were used to analyse the study objectives.

The study was based on Urban and Peri-urban consumers in Tamale metropolis. Cross-sectional research design was employed to collect primary data from 300 respondents.

3.3 Study Area

The study was conducted in the Tamale metropolis of Northern region, Ghana. Geographically, Tamale Metropolitan Area shares common boundaries with Savelugu and Nanton Districts to the north, Tolon and Kumbungu Districts to the west, Central Gonja District to the southwest, East Gonja District to the south and Yendi Municipal to the east. The Metropolis lies between latitude $9^{\circ}18'N$ and $9^{\circ}26'N$ and between longitude $1^{\circ}15'E$ and $1^{\circ}23'W$. It occupies an area of approximately 750 square kilometers, which is 13 percent of the total area of the Northern Region. From the demographic characteristics according to the Ghana Statistical Service (2010), the Tamale Metropolis has a population of 371,351 represents 15 percent of the region population. This is far higher than the regional and national rates of 2.8 percent and 2.7 percent respectively. This is because Tamale is a fast growing city and as result a lot of people move to the city to do business. Tamale, in recent years, has become the fastest growing city in the West African Sub-region and demand for food is more likely to increase in the area. Its local economy is predominantly agriculture, but the expansive city is also a centre for manufactured goods due to its growing population. Apart from the change in boundary of the metropolis,



Tamale was the capital of the three regions in the North. For that reason, certain major administrative services are still rendered in the Metropolis and because of this people move there for these services. With an urban population of 67.1 percent; the Metropolis is the only district in the region which is predominantly urban.

The population density of 318.6 persons per square kilometers for the Metropolis is about 12 times higher than the regional average density of 25.9 persons per square kilometers. Therefore, the growth rate and the density of population in the area have implications for the demand of food



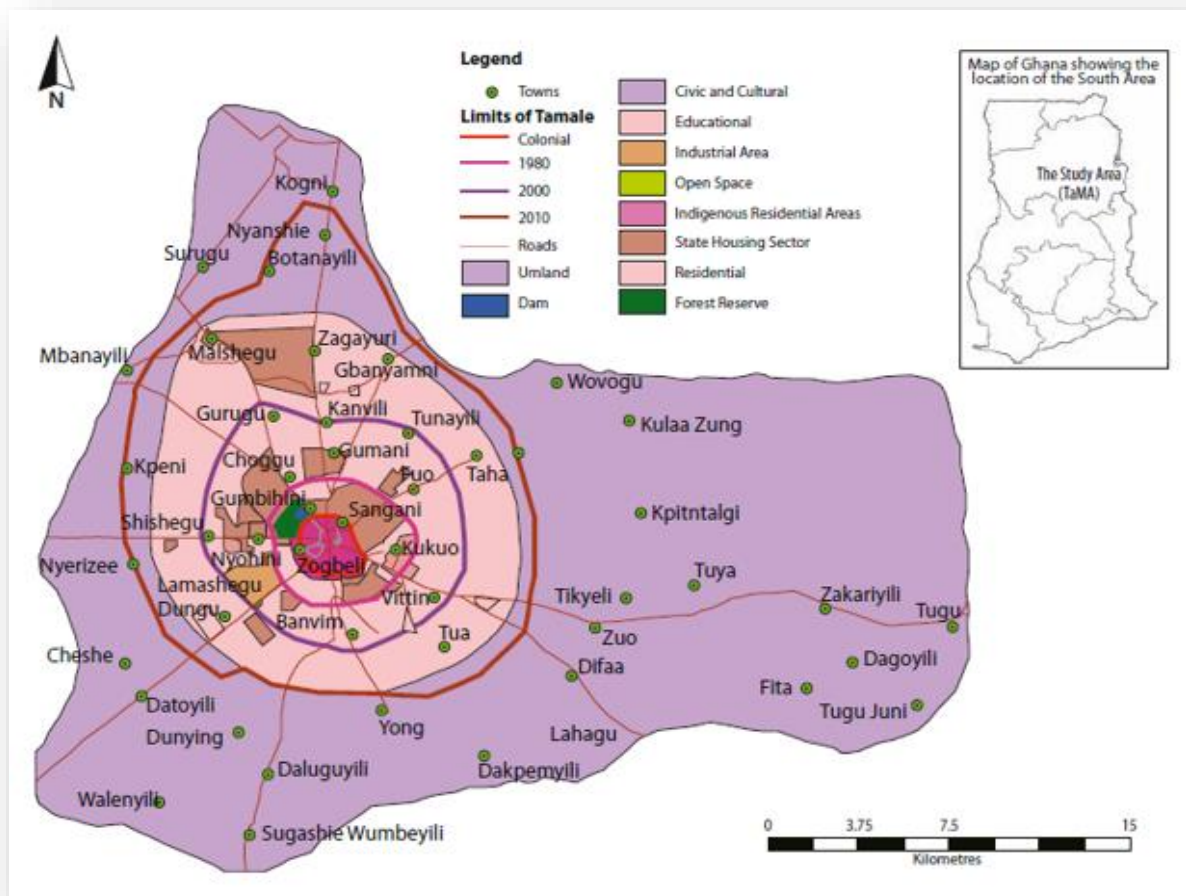


Figure 1: Map of Tamale Metropolis

Source: Town and Country Planning Department, Tamale obtained by UNEP

3.4 Sources of Data

Household cross-sectional survey was conducted for consumers to obtain primary data for analysis. The data comprised information on consumers' socio-economic characteristics (such as age, sex, marital status, educational level, household size, income), awareness and perceptions, and expenditure. This information enabled to examine the personal characteristics of consumers that influence their WTP. Again, questions were

solicited concerning consumers' level of knowledge, awareness, perceptions; purchasing behaviour, and factors that influence WTP for GM food.

3.5 Sampling Techniques and Sample Size

To compute the appropriate sample size, the formula below was used:

$$n = \frac{N}{1 + N(\alpha)^2} \quad [9]$$

$$n = \frac{233252}{1 + 233252(0.05)^2}$$

$$n = 399.3$$

Therefore $n = 399$

Where N = number of units in the population, α = confidence level (α at 95% confidence level is (0.05) and n = sample size

GM products are not yet on the market and as a result, many people do not have much information about it, especially those in the rural areas due to the high illiteracy rate hence rural Tamale was excluded from the sample.

The data collection took more time and made the data collection period long and expensive.

However, due to inadequate finance a sample size of 300 was selected in an unbiased manner across the metropolis to obtain a true representative response.





A multi-stage sampling technique was used to select the final respondents for the study. In the first stage, stratified sampling technique was used to put Tamale into three (3) geographical zones. These comprised of the 3 sub-metros: Tamale Central, Tamale South and Tamale North. The simple random sampling technique was then used to select 5 communities from each sub-metro, giving a total of 15 communities. In stage 2, stratified sampling technique was used to place the households in each community into three homogenous subgroups based on income. To do this, housing structures and other characteristics that define income levels of the households as being low, middle or high are used as a guide. The low income households are characterized with buildings of poor quality materials such as mud or mud bricks, raw timber and thatch roofs. Middle income households are those with rooms predominantly built with bricks or blocks and zinc roofing sheets. Finally, houses usually built with blocks, roofed with aluminium or asbestos roofing sheets or roofing tiles and have concrete or wired nets as walls were classified as high income households.

In the third and final stage, simple random sampling was used to select 20 households from each of the community. This gave a total of 300 respondents. This is because; most houses in Tamale Metropolis are not ordered, making it impossible to use the systematic sampling technique. In using this procedure however, the researcher and his assistants made sure they randomly interviewed equal numbers of households (20) from each of the 15 communities. The primary respondents were household heads; instances where the household head was not available, any other adult person in the house who participated in cooking/purchasing household food was interviewed. The sample composition of the study is shown in Table 2.

Table 2: Distribution of Respondents in the Suburbs and Markets Sampled

Metropolis		
<i>Sub-metro</i>	<i>Community (Suburb)</i>	<i>Number of Households</i>
Tamale Central	Aboabo	20
	Changli	20
	Sakasaka	20
	Tishigu	20
	Zogbeli	20
Tamale South	Nyohini Zujung	20
	Kalpohini Estate	20
	Viting	20
	Wamali	20
	Lamashegu	20
Tamale North	Gumani	20
	Fuwo/SSNIT	20
	Yapalsi	20
	Tunaayili	20
	Choggu	20
<i>Sub-total</i>	15 suburbs	300 respondents

Source: Author

The data collected for consumers' WTP for GM Rice was undertaken in February /March, 2016. The questionnaire used composed of nine sections. **Section A** contained the consent form which involved the purpose of the survey, the ethics (consumers were made to know that whatever information they were giving was confidential and participation is voluntary) whereas **Section B** asked questions on demographic characteristics. Age, educational level, household size, income level, main economic occupation, among others important factors foretelling the willingness of consumers to pay for GM Rice. **Section C and D** captured questions on household source of income, amount of income per month, expenditure on food commodities, frequency purchase, and the average amount spend per week. Again, **section E, F, G and H** elicited consumers' preference for attributes of food commodities (rice), consumers' knowledge on GM foods and source of information and perceptions



respectively. Section I prompted information on how much consumers were willing to pay for GM foods (rice). A detail of the survey questionnaire is provided in the Appendix.

3.7 Method of Data Collection

After selecting the urban rice consumers for the survey, an easy to understand semi-structured questionnaire was developed and administered through personal interviews to obtain the primary data. GMO products are not yet on the market in Tamale (to the best of author's knowledge). Hence, face-to-face interview was employed so that the interviewers could get the chance to explain and interpret questions to respondents. The face-to-face interview approach also offered the opportunity to explain certain questions that seemed difficult to understand. This helped to obtain accurate information for analyses.

3.8 Pilot Survey

Questionnaire pre-testing was conducted before the actual survey. A small segment of respondents were sampled in the university community (UDS-Nyankpala campus) and others from the Nyankpala township for the pilot study. Three (3) respondents from each faculty (faculty of Agriculture, Faculty of Renewable Resources and Faculty of Agribusiness and Communication Sciences) were interviewed and 6 from Nyankpala township to make a total sample size of fifteen (15). The questionnaire pre-testing was meant to test the questionnaire feasibility and degree of respondents' understanding of the questions. It was also to test whether enough, accurate and all the necessary information had been captured to address the research objectives. The community used for the pilot study share common characteristics with those from the main study.



. The pre-test offered relevant information used for the improvement of the final questionnaire used in the actual survey.

3.9 The Ordered Probit Model

The standard double dichotomous choice outcomes are presented as follows; the respondent prefers only the non-GM product, that is “no” to both offers; (2) the respondent is not willing to purchase the GM product at the same price as the non-GM product, but is willing to purchase the GM product at the random lower price, a “no” followed by a “yes”; (3) the respondent is willing to pay for the GM product at the same price as the non-GM product, but is not willing to purchase it at a premium, that is, a “yes” followed by a “no”; (4) the respondent is willing to purchase the GM product at the same price as non-GM product and also willing to purchase at a random premium offered relative to the non-GM product, that is, “yes” to both bids. Following these outcomes, the ordered probit model was used to identify and quantify the determinants of consumers’ willingness to pay more for GM foods. This is because the dependent variable (WTP) involves multiple categories in this case four outcomes (NO-NO, NO-YES, YES-NO and YES-YES), which is intrinsically ordered from low to high WTP.

Ordered probit model is one of the most appropriate ordered response models suggested for the solution of data sets with these kinds of variables. It is usually used in social sciences (Maddala, 1983 and Long, 1997). Quite a number of studies have also employed the ordered probit model in assessing consumers WTP. Among them are Yayar *et al*, 2014, Bocalettive and Moro, 2000; Nayga, *et al.*, 2002; Cranfield and Magnusson, 2003; Magnusson and Cranfield, 2005; Harris and Zhao, 2007; Erdem *et al.*, 2010; Gündüz and Emir, 2010; Hasegawa, 2010; Lefevre, 2011).



The ordered probit model is assumed a latent regression in the same manner as the binomial probit model. In the closed-ended questions like the double bounded dichotomous format, the latent variable WTP^*i is not observed. However, WTP can only be observed in the range in which WTP^* can lie. The underlying unobserved latent (continuous) variable for WTP for GM is modeled as a linear function of personal and product characteristics X' and an error term ε , which is assumed to be independent and identically distributed reflecting standard normal distribution with mean 0 and variance σ^2 , β is a vector of unknown parameters to be estimated as specified below:

$$WTP_i^* = X'\beta + \varepsilon_i \quad [9]$$

However, WTP is observed if WTP^* lies in a specific range of ordered discrete values ($j=1, 2, \dots, M$), such that

$$WTP = \begin{cases} 0 & \text{if } WTP_i = 0 \\ 1 & \text{if } 0 < WTP_i < \beta_0 \\ 2 & \text{if } \beta_0 \leq WTP_i < \beta_1 \\ 3 & \text{if } WTP_i \geq \beta_1 \end{cases} \quad [10]$$

The probability of observing a particular ordinal outcome j (i.e. a given bid) is

$$\Pr(WTP = j / X) = \Phi(\mu_j - X'\beta) - \Phi(\mu_{j-1} - X'\beta) \quad [11]$$

where $\Phi(\cdot)$ is the cumulative density function of the Standard Normal Distribution and where μ_j are thresholds defining potential ordered outcomes for WTP. Specifically, probability of observing individual ordinal outcomes' j is given as



$$\begin{aligned}
 P_{YY}(YES - YES) &= \Pr(WTP_n > \mu_3) = 1 - \Phi(\mu_3 - X'\beta) \\
 P_{YN}(YES - NO) &= \Pr(\mu_2 < WTP_n < \mu_3) = \Phi(\mu_2 - X'\beta) - \Phi(\mu_3 - X'\beta) \\
 P_{NY}(NO - YES) &= \Pr(\mu_2 < WTP_n < \mu_1) = \Phi(\mu_1 - X'\beta) - \Phi(\mu_2 - X'\beta) \\
 P_{NN}(NO - NO) &= \Pr(WTP_n < \mu_1) = \Phi(\mu_1 - X'\beta)
 \end{aligned} \tag{12}$$

where; P_{YY}, P_{YN}, P_{NY} and P_{NN} are the probabilities of ‘YES-YES’, ‘YES-NO’, ‘NO-YES’ and ‘NO-NO’ in that order, WTP_n is the sum of money respondent n is willing to pay for GM food) $\Phi(X'\beta)$ is a cumulative density function which measures the probability of WTP being less than the individual threshold level and β are the parameters to be estimated (Hanemann *et al.* 1991 cited in Kimenju *et al.* 2006).

The practical question is which CDF is the most appropriate for the study? There are two options that have to be considered. That is the logistic and the standard normal density functions which are readily available. If the CDF is the logistic density, the resulting probability model is the ordered logit. On the other hand, if CDF is standard normal density, the subsequent probability model is the ordered probit. Since the distributions of both densities are similar (asymmetric and bell shape), the study employed the ordered probit model which allows for the calculations of predicted probabilities for each WTP category and marginal effect just like other probability models (Cranfield and Magnusson, 2003).

3.10 Marginal Effects

The probabilities for WTP categories need to sum up to one (1) and the change in probabilities for the WTP sets must sum to zero. Binary variables marginal effects are



discretely approximated using the difference in expected probabilities when the dummy variable under consideration is set equal to one (1) and zero (0).

Dependent variable of the study was the willingness of consumers to pay more for GM foods. This was ordered into groups. That is, YES-YES', 'YES-NO', 'NO-YES' and 'NO-NO'.

The marginal effects of (four) probabilities can be estimated using the following equations through the derivation by Greene (1997) as follows:

$$\begin{aligned}\frac{\partial pr(WTP = 0|X)}{\partial X} &= \phi(X^1 B)B \\ \frac{\partial pr(WTP = 1|X)}{\partial X} &= [\phi(-X^1 B)B - \phi(\mu_1 - X'\beta)]\beta \\ \frac{\partial pr(WTP = 2|X)}{\partial X} &= [\phi(-X^1 B)B - \phi(\mu_2 - X'\beta)]\beta \\ \frac{\partial pr(WTP = 3|X)}{\partial X} &= \phi(\mu_2 - X'\beta)\beta\end{aligned}\quad [13]$$

where $\frac{\partial pr}{\partial X}$ is the partial derivation of probability base on X.

3.11 The Empirical model

The empirical model for factors influencing consumers' WTP for GM food products can be represented as follows:



$$WTP_{ij} = \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 X_{i7} + \beta_8 X_{i8} + \beta_9 X_{i9} + \beta_{10} X_{i10} + \beta_{11} X_{i11} + \beta_{12} X_{i12} + \beta_{13} X_{i13} + \varepsilon_i \quad [14]$$

where WTP_{ij} is the willingness of buyer i to pay for option (GM food) among other options and it is considered the response variable, the remaining beta values ($\beta_1 - \beta_{13}$) estimate the effects of the subsequent explanatory variables on the response variable (WTP_{ij}), and ε_i is the stochastic term indicating the unpredicted or unexplained variation in the response variable and is assumed to be on a regular basis distributed

Table 3: Description of Variables used in the ordered probit model

Explanatory Variable	Slope Coefficient	Description	Measurement/Coding	A Priori Expectation
X_1	β_1	Age	Actual number of years	+
X_2	β_2	Sex	Dummied: 1 if female, 0 if male	+/-
X_3	β_3	Income level	Ghana cedis (GH¢)	-
X_4	β_4	Educational level	Years in school	-
X_5	β_5	Household size	Number of people in a household	-/+
X_6	β_6	Price of GM food	Ghana cedis (GH¢)	+/-
X_7	β_7	Nutrition	Dummied: 1 if respondent considers nutrition and health for consumption, 0 if otherwise	+/-
X_8	β_8	Taste of GM food	Dummied: 1 if the consumer considers taste of GM food before purchasing, 0 if	+/-



otherwise

X_9	β_9	Awareness or degree of knowledge consumers have regarding GM food	Dummied: 1 if the respondent is aware of GM food, 0 if otherwise	+
X_{10}	β_{10}	Religious affiliation	Dummied: 1 if the respondent is a Muslim, 0 if otherwise	+
X_{11}	B_{11}	Source of information		+/-
X_{12}	B_{12}	Ethical consideration(GM foods are unnatural)		+/-
X_{13}	B_{13}	Perceived nutritional benefits		+/-

3.12 Description of Variables and *a priori* Expectations

From literature, the following variables were included in the empirical model to assess how they influence consumers' WTP for GM rice and maize. For the purpose of modeling, some of these explanatory variables were recorded as dummy; where code 1 was assigned if the attribute under thought is present and 0 if absent/otherwise. They are expected to influence WTP positively, negatively or either.

Sex: sex was expected to have a positive effect on the WTP because female consumers are considered more demanding about new product or food assumed to be more nutritious than male.





Age: This variable was considered because different age groups have different demand for food products in relation to food attributes (Pitman and Reinhardt, 2000). GM rice has being fortified with Vitamin A to held in normal vision .The elderly are mostly involved in household food needs than the younger ones. The age variable is expected to be positively related to the WTP because older people give more importance to their health, especially related to their eye sight and might be willing to pay a higher price than other age groups since the consumption GM foods might reduce vision related problems. Tasteand preference change over time and expected that people preference may change as they grow.

Household size: is also expected to be negatively related to the WTP. Increase in household size decrease per capita expenditure of households and also comes with more responsibility (food and shelter, heath care, education and utilities).The additional cost might hinder the household willing to pay more.

Education affects people's awareness, perception and attitudes.This variable is important because it gives consumers the opportunity to be able to research to have much information in relation to the benefits and the side effect of consuming GM foods. Moreover, people with considerable years of education respond fasterin decision making in terms of the introduction of new food commodity on the market. It is assumed that people with high level of education tend to have high income are expected to choose non-GM foods even if they are expensive.Education variable is hypothesized to have negative coefficient since consumers who have higher level of education might have being exposed to the controversies surrounding the GM product.

Income: we expect income to positively influence consumers' WTP. An increase in a person income will enable him/her to pay more for additional benefits. Consumers with high income have the ability purchase and taste new product in the product. This also hypothesized to negatively influence WTP.

Risk perceptions variables are expected to be negatively related to WTP. As a consumers will pay lesser for products that they consider as risky. When people are not sure of the content of the product and suspect a health and other associated risk of consuming the GM food they will be more likely to pay less for it. Consumers are rational and will only pay more if the commodity (GM food) gives higher satisfaction.

Religion play an important role in choice of food consumption, consumers makes decisions on the kind of food to purchase in relation to their religious believes and values. Religion is dummied, 1 if Muslim, 0 otherwise. We expect religion to positively influence WTP since rice is consumable by all religious groups and once is fortified with Vitamin A (GM rice) will increase WTP.

Ethical concerns variables (GM foods are unnatural) are also expected to have a negative association to WTP. Food production is perceived by some people to exclude any form of modification. Some consumers see it as unnatural and ethically unwholesome.

Awareness (heard or read) of GM foods: This variable was described as consumers' level of awareness GM foods and was dummied (1 = respondent is aware of GM foods, 0 = otherwise). The study assumed that, this variable will have a positive relationship with consumers' WTP



Source of information: Consumer's source of information is expected to influence WTP positively and negatively depending on the source and how it was framed.

3.13 Statement of hypotheses

The following hypotheses were tested based on *a priori* expectation. The principal hypothesis tested in the study is that, consumers are WTP for GM food in Tamale Metropolis. The other alternative hypotheses are as follows:

H₁: Socioeconomic characteristics of consumers' have a significant influence on their WTP for GM food

H₂: Nutritional content (vitamin A) positively influences consumers' WTP for GM food

H₃: Price of GM food has influence on consumers' WTP for GM food.

H₄: Level of consumers' knowledge and awareness of GM food directly influence their WTP.

H₅: Consumers' source of information significantly affects their WTP for GM food.

H₅: Consumers' perceptions significantly affect their WTP for GM food

3.14 Data Analysis Process

The first stage taken in examining the data of each and every questionnaire is to find out any inconsistency, omission and outliers in the entered data to avoid inappropriate information. This was done through data cleaning.

Quantitative and qualitative data were entered into the computer using SPSS and organized accordingly. Qualitative data were first coded and converted into quantitative type in order



for them to be computed and then the analysis was done. Finally tabulated data were analyzed using simple statistical techniques such as mean, standard deviation and percentage. However the WTP analysis was done by using STATA.



CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discussions of the study. While the descriptive statistics are presented in the form of frequencies, percentages and means, the estimation results of the ordered probit model are presented in the form of tables .

4.2 Demographic and Socioeconomic Characteristics of Respondents in the study area

The demographic characteristics of rice consumers considered in the study include age, sex, relationship with household head, educational level, household size, and ethnic and religious affiliation. Besides, the study examined the respondents' main economic occupation, number of household members earning cash income, combined monthly earnings of all household members. Household weekly expenditure on foodstuffs was also captured. Consumers' sex, age, level of education, household size and income level are essential characteristics that affect WTP and consumption patterns (Campicheet *al.*, 2004).

- **Sex of Respondents and Household Heads**

The sampling of consumers was conducted on household basis from which only household heads responded. In all, 75% of the sampled respondents were male and the remaining 25 % were females. This means that households were predominantly male headed. This is not surprising because households in the three regions of the North are dominantly male headed. The women headed households were found to be widowed headed, separated/divorced families or households in rented apartment outside extended family homes. The household heads are the principal decision makers in the households including



food purchasing. Hence they have significant influence on the type of foods consumed in the households. It was upon these bases that the researcher interviewed only household heads.

- **Age of Respondents:** The average age of consumers in the sample was 48 years, the minimum age was 20 years and the oldest in the sample aged 87 years. This result was anticipated since in the Ghanaian setting, older people are mostly heads of households and take major household food decisions. About 18% of the consumers interviewed fell within 21 – 40 years age bracket, meaning fewer proportion were in the lower age category. However, close to 50% of the urban consumers belong to the age bracket of 41-60 years.

The aged class (65 years and above) constituted 4.73 per cent of the total sample. This is consistent with the finding of the 2010 PHC(GSS, 2012).The age category below 21 years is 2.67 % which contradicts the 2010 PHC finding.

- **Educational Level:** Education was measured in relation to the number of years a respondents spent in formal education. The respondents under the category of no-formal education were those who have never attended formal school and cannot read and write. This group constituted approximately 33% of the entire sample. This could be attributed to the old age of the average respondent, 48 years, because years back, many did not attach relevance to the white man's western education and so denied their children the chance to education, hence the 33 % were probably disadvantaged of formal education.The proportion of respondents with primary education was approximately 6%, and represents the least in the entire sample. Also, those respondents who had secondary education (that is, at least Junior High



Education) constituted about 22%. However, a significant proportion (39%) of the respondents had tertiary education and could increase their awareness about GM foods, hence influence their willingness to pay.

- **Ethnic Affiliation:** Tamale is a cosmopolitan city made up of different people from many different places and cultures, thus making it a multi-cultural and multi-ethnic city. Close to half (48.3%) of the consumers interviewed were Dagombas who are indigenes. Also, Mamprusi, Gonja and Frafra constituted 14.2%, 8.0% and 3.4% respectively. Akan and Kasena/Nankana constituted 3.38% and 2.0% in that order. Meanwhile, those who belong to other ethnic groups also constituted 20.7%. They comprised the Hausa, Grusi, Ewe, Ga, Bimoba, Moshie, Dagaati and Waala. These findings conform to GLSS 5 (2008) results which indicated that, Mole-Dagbani constitutes 55.8% of the ethnic groups in Northern Region. The result shows that, Tamale is ethnically heterogeneous and cosmopolitan, and constitutes quite a lot of migrants. It is therefore not surprising that the city is considered one of the fastest growing in West Africa.

Table 4: Statistics of Respondents' Demographic Characteristics

Characteristic	Category/Description	Frequency (%) (n=300)
<i>Age</i>	Below 21	8 (2.67)
	21 – 30	55 (18.33)
	31 – 40	50 (16.67)
	41 – 50	70 (23.33)
	51 – 60	76 (25.00)
	Above 60	41 (13.67)
<i>Sex</i>	Male	225(75.00)
	Female	75(25.00)
<i>Marital Status</i>		



	Married	189(63.00)
	Single	104(34.67)
	Widow	4(1.33)
	Divorced	3(1.00)
<i>relationship with Household Head</i>		
	Wives	128(42.67)
	Mother	13 (4.30)
	Brother	9 (3.00)
	Sister	1 (0.33)
	Father	40 (13.3)
	House maid	0 (0.00)
	Uncle	11 (3.67)
	Grandparent	6 (2.00)
	Household head	92 (30.67)
<i>Level of formal education</i>		
	None	98 (32.67)
	Primary	19 (6.33)
	Junior High School	25 (8.33)
	Senior High School (Secondary)	40 (13.33)
	Tertiary	118 (39.33)
<i>Ethnic Affiliation</i>		
	Dagomba	143(48.31)
	Gonja	24 (8.00)
	Mamprusi	42 (14.19)
	Frafra	17 (5.74)
	Akan	10 (3.38)
	Kasena/Nankana	6 (2.03)
	Others	58 (19.59)

Source: Field survey, 2016

- **Main Economic Occupation:** This included the main sources of livelihood for the sampled respondents. The study results indicated that, the main occupation of the respondents were petty traders and salary workers, who constituted (28.73%) and (27.68%) of the respondents respectively. Tamale is inhabited by a growing number of



business men and women because the area is one of the fastest growing cities in West Africa. There are also a substantial number of public and private institutions in Tamale compared to any other district in the northern region. Respondents who were engaged in agricultural activities also constituted 21.80%.

- **Composite Monthly Income:** This was computed for household members who were formally or informally employed. Thereafter, the individual household members' monthly income was taken as aggregate income of the households. In all, 48.46% of the respondents' household income was less than GH¢1000 while those who earn between GH¢ 1000 and 1500 were also 15.77%, and about 20% of the households earn more than GH¢2000 a month.

Table 5: Occupational distribution and composite monthly income of households

Variable	Category/Description	Frequency (%)
<i>Main Economic Occupation</i>		(n=289)
	Self-employed in agriculture	63 (21.80)
	Trade / business	83 (28.73)
	Salaried worker/wage earners	80 (27.68)
	Pensioners	10 (3.46)
	remittance	
	Student	29 (10.03)
	Others	
		(n=299)
<i>Composite monthly income</i>		
	Less than GH¢ 1,000	138 (48.46)
	GH¢ 1,000 to GH¢ 1,500	44 (15.77)
	GH¢ 1,501 to GH¢ 2,000	26 (9.32)
	GH¢ 2,001 to GH¢ 2,500	14 (5.02)
	More than GH¢ 2500	39 (20.43)

Source: Field survey, 2016



4.2.3 Household Weekly Expenditure on Foodstuffs

Household food expenditure is mainly influenced by factors such as the number of people in the household eating from the same pot, purchasing power (income) and the type (quality) of foodstuffs that consumers prefer. Earlier studies show that income level and frequency of purchase determine household food consumption expenditure (Kassali *et al.*, 2010). Similarly, Engel (1857) established that, the percentage of income that goes into food is directly associated to household size, where bigger households spend a higher proportion of their income on food than smaller households. Moreover, poor households tend to spend a larger percentage of their income on food compared to richer households. Average weekly household expenditure was computed for food items (see table 6).

It was revealed from the study that, 81.3 % of respondents interviewed consume rice and rice products, while 73 % consume maize and related products. These findings contradict earlier studies by MoFA (2011) who reported that, rice is the second most important grain staple food in Ghana, next to maize. It is also noted that production of these two commodities is in shortfall to demand. The government of Ghana however, spends huge revenues to bridge the gap, especially of rice through imports (CARD, 2010). Again, as expected, a very high number of respondents (200) consume yam whereas few consume millet (65 respondents) and sorghum (38 respondents).



Table 6: consumers' weekly expenditure on food commodities

Food Item	Number of consumers of food item (n = 300)	Average frequency of shopping	Average amount spent per week (GH¢)
Rice and rice products	244	2.70	18.25
Millet	65	2.50	9.5
Sorghum	38	1.00	8.0
Maize and maize products	219	3.50	13.5
Yam	200	2.00	15.3
Meat/Fish	251	5.00	7.09
Cooking Oil	241	3.30	3.49
Fruits	143	5.00	10.26
Beverages (non-alcoholic or alcoholic)	114	4.00	12.24
Eggs and dairy	144	3.00	8.6
Salt	300	1.25	1.09
Spices (maggi, onga, curly powder)	201	5.00	1.43
Vegetables	192	3.40	9.26

Source: Field survey, 2016

4.3 Consumers' Awareness of GM Foods

The results showed that, 68.7% indicated their awareness of GM foods, but the rest of the respondents (31.3%) were not aware of GM foods. This result shows that consumer awareness of GM foods in the study area is quite high.

To get a more expanded overview of the relationship between awareness level and demographic factors, a cross-tabulation was used. Out of the 68.7% of respondents who were aware of GM foods, 77% were male and 22.3% were female. This could be attributed to the fact that, males have usually encountered information and shared it with themselves first before their female counterparts. They also dominate attendance to social gatherings, especially in the northern regions. Women are mostly considered housewives and are confined in the homes to take care of the children. Further analysis of the data showed that respondents within the age groups 41-50, 51-60 and above 60 years were more aware of



GM foods than other age groups. The percentage of respondents who indicated their level of awareness among the age groups were 19 %, 29 % and 15 % respectively. Age in a broader spectrum increases with increasing level of responsibility of a person regarding food decision. The socioeconomic variable, education, also showed more of an influence than any other variable. Respondents who had tertiary education (92) indicated greater awareness of GM foods than other respondents. Hence, highly educated individuals considered themselves to be more informed about GM food than the less educated respondents. Awareness level also varied among the respondents with regards to their occupation/economic activities. The majority of the respondents who were aware or have knowledge about GM foods were employed in the formal sector (salary and wage earners) and business men and women.

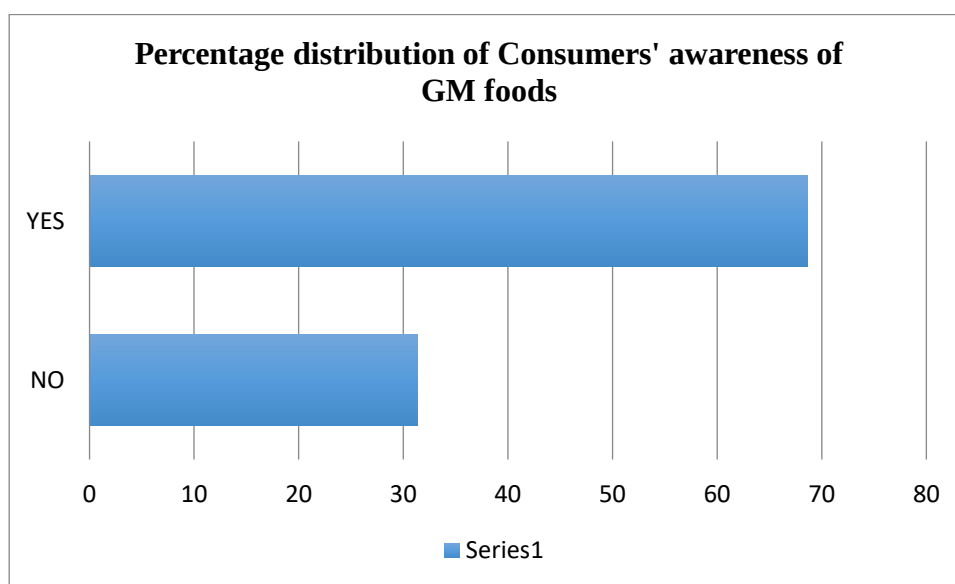


Figure 2: Consumer's Awareness of GM Foods



Table 7: Consumers' awareness of GM foods by demographic characteristic

		Yes	No	Yes (%)
Highest Educational level of respondents	No formal education	60	38	29.13
	Primary	13	6	6.31
	JHS	13	12+	6.31
	SHS	28	12	13.59
	Tertiary	92	26	44.66
Sex	Male	160	65	77.67
	Female	46	29	22.33
Marital status	Married	134	55	65.05
	Single	67	37	32.52
	Widowed	2	1	0.97
	Divorced	3	1	1.45
Age	Below 21	6	2	2.91
	21 – 30	42	13	20.39
	31 – 40	30	20	14.56
	41 – 50	37	33	17.96
	51 – 60	60	16	29.13
	Above 60	30	11	14.56
Occupation	Self-employed in agriculture	44	20	21.36
	Trade/Business	49	40	23.79
	Salary/wage earners	61	19	29.61
	Pensioners	9	1	4.37
	Students	27	5	13.10
	Unemployed	7	4	3.40
	Others	8	5	3.88

Source: Field survey, 2016

4.4 Consumers' Sources of Information on GM Foods

Information influences knowledge and perception of consumers about a product. The study revealed that, the greater source of information on GM was from family and friends. They accounted for 53.0% of the media through which consumers have heard about GM. Consumers who also stated hearing of GM foods from the radio constituted 52.7%. The results confirm the findings of Buah (2011), that friends and relatives were the



commonest medium through which consumers obtained information on GM foods. About 42% of the consumers had heard about GM foods through the television. However, the findings of Kenneth (2011), Keraita *et al.* (2010), Obouret *al.* (2015), Vestal and Briers (2000) and Boholm (1998) stated the mass media as the main source of knowledge through which consumers and farmers obtain information. It was also recognized from their studies that the mass media is the main source of information on GM crops and foods. The mass media are an important source that can be used to effectively disseminate information. Even though the media have the potential of reaching many people who may not have access to scientific information, the accuracy of the final message may be compromised as a result of exaggeration. Also, some of the respondents had their information from MOFA (25%), internet (30.7%), magazines (11.3%), lectures, seminars and workshops (40.3%), and community meetings (6.7%) while 2.7% of the respondents who heard of GM food do not remember where they heard it for the first time.

Table 8: consumers' Source of Information on GM foods

Source of information	Yes		No	
	Frequency	%	Frequency	%
Radio	158	52.7	142	47.3
Friend/relative or someone else	160	53.3	140	46.7
MoFA	75	25.0	225	75.0
TV	126	42.0	174	58.0
Internet	92	30.7	208	69.3
Magazine	34	11.3	266	88.7
Newspapers	56	18.7	244	81.3
Lectures, seminars and workshops	121	40.3	179	59.7
Community meetings	20	6.7	280	93.3
Others	8	2.7	292	97.3

Source: Field survey, 2016





4.5 Consumers' Perceptions of GM Foods

Each perception statement was given five response options coded 1 to 5; namely agree, strongly agree, not sure, disagree and strongly disagree. Even though five different response options assured a distinguished response, the findings were further simplified into “strongly disagree” and “disagree”, as well as “strongly agree” and “agree” for easy understanding. Perception of consumers about GM foods was assessed and the results are shown in **table 9**.

On nutritional issues concerning GM foods, most consumers (41.0%) agreed to the statement that GM foods are nutritious and could enhance normal vision while 24.0% showed disagreement with the statement. About 35.0% of the respondents did not know whether or not GM foods were nutritious. On pesticides use, 42.3% of the consumers agreed that GM crops could reduce the use of pesticides in crop production, thereby reducing health risks and making the food produced safer for consumption. But 21.7% disagreed that GM crops could reduce the use of pesticides in crop production while 36.0% were not sure of GM crop production being able to reduce the use of pesticides in crop production. The reasons for the respondents not being sure of GM crops as capable of reducing the use of pesticides in crop production may be due to limited knowledge of GM technology.

On food security, most consumers (44.4%) interviewed believed that GM foods are a solution to global food security through increases in yields, while 21.7% disagreed and 36.0% were not sure. On plant variety, a significant number of the respondents (47.3%) interviewed were of the view that GM crop could potentially lead to the loss of the original

plant varieties. As a result, consumers might not be able to access the indigenous food crops. On the issues of the environment and the ecosystem, a significant percentage of the respondents (46.0%) opined that, they were not sure about GM crop production resulting in the death of important insects such as bees. On the contrary, 20.3% agreed to the assertion while 20.7% disagreed.

In relation to health, close to half of the respondents (46.3%) indicated that GM foods have negative health implications, with 13.0% of the respondents disagreeing while the remaining 40.7% were not sure about the assertion. On allergic reactions, 36.7% of the respondents agreed that people could suffer allergic reactions after consuming GM foods, with 16.3% of the consumers showing disagreement with the statement. However, most consumers did not know whether or not a person may have an allergy after consuming GM foods.

On ethical issues, the majority of the respondents (51.7%) were of the view that, GM foods are unnatural, with 19.0% of the consumers disagreeing to the claim. But 29.3% of the respondents were not sure of the claim. Again, 25.0% of the respondents thought that that scientists of GMO were challenging God, with 35.0% of the showing disagreement to the statement. Also, most of the respondents (40.0 %) said they were not sure of the statement.

On the economic and social benefits, 32.7% indicated that companies or nations involved in GM productions are doing it for their own benefit with 27.3% of the consumers opposing the claim, but the majority of the respondents were indifferent to the claim. This could be as a result of low level of knowledge about the GM foods. Similarly, a significant proportion of the respondents (42.7%) were of the view that GM technology is mainly profit driven; they



focus on a few crops with commercial value, but 19.3% voted against the statement while 38 % of the respondents were not sure about the statement.

Table 9: Consumers' Perceptions about GM Foods

Statement about GM foods	Agree (%)	Disagree (%)	Not sure (%)
GM foods have high nutritional values.	41.0	24.0	35.0
GM foods can reduce the use of pesticides in crop production.	42.3	21.7	36.0
GM foods are a solution to global food problem through increase in yield.	44.4	24.4	31.3
original plant varieties may be lost through GM	47.3	17.5	35.5
Important insects may be killed through insect resistant GM crops.	20.3	20.7	46.0
GM food has health implications.	46.3	13.0	40.7
People could suffer allergic reaction after consuming GM foods.	36.7	16.3	47.0
GM foods are unnatural.	51.7	19.0	29.3
GM technology makers are challenging God.	25.0	35.0	40.0
GM foods are being forced on developing countries by developed countries.	28.7	28.0	43.3
GM products may benefit large-scale farmers than small-scale farmers.	41.3	25.7	40.0
Companies or nations involved in GM production are doing it for their own benefit.	32.7	27.4	40.0
The technology is mainly profit driven	42.7	19.3	38.0



(focus on crop few crops with commercial value)

Seeds will be unreliable	60	25	15
Resistance to drought	20	45	35

Source: Field survey, 2016

4.6 Consumers' WTP for GM Rice

The study estimated how much consumers were willing to pay for GM rice in Urban Tamale. The consent of the respondents was sought before their participation in the interview. The respondents were first asked to indicate their WTP more for GM rice (fortified with vitamin A) before the lower and upper bids were elicited.

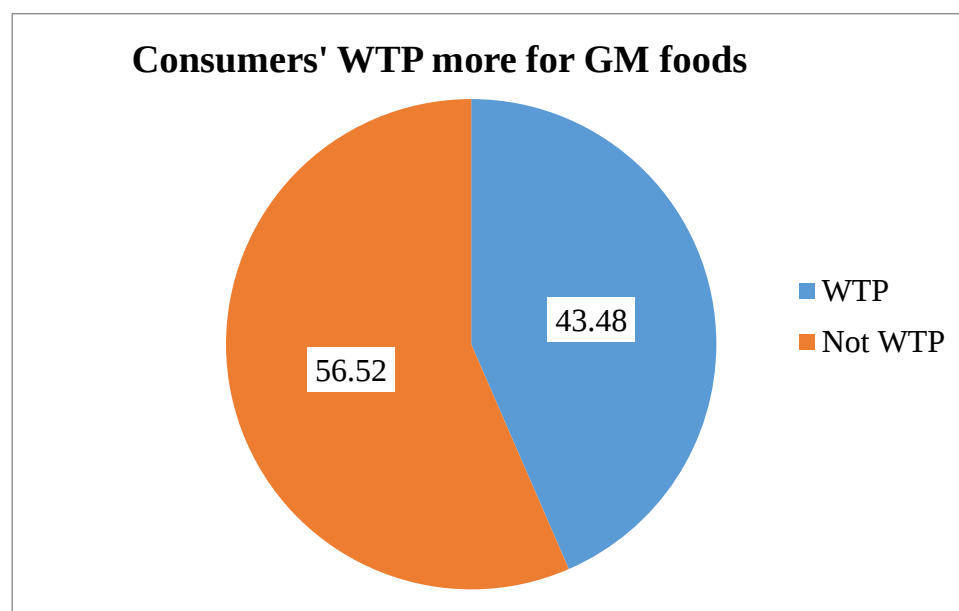


Figure 3: Consumers' Willingness to Pay more for GM Foods

In figure 3 above, consumers' willingness to pay more for GM foods (rice) were generally low as 56.5% were not willing to pay more. Reasons given by the respondents for not willing to pay are as follows: cannot afford a higher price (28.7%), prefer non GM foods (because they are natural) (26.9%), do not trust GM technology makers (20.4. %), health



implications (21.6%) and will not purchase a product that they have not seen (2.4%). On the contrary, consumers who were willing to pay more cited the following reasons: concerned about nutrition and health (86.4%), can afford (8.0%), the solution to global food insecurity and tastier (5.6%).

Consumers' were asked if they were willing to pay more for GM rice. If the answer was No, they were asked if they were willing to pay the same price as their favorite rice brand. When the response is No, a percentage discount lower offer is presented on the GM rice relative to the non-GM products. However, if the respondent answers Yes to the first question (i.e. willing to pay more), they are further asked if they are willing to pay for a percentage increase in the bid price in relation to the current market prices of one of the most consumed food commodity selected in Urban Tamale. For this study, the discount and premium were set at 5%, 10%, 15%, 20% and 25% respectively.

Meanwhile, before taking the respondents through the amount they were WTP, they were asked to state the most consumed rice brand and their prices (see table 17). Ten commonly consumed brands were mentioned. These are local rice, Cindy, Lele, Millicent, Vietnam, Texas, Uncle Sam, Royal feast, Sultana and American rice. They were further asked to state their willingness to pay for a percentage change in the market price of the new product that is not yet on the market with additional benefits. Majority of the respondents (56.5%) were not willing to pay more for GM foods and when they were offered the same price for GM as equivalent to the traditional rice that they consume, only 10.0% of them were willing to pay an equal price for GM foods. Also, the unwilling-to-pay respondents were then presented a 5%, 10%, 15%, and 20% discount price for GM foods. Among them, respectively 25.32%, 26.76%, 28.43% and 30.43% of the respondents were willing to pay



for GM foods as the discount price increased in that order. However, for the 130 (43.48%) respondents who were willing to pay, a premium price of 5%, 10%, 15%, 20% and 25% more than the price of traditional foods (rice) was set to ascertain their WTP. Respectively, 41.13%, 26.76%, 19.40% and 13.38% respondents were willing to pay 5%, 10%, 15%, 20% and 25% more.

It can also be observed in **figure 5** that as GM food price increases, the respondents' willingness to pay for GM rice continues to decrease. For instance, a percentage increase in price from 5% to 10% decreases the number of consumers willing to pay from 41.13% to 26.76%. It further reduced to 19.40% when the price change increases from 10% to 15%. However, when the percentage decreases in price were set for those who said they were not willing to pay more for GM rice, at a 5% to 10%, the number of consumers willing to pay for the GM rice increase from 25.32% to 26.76%. This supports the law of demand, which states "the higher the price the lower the quantity demanded" for a normal good. In this context, lower price of GM commodity leads to a rise in the number of consumers willing to pay more for it. This implies that consumers who are willing to pay for GM foods want it at a discount. This is similar to the findings of Jin *et al.* (2013) and Udomroekchai and Chiaravutthi (2012). Figure 4 and 5 show the distribution of the willingness to pay (WTP) responses with respect to percentage increases and decreases in prices respectively.



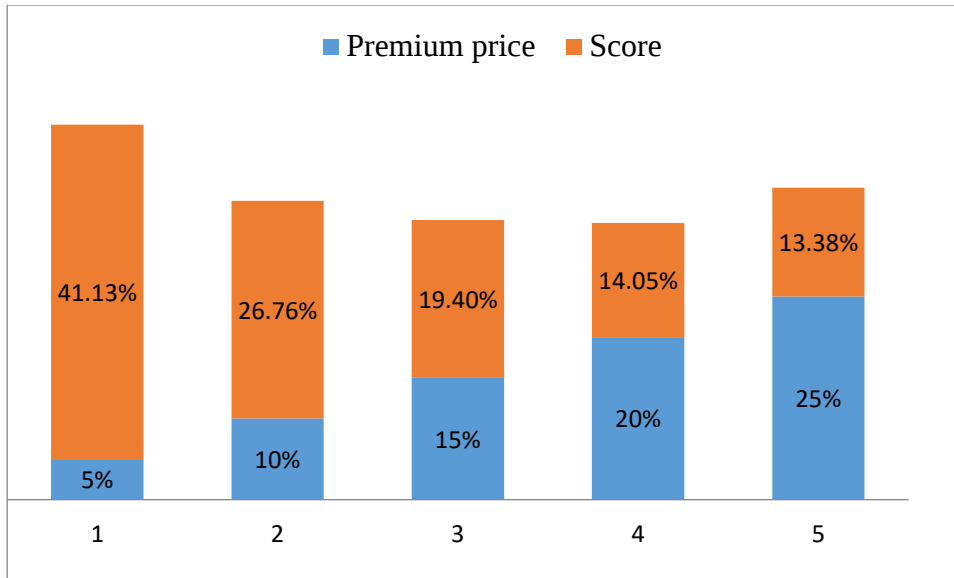


Figure 4: Consumers' WTP a Premium for GM Foods



Figure 5: Consumers' WTP a Discount for GM Foods

Education provides an individual(consumer) with the ability to seek, evaluate, and understand information about innovations in the context of GM technology and it products.

It was confirmed in the study that the highly educated respondents were more aware of GM

foods than the less educated. This suggests that highly educated people are also aware or have heard about the controversies surrounding GM foods. The comparison of WTP and educational level indicated that, majority of respondents in this category of education (tertiary) were willing to pay the lower price premiums for GM foods compared to those who have not attained any formal education. About 49% of respondents without formal education were willing to pay the highest bid (20%) compared to 28% the respondents with tertiary education who were willing to pay the high bid. About 43% of the respondents with tertiary education stated that they were not willing at all to pay for GM foods.

Table 10: Relationship between Educational level and WTP for GM Foods

	WTP by Educational level			
	Yes –Yes	Yes-No	No-Yes	No-No
No formal education	48.7%	34.1%	30.0%	26.7%
Primary education	2.5%	9.4%	3.3%	8.1%
J.H.S education	12.8%	7.1%	10.0%	5.8%
S.H.S education	7.6%	11.7%	14.4%	16.3%
Tertiary education	28.2%	37.6%	42.2%	43.0%

Source: Field survey, 2016

The results also show that, the general WTP for GM foods was low for both Christians and Muslims, however, greater proportion of the Christians were willing to pay the highest price premiums for GM foods compared to the Muslims. Approximately, 17% of the respondents who were Muslims indicated that they were willing to pay the highest bid



(20%) while 25.7% of the Christian respondents were willing to pay the highest price premium for GM foods.

This could be attributed to the perception of GM foods being unnatural. .

Table 11: Relationship between Religious affiliation and WTP Foods

Religion	WTP by Religious affiliation			
	Yes –Yes	Yes-No	No-Yes	No-No
Christian	25.7%	6.4%	33.9%	33.9%
Muslim	17.0%	29.8%	27.7%	25.5%

Source: Field survey, 2016

Ironically, the low income earners were willing to pay the highest bid for GM foods compared to the higher income earners. This may be due to the fact that the lower income earners are those who are not much knowledgeable about the controversies surrounding the GM foods. Also, it can be inferred that, the high income earners may have access to other food options than the low income earners. The results showed that, about 16% of the respondent within the low income earners were willing to pay the highest price premiums for GM foods compared to approximating 9% of the high income earners who were willing to pay the highest price premiums for GM foods. This implies that lower income groups are more willing to pay for GM foods than the higher income groups.



Table 12: Relationship between Income level and WTP for GM Foods

Income	WTP by Income Level			
	Yes –Yes	Yes-No	No-Yes	No-No
< =GHS 1000	16.9%	30.0%	32.35	20.8%
GHS 1001-1500	10.7%	23.2%	32.1%	33.9%
GHS 1501-2000	13.3%	30.0%	26.7%	30.0%
> GHS 2000	9.3%	35.2%	22.2%	33.3%

Source: Field survey, 2016

The WTP for GM foods did not differ much across the household sizes. It was expected that larger households will be willing to pay lower bids than smaller households due to the extra cost they will incur to purchase GM foods with additional benefits which will typically increase their expenditure.

Table 13: Relationship between Household Size and WTP GM Foods

Household size	WTP by Household size			
	Yes –Yes	Yes-No	No-Yes	No-No
5 people & below	14.3%	26.2%	33.3%	26.2%
6-10 people	13.1%	27.1%	28.0%	31.8%
above 10 people	13.5%	32.7%	23.1%	30.8%

Source: Field survey, 2016

The cross tabulation result shows that the elderly are willing to pay a lower bid for GM food than the young. Also, 50% of the elderly (51-60 and above 60 years) were not actually



willing to pay for GM foods. This may be due to the public debate with regards to risk associated with consumption of GM foods. Older people are more conscious of their health and not willing to take risks by consuming a new food commodity which is surrounded by controversies worldwide.

Table 14: Relationship between different Age Groups and WTP for GM Foods

Age Category	WTP by Age Category			
	Yes –Yes	Yes-No	No-Yes	No-No
30 years &	15.4%	10.6%	15.6%	11.6%
31-40	20.5%	20.0%	18.9%	16.3%
41-50	38.5%	30.6%	24.4%	22.9%
51-60	17.9%	22.6%	23.3%	27.9%
above 60	7.7%	16.5%	17.8%	22.1%

Source: Field survey, 2016

Consumers' who were aware or have knowledge about GM foods are either willing to pay a lower bid or not willing to pay for GM foods. Only close to 13% of the respondents who were aware of GM foods were WTP a higher premium. However, 14% of the respondents who were not aware were willing to pay a higher premium. It can be concluded that almost all the respondents wanted GM food at a higher discount, but more knowledgeable consumers want it at lower discount than those with limited knowledge.



Table 15: Relationship between Awareness of GM Foods and WTP

Awareness of GM	WTP by Awareness			
	Yes –Yes	Yes-No	No-Yes	No-No
Not aware	13.83	32.98	27.66	25.53
Aware	12.62	26.21	31.07	30.1

Source: Field survey, 2016

Table 16. Distribution of Consumers' First Choice of Rice Brand at Urban Tamale Dwellers

Rice brand	Frequency	Percentage
Local rice	110	36.7
Cindy	59	19.7
Millicent	16	5.3
Lele	40	13.3
Vietnam	14	4.7
Texas	39	13.0
Uncle Sam	3	1.0
Sultana	4	1.3
Royal feast	10	3.3
American rice	5	1.7
<i>Total</i>	<i>297</i>	<i>100</i>

Source: Field survey, 2016



4.7 Summary Statistics of Variables Influencing Consumers' WTP

Several factors come into play regarding consumers' decision to select a particular food (rice) among the two competing product: In this case, GM rice and non-GM rice. Most significantly, price of the product, consumers concern about nutrition, education and awareness are key influencers of consumers preferences for GM rice. Also, source information (radio), age and perceptions influences consumers choice.

From Table 17, the mean age is 48 years while the mean years of education is 10 years.

It was also revealed from the study that the average weekly expenditure of household on food was GHS 137.5.

Additionally, 69% indicated that they aware of GM foods with 53% considering the radio as the main source of information.

Moreover, 90% indicated that they consider the appearance, 83% consider taste and 77% considers labels before buying rice.

Table 17: Descriptive Statistics of collected Variable during the 2016 in Urban Tamale (n=300)

Variable	Mean	Std. Deviation	Minimum	Maximum
Age of respondents(years)	48.24	13.62	20	87
Years of education	10.49	5.63	0	18
Sex of respondents				
Price of food commodities	0.86	0.34	0	1
weekly food expenditure	137.52	85.16	50	480



Awareness of GM foods	0.69	0.49	0	1
Hearing of GM the radio	0.53	0.50	0	1
Perceptions of health implication of GM foods	3.49	1.05	1	5
Perceived nutritional benefits of GM foods.	3.35	1.04	1	5
Perceived allergic to GM foods.	3.35	1.04	1	5
Perceptions of GM foods being unnatural	3.48	1.15	1	5
Taste of GM foods	0.83	0.38	0	1
Appearance of GM foods	0.9	0.30	0	1
Labels of GM foods	0.77	0.42	0	1

Source: Author's Estimations from Field Survey Data(2016)

Source: Field survey, 2016

4.8 Determinants of Consumers' WTP for GM Foods

The fourth objective of the study sought to investigate factors that influence willingness of consumers to pay more for GM rice in Tamale.

The third objective of the study was to investigate factors that influence willingness of consumers' to pay more for GM rice in Tamale. These factors are reported in the coefficients (see Table 18).



The results based on the LR chi-squared test from the ordered probit model shows that the explanatory variables jointly explain the probability of consumers' WTP more for GM foods. The Pseudo R^2 value of 0.1047 implies that about 10.47% of the variation in probability of consumers' WTP price premiums for GM foods is explained by the selected covariates.

Individual consumers take personal decisions under different circumstances in choosing a product. Several factors account for this decision. This section analyzes the factors influencing consumers' WTP price premiums for GM foods. From the study, age of the consumer, education, perceived health implication and perceived allergic to GM food positively influence WTP for GM foods while, awareness of the product, source of information on GM products and nutritional benefits of the product as well as ethical concerns (GM foods unnatural), were also found to influence consumers' WTP for GM foods negatively. Other factors that were measured and included in the analysis but not significant were sex, income level, taste, weekly expenditure on food and household size.

However, the coefficients values of the ordered probit model obtained from **Table 18** do not offer the best indications of the signs and effects of independent variables on WTP bids as these bids are in categorical levels. Hence, to estimate the magnitude of change in the level of WTP decision as a result of a unit change in any of the independent variables, marginal effects will serve as a more meaningful measure of the effect of independent variables were produced



Table 18: Estimated Coefficients of Factors influencing Consumers' WTP from the Ordered Probit Regression Model

Variable	Coefficients	Standard error
Age of respondents(years)	0.0089*	0.0049
Sex of respondents	-0.0244	0.1623
Religion	-0.2509*	0.1406
Price of Non GM food commodities	0.5207***	0.1994
weekly food expenditure	0.0007	0.0008
Total income	0.0001	0.0001
Taste	0.2105	0.1816
Appearance	0.1262	0.2269
Awareness of GM foods	-0.3574*	0.1573
radio information on GM	-0.5730***	0.1467
Perceived nutritional benefits	-0.2342***	0.0640
Perceived health implications	0.0685	0.0740
Perceived allergies	0.1639**	0.0749
Perceptions as unnatural	-0.1246*	0.0679
Education	0.0430***	0.0118

<i>Number of observations</i>	287
<i>Wald chi2(13)</i>	105.55
<i>Prob > chi2</i>	0.000
<i>Pseudo R2</i>	0.1047
<i>Log pseudo likelihood</i>	-379.616



***, **, * respectively indicate significance level at 1%, 5% and 10%.

Marginal Effects of Explanatory Variables on WTP Amount

It can be observed from Table 19 that for each explanatory variable, the estimated marginal effects sum up to zero across the WTP bids. Thus, if a WTP bid has a higher probability, it implies that the other(s) have lower probability. Result from the analysis showed that, the variables had different directions for the various bids; some had positive coefficients for lower bids but negative coefficients for higher bids and vice versa as discussed below.

Age of consumers negatively influence WTP higher price premiums for GM foods. This means that consumers' probability of paying the highest bid (YES-YES) decreases with increasing in age of the consumer. That is, if a consumer gains an additional year in age, the probability of WTP higher price premiums for GM foods decreases by 0.15%, holding all other factors constant. The implication is that, older people are more concerned about the risks and safety of food commodities (Knight, 2007), but this is contrary to the findings of Jin *et al.* (2014).

Religious affiliation of consumers was a dummy variable in the regression. Islam was coded 1 while Christianity was coded 0. The result showed that religious affiliation negatively influences consumers' WTP. Christian consumers are willing to pay more for GM foods than their Muslim counterparts. The marginal effect of 0.024 for religious affiliation shows the difference between the highest WTP for GM for Christians and Muslims. Thus, Muslims are 4.2% more likely to pay higher bids than Christians, holding all other factors constant. This result conforms to the findings by Huffman *et al.* (2004). The reason for unwillingness to pay for higher bids with regards to Christian could be based on



a reservation on their religious beliefs and teaching. They could be genes from organisms that are prohibited to consume.

Awareness of GM foods was significantly negative and was contrary to the researcher's *a priori* expectation. In practice, awareness creation is a first step to provide information on the benefits and risks of GM foods as well as the potential negative effects that it might have on the environment. The negative sign of this variable in the model for GM rice enhance nutritional benefits (Vitamin A) indicate that consumers reads or hear negative information about the product which overall decreases their trust in the GM foods. If what they hear or read with regards to the benefits outweigh the risks, then WTP the highest bid for GM foods might have increased. The marginal effect of awareness of 0.063 means that a person who is aware of GM foods is about 6.3% less likely to pay more for GM foods. While the marginal effect of 0.1128 for the NO-NO category implies that, a person who is aware of GM food is 11.28% more likely to pay less for GM rice, *ceteris paribus*. These findings confirm that of Boccaletti and Moro (2000), who established that awareness had a negative association with WTP for GM foods in Italy. They attributed this to undesirable information which tends to decrease consumers' overall positive level of trust in GM foods, leading to the development of negative attitudes.

Access to information on GM from radio was an important factor in explaining consumers' WTP higher price premiums for GM foods. The result shows a negative relationship between hearing about GM from radio and WTP for GM foods. The negative relationship, however, corresponds to WTP higher price premium (20%) for GM foods. This means that access to radio information on GM foods, tend to increase consumers WTP price premium for GM foods. The marginal effect of 0.095 means that when a consumer





hears information about GM foods from radio it increases the probability of paying a higher price premium for GM foods by approximately 9.5% holding all other explanatory variables constant. It is alleged that information from the mass media is more focused on negative information (Moon and Balasubramanian, 2004). Accordingly, consumer beliefs are formed from the negative information and as a result, consumers develop disapproving attitudes towards GM foods. However, as consumers become more knowledgeable and make informed choices, their risk perception decreases (Moon and Balasubramanian, 2004).

For the **nutrition variable**, it was expected that the higher the consumers' perception of association between nutrition and WTP, their WTP price premiums for GM foods should increase. The estimates of this variable were significant ($p < 0.01$) and had a positive influence on consumers' WTP. The implication is that, consumers who perceived GM foods to be highly nutritious tended to place higher monetary value on them. Accordingly, WTP price premiums (YES-YES) for GM foods increases with greater consumer perception of GM foods as being highly nutritious. The marginal effect of perceived nutritional benefits of GM foods (0.039) means that once the consumer perceived GM foods to be of high nutritional value, s/he is likely to pay an additional 3.9 % higher price premium than consumers who do not perceive GM foods of high nutritional value holding all other variable constant. The finding that perceived nutritional benefit significantly increases consumers' WTP more for GM foods agrees with that of Munene *et al.* (2006), which shows a positive association between nutrition and WTP a premium for functional foods.

Perceived allergy to GM foods had a negative relationship with consumers' WTP higher price premiums for GM foods. Some consumers indicated that eating GM foods could cause vomiting and skin disorders. This may be the reason for the negative marginal effect. The marginal effect of perceived allergy to GM foods is 0.027 which implies that, once the consumers perceived that they were allergic to GM foods, they are 2.7% less likely to pay the price premium as opposed to consumers who do not have this perception about GM foods. The finding of this study is in line with that of Senturk (2009).

A perception of GM foods being unnatural was an important determinant of consumers' WTP higher price premiums for GM foods. It is, however, important for consumers to examine whether GM foods are produced through the natural process or artificially made and whether they are ethically accepted. The sign of the coefficient did not meet our *a priori* expectation. The positive coefficient implies that consumers who perceived GM foods as not meeting ethical or moral standards actually place higher price premiums on GM foods. Thus, consumers who perceive GM foods as unnatural are rather more likely to pay higher price premiums for GM foods. This marginal willingness is about 2.0% for consumers with unnatural perceptions. This result contradicts the findings of Botelho and Kurtz (2008).

Education was also an important determinant of consumers' WTP higher price premiums for GM foods. It was hypothesized that, as one's level of education increases s/he is likely to have advanced knowledge of GM foods which will have a positive or negative relationship with consumers' WTP higher price premiums for GM foods, depending on the nature of the knowledge gained. The results show that consumers who have acquired higher education are less likely to state higher price premium for GM foods. The marginal effect estimate of education was 0.0072 (YES-YES) and 0.0092 (YES-NO), which indicates that as



consumers' years of education increases by one year, they are 0.72% and 0.92% less likely to pay additional price premiums, holding all other variables constant. The marginal effect of 0.0139(NO-NO) and 0.0026(NO-YES) increase the probability of consumers responding NO-NO and NO-YES by 1.39% and 0.26%. This result contradicts that of Kimenju and De Groote (2008) and Deffort (2014).



Table 19: Marginal effects of explanatory variables after ordered probit regression

Variable	WTP=0		WTP =1		WTP=2		WTP=3	
	Marginal effect	Standard error	Marginal effect	Standard error	Marginal effect	Standard error	Marginal effect	Standard error
Age (years)	.0029*	.0015	.0005*	.0004	.0019*	.0011	-.0015*	.0008
Sex	-.0079	.0520	-.0015	.0103	.0052	.0347	.0041	.0276
Religion	-.0812*	.0455	-.0149*	.0103	.0541*	.0310	.0419*	.0239
Week	0000	.0003	0000	.0001	-.0002	.0002	-.0001	.0001
Income	0000	0000	0000	0000	0000	0000	0000	0000
Taste	.0647	.0530	.0171	.0192	-.0433	.0355	-.0386	.0366
Appearance	.0394	.0683	.0095	.0208	-.0264	.0459	-.0225	.0432
Awareness	.1128*	.0484	-.0244*	.0147	-.0748*	.0331	-.0625*	.0294
GM in	-.1853***	.0474	-.0304***	.0145	.1206*	.0327	.0951***	.0263
Perceived benefit	-.0757***	.0208	-.0139***	.0067	.0505*	.0151	.0392***	.0115
Perceived health	.0222	.0240	.0040	.0046	-.0148	.01604	-.0115	.0125
Implicit	.0530*	.0243	.0059*	.0097	-.0353*	.01669	-.0274*	.0129
Perceived unnatural	-.0403*	.0220	-.0073*	.0049	.0269*	.01498	.0208*	.0116
Education	.0139***	.0038	.0026***	.0012	-.0092*	.0028	-.0072***	.0021

Note: The values in parentheses represent the marginal probability of each WTP outcome and sum to zero. WTP =0, WTP=1, WTP =2 and WTP=3.

***, **, * indicate significance level at 1%, 5% and 10%.

Source: Author's calculation, 2016



CHAPTER FIVE

SUMMARY OF KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0: Introduction:

This chapter consists of the summary of the study. Specifically the chapter gives a summary of the objectives and method of analysis as well as the key findings, conclusion and recommendations.

5.1 Summary

The objective of this study was to investigate consumers' WTP for GM foods (rice) in Urban Tamale, of the Northern Region of Ghana. Specifically, the study examined consumer awareness, perceptions, amount as well as the factors that influence their WTP. The multi-stage sampling technique was used to sample 300 respondents while a simplified semi-structured questionnaire was used through face-to-face interview to collect data for analysis. The double-bounded dichotomous choice CVM was used to elicit consumers' WTP, while descriptive statistics were used to present consumers' awareness, source information and perceptions on GM foods.

The ordered probit model was used to analyze factors influencing consumers' WTP for GM rice.

The key findings from the study are as follows:

Generally, consumers' awareness of GM foods was high, but they were not knowledgeable enough about GM foods.



Most consumers have negative perceptions about GM foods, even though they were not sure of their claims.

With regards to the amount consumers are WTP, a significant proportion (43.48%) of the consumers were WTP more for GM foods; they wanted it at a premium price of 5% higher than the price of related foods. However, 30.43% of those who were not WTP more (56.52%) for GM foods wanted it at a discount of 20%.

The lower income groups are willing to pay more for GM foods than the higher income groups. From the ordered probit regression results, it was observed that age, education, religious affiliation, awareness of GM foods and perceived allergy influenced willingness to pay more negatively, while perceived nutritional benefits of GM and ethical concerns (perceived as unnatural) has positive influence on higher price premiums for GM foods rice.

Conclusions

Consumers' level of awareness of GM foods was quite high.

Consumers' major source of information about GM were from friends and relatives.

Most consumers had negative perceptions about GM foods even though they were not sure of their claims; consequently, their WTP for higher price premium for GM foods was low.

Socioeconomic characteristics and some perceptions variables of consumers significantly influenced their WTP for GM foods.

Consumers in Tamale want GM rice to be lower than their non-GM counterparts.



Recommendations

Educational campaigns should be implemented in Ghana to provide consumers with scientific knowledge. Biotechnologists and the whole scientific community in collaboration with the media, the Food and Drugs Authority and the Ministry of Food and Agriculture (MOFA) should endeavor to provide the public with scientific information that will change consumers' subjective knowledge which may lead to the development perceptions to influence their WTP for GM foods.

There should be intense efforts by food biotechnologist to make food as safe and nutritious as possible to influence consumers' WTP higher bids because consumers are much conscious about health, nutrition and food safety and these have a direct influence on WTP for GM foods.

Policy makers must consider the issues of labeling of GM foods to distinguish it from other food products for consumers' to make their choice.

Potential for investors: Investors in GM should target the less educated, the young and those who perceived GM to be nutritious, since these groups of consumers have higher WTP.

In order to get the lower income group who are in the majority to buy GM foods, they should be made affordable to them. This can come through subsidization by government.

SUGGESTIONS FOR FURTHER RESEARCH

The study revealed that majority of the respondents were not willing to pay, hence future studies should be on WTA, whereby respondents are given subsidies and asked to indicate their WTA.



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APPENDIX

SURVEY QUESTIONNAIRE

UNIVERSITY FOR DEVELOPMENT
STUDIES, TAMALE, GHANA
Department of Agricultural and Resource Economics (ARE)

Survey Questionnaire for Rice Consumers

Consent Form

Thank you for the opportunity to speak with you, my name is _____. Today we're conducting a survey on consumer awareness, perceptions and willingness to pay for genetically modified food and we're interested in your opinions. We have selected your household by chance from this area. Please speak your views freely because whatever you say is confidential; we are combining your views with those of hundreds of others who are also being interviewed. There is no right or wrong answer it is just your honest views we are interested in. After entering the questionnaire into data base, we will destroy all information such as your name which will bind these responses to you.

. Household information

. Name of house head.....

. Name of respondent (if not head).....

. Relationship with household head (if not head).....

. Marital status: Married [1] Single [2] Divorced [3] Widow [4]

. Phone number (if available).....

. How many people live in your household (including yourself) and eat from the same pot.....

7. What is your ethnic affiliation? Dagomba [] Gonja [] Mamprusi [] Frafra [] Akan [] Kasena/Nankana [] Other(Please specify.....)

8. What is your religious affiliation? Christian [] Muslim [] Traditionalist [] 9.

Do you belong to any group (religious, saving and farming) in your community? Yes [] No []



Characteristics of household members

Please give me the names of all members of your household. Starting with the first	UNIVERSITY FOR DEVELOPMENT STUDIES	Sex	Age (in years)	educational level (in years)	What is primary Occupation of (Name)?	What is secondary Occupation of (Name)?
		1. Male			1. Self –employed in agriculture	1. Self –employed in agriculture
		2. Female			2. Trade/business	2. Trade/business
					3. Salary/Wage earner	3. Salary/Wage earner
					4. Pensioner	4. Pensioner
					5. Unemployed	5. Unemployed
					6. Student	6. Student
					7. Other(specify)	7. Other (specify).....



B. Household source of income

Economic Activities	Income per month
Crop farming	
Livestock production	
Petty Trading	
Salary/ wage employment	
Self-employed(artisanry - mason, carpentry, tailoring)	
Remittance and gifts	
Pensioner	
Others (specify).....	
Total	

C. Expenditures on food commodities

Food Item	Frequency of purchase	Average Amount per week(GHC)
Rice and rice products		
Maize and maize products		
Millet		
Sorghum		
Cowpea/beans		
Yam		
Meat/Fish		
Cooking Oil		
Fruits		
Beverages (non-alcoholic or alcoholic)		
Eggs and dairy products		
Salt		
Spices and condiments (maggi, onga and dawadawa, etc.)		
Vegetables		
Indomie (spagatie)		
Others (specify).....		
Total amount		

D. Exploring attributes of food products (maize and rice)

1. Have you ever taken a course or had training related to food and nutrition?

Yes [] No []

2. When buying food products (maize and rice), do you consider the nutritional components? Yes [] No []





3. When buying food products (maize and rice), do you read the nutritional labels/expiry date? Yes [☐] No [☐]
4. When buying food products (maize and rice), do you consider the taste? Yes [☐] No [☐]
5. When buying food products (maize and rice), do you consider the price level? Yes [☐] No [☐]
6. When buying food products (maize and rice), do you consider the appearance/purity? Yes [☐] No [☐]
7. Do you trust the institutions that are supposed to ensure foods safety in the market? Yes [☐] No [☐]

E. Consumers' knowledge on GM food

Have you ever heard of the term GM foods? Yes [1] No [2]

What is your understanding of GM

foods?.....

.....

No.	Questions	Yes[1]	No [2]
1	Do you know that some GM foods are nutritious?		
2	Are you aware of GM rice?		
3	Are you aware that GM maize is resistant to diseases and pest?		
4	Do know that some GM foods are resistant to herbicides that makes the food safer?		
5	Are you aware of GM potato?		
6	Are you aware of GM soybeans?		
7	Are you aware of GM tomatoes?		
8	Are you aware of BTmaize?		
9	Are you aware of BT cotton?		

F. Consumers source of information on GM food

No.	Questions	Yes [1]	No [2]
<i>Which of the following source(s) have you ever heard or read about GM foods before?</i>			
1	Radio		

2	Friend/relative or someone else		
3	MoFA		
4	TV		
5	Internet		
6	Magazine		
7	Newspapers		
8	Lectures, seminars and workshops		
9	Community meetings		
10	Others source (specify).....		

G. Consumers' perceptions on GM food

Please rate the following statements by ticking the most appropriate box, *Strongly Disagree* to *Strongly Agree*.

	1. Strongly disagree 2. Disagree 3. Not sure 4. Agree 5. Strongly agree	Response
1	Do you think GM foods have high nutritional values?	
2	Do you think GM foods can reduce the use of pesticides in crop production?	
3	Do you think GM foods are a solution to global food problem through increase in productivity?	
4	Do you think the original plant varieties may be lost through GM?	
5	Do you think important insects (bees) may be killed through insect resistant GM crops?	
6	Do you think GM food has health implications?	
7	Do you think people could suffer allergic reaction after consuming GM foods?	
8	Do you think GM foods are unnatural?	
9	Do you think GM technology makers are challenging God?	
10	Do you think GM foods are being forced on developing countries by developed countries?	
11	Do you think GM products may benefit large-scale farmers than small-scale farmers?	
12	Do you think companies or nations involved in GM production are doing so for their own benefit?	
13	The technology is mainly profit driven (focus on crop few crops with commercial value)?	

Other perceptions

What other things do you know about GM foods?



No.	
13	
14	
15	
16	

H. HOW MUCH CUSTOMERS ARE WILLING TO PAY FOR GM FOODS

There is Vitamin A deficiency in developing countries like Ghana. Meanwhile Vitamin A is important for normal vision, the immune system and reproduction. It also helps the heart, lungs, kidney and other organs to work properly. Due to this, biotechnologists have developed GM rice (Golden rice) fully fortified with Vitamin A to help increase the Vitamin A components of rice since it is one of the foods commonly consumed. Consuming GM rice therefore has the potential to reduce amounts spent on hospital bills resulting from vitamin A deficiency. Other potential sickness might be prevented by consuming GM products

Due to the additional cost of purchasing the seeds and other inputs for production, producers of GM crops may incur higher costs and would have to pass on part of that cost to consumers, resulting in higher price compared with the non-GM products that do not contain vitamin A.

7. Would you be willing to pay more for these GM products? Yes [] No []

8. If no to question 1, why?

a) I cannot afford it []

b) I think the non GM products already on the market are nutritious []

c) I do not trust the agency that will produce the GM products []

d) I think the GM products has health implications

e) Other reason

If yes to 1, please proceed with the following questions.

7. Why are you willing to pay higher prices for the GM products?

a) I can afford []



- b) I am concerned with health and nutrition []
 c) Other reason

Which rice brand do you mostly consume.....?

8. If the rice is GM to contain Vitamin A, will you be willing to pay more for it?

Yes [] No []

If yes to question 4, answer questions 5 – 9; if no to 1, skip to questions 10 – 12

<i>Yes to Question 4</i>		<i>No to Question 4</i>	
<i>Bid</i>	<i>Response</i>	<i>Bid</i>	<i>Response</i>
Are you willing to pay.....?		Are you willing to pay.....?	
5. 5% more	Yes [] No []	Same price	Yes [] No []
6. 10% more	Yes [] No []	5% less	Yes [] No []
7. 15% more	Yes [] No []	10% less	Yes [] No []
8. 20% more	Yes [] No []	15% less	Yes [] No []
9. 25% more	Yes [] No []	20% less	Yes [] No []

Thank you

