Sensory acceptance of quality protein maize dishes and willingness to pay for its grain in districts around Gilgel Gibe hydro-electricity dam: *Omo Nada* district

MSc Thesis

By: Samuel Diro

October, 2015

Jimma, Ethiopia

Sensory acceptance of quality protein maize dishes and willingness to pay for its grain in districts around Gilgel Gibe hydro-electricity dam: *Omo Nada* district

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APPROVAL SHEET

School of Graduate Studies

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As, thesis research adviser, I hereby certify that: I have read and evaluated this thesis prepared, under my guidance, by Samuel Diro, entitled "***Sensory acceptance of quality protein maize dishes and willingness to pay for its grain in districts around Gilgel Gibe hydro-electricity dam: Omo Nada district ***". I recommend that it be submitted as fulfillment of the thesis requirement.

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ACRONYMS AND ABBREVIATIONS

ACC----------Association of corporate counsel

BDM- ----------Becker-De Groote-Marschak auction mechanism

CIAT ----------International center for tropical agriculture

CIMMYT----------International maize and wheat development center

CLT----------Central location test

CM----------Conventional maize

CSA----------Central Statistics Authority

ETB---------- Ethiopian Birr

FAO----------Food and agricultural organization

HUT----------Home use test

IFPRI ----------International food policy research institute

MHUT----------Modified home use test

MoH----------Ministry of health

NuME----------Nutritious maize for Ethiopia project

O2----------Opaque two

PA----------peasant association

PLUM----------Polytomous universal model

QPM----------Quality protein maize

SCN----------Standing committee on nutrition (UN)

SPSS----------Statistical package for social science

USD----------United State dollar

WFP----------World food program

WHO----------World health organization

WTP----------Willingness to pay

BIBLIOGRAPHICAL SKETCH

The author was born in 1986 in Ilfeta district, west Shoa zone from his father Diro Chelkeba and his mother Tsedale Birhanie. He finalized his primary education at Bake Abbo primary school and Selam Ber primary school in Ilfeta *Woreda* and Addis Ababa city respectively. After completion of secondary school at Addis Ababa kolfe comprehensive senior secondary school, he joined Agarfa TVET College in 2001/2002, and graduated in diploma in natural resource management on July 2004. The author then joined Unity University and graduated in B.A degree in 2009 in economics. He then joined Ethiopian institute of agricultural research (EIAR) and worked at Jimma agricultural research center in agricultural economics, research extension and gender linkage research process as a junior researcher.

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ABSTRACT

The study was aimed to identify consumer's sensory preference for quality protein maize and conventional maize traditional dishes and then try to estimate the willingness to pay for quality protein maize grain in Jimma Zone. It used sensory evaluation techniques like central location test, modified home use test and triangular test; and Becker-De Groote- Marschak method as experimental auction mechanism. The treatment products used on the experiments was white and yellow quality protein maize and the control products used was white and yellow conventional maize. SPSS-20 was used for descriptive statistics, inferential statistics and ordinal logistic regression and Stata 12.1 was used for random effect model. The result from triangular test shows significant sensory difference between quality protein maize and conventional maize dabo. The result from central location test and modified home-use test explored, quality protein maize dishes was significantly appreciated than the conventional counterpart. The overall score of children also realized quality protein maize genfo was highly appreciated than the conventional maize genfo. Becker-De Groote-Marschak mechanism result revealed that sample respondents were willing to pay more for quality protein maize. The result also shows information has boosted bids for quality protein maize grain and reduced the bids of the conventional maize grains. Finally the study recommended concerning bodies to use quality protein maize sensory superiority and market potential to adopt and disseminate the technology.

Key words: Sensory evaluation, willingness to pay, Becker-De Groote-Marschak, random effect model, ordinal logistic regression.

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Agriculture, the mainstay of Ethiopian economy, directly supports about 85% of the population in terms of employment and livelihood, contributes over 41% of the country's gross domestic product; generate about 90% of export earnings. It is also an important sector in supplying food for the population and raw material for agro-based domestic industries and in generating surplus capital to speed up the country's overall socio-economic development (CSA, 2014).

Despite progress in production and productivity of agricultural produces, food insecurity and per capita calorie consumption in the world has not registered a significant improvement in recent years. Consequently malnutrition, specific nutrient deficiencies and anemia primarily causes immune deficiency and then finally increases the risk of maternal morbidity and mortality (Domellof, 2011).

Lack of inadequate supply of food and low purchasing power of families are not only causes of malnutrition and related problems. However, the intention and capability of rural population towards regularly feeding the family with disease preventing and body building foods such as vegetables, fruits and animal products as well as supplementation of food to children as an addition to breast milk is very poor (MoH, 2003). Hence, the adoption and diffusion of staple crops based bio fortified commodities such as quality protein maize may be regarded as a good option for rural smallholder farmers (De Groote et al., 2010).

Quality protein maize (QPM) is a bio fortified maize variety with high lysine and tryptophan and proved to have positive results towards malnutrition (Gunaratna et al., 2008). QPM plays very important role for food security and to increase protein intake

for smallholder farmers of developing economies especially sub Saharan African countries who are characterized by high population growth and large family size, high child mortality, malnutrition and food shortage (Krivanek et al, 2007).

The most important factor that drives to massive adoption of new agricultural technology is its sensory quality among users. This sensory quality of food is evaluated by consumers using different sensory evaluation techniques. Sensory evaluation is a vital tool for new product development, product improvement, product grading, consumer acceptance and opinions (Institute of food technologists; 1981). The study is aimed to identify consumers' sensory preference for QPM and the conventional maize based traditional dishes and tries to estimate the willingness to pay for QPM grain through different experimental techniques as QPM is recognized as a tool to tackle protein energy malnutrition.

1.2 RATIONALE AND STATEMENT OF THE PROBLEM

Basically experimental economics is playing important role in estimating new product premiums and targeting novel and safer foods to specific consumer segments especially in this period when producers, consumers and retailers are attempting to add value to agricultural products. Exploiting the sensory characteristics of new product helps in determining and maintaining the quality of a product and in forecasting market behavior of the product (Koehl et al., 2007).

Different physiological and agronomic studies on QPM have been conducted in Ethiopia by international and national research organizations particularly where maize is dominantly produced and consumed. Quality protein maize has been disseminated to *Jimma* zone for limited users with its own full agronomic practices and recommendations like fertilizer rate, pest and disease management and spacing though no difference with the conventional one in this regard (Prasanna et al., 2001). Even though all activities and decisions are colored by the consumer, QPM acceptance and preference study is few and market study has not been investigated

whole in whole for the area and even for the country. Few studies on farmers' acceptance of QPM traditional dishes and willingness to pay for its grain or flour was conducted in some African countries including Ethiopia.

De Groote et al., (2010), on the study in Ghana and Tanzania, used BDM mechanism to elicit the true willingness to pay of consumers for conventional and bio fortified maize varieties with and without varieties nutritional information. However, the consumers' willingness to pay before and after nutritional information has not been incorporated during the auction. Some sensory evaluation experiments on QPM and conventional maize acceptance and preference study was undertaken in Ethiopia. Any of those experiments did not combined experimental auction.

On the study conducted in Ethiopia, a different proportion of maize-t*eff* mixture and pure *teff Enjera* were evaluated and compared by respondents and the evaluation included different QPM and conventional maize variety (De Groote et al., 2014). Another study in Ethiopia used home use-test sensory technique only and participated women and children in the evaluation process. The maize varieties used on the study was white QPM and white conventional maize flours (Gunaratna et al., 2015). The study in Tanzania used only two varieties of maize and one traditional dish (Kiria, 2010) and the experiment in Ghana used one traditional dish and three different maize in evaluation process (De Groote et al., 2010).

This research fills the limitations of the studies highlighted above and other similar studies conducted before in three fundamental notions. First, it elicited the true willingness to pay with three nutritional information provision forms such as auction with information, auction without information and auction before and after information. Secondly, it incorporated children aged 6-23 months in sensory evaluation process since sensory testing with children can provide valuable data in basic research or product development. Thirdly, on this study two types of traditional dishes: *dabo*[1] *and genfo*[2] were used made from four varieties of maize grain: white and yellow QPM and white and yellow conventional maize varieties.

[1] Traditional bread baked from mixed and fermented maize or wheat flour
[2] stiff porridge

Thus, the study is expected to fill a gap existed regarding shortage of literature on QPM dishes acceptance and WTP for Ethiopian condition, children acceptance of local food from different maize varieties and sample diversity of food types, maize type and maize color. The results of the study are likely to be used by CIMMYT or NuME scientists, policy analysts, national and regional research centers, other organizations and agencies such as district, zonal and regional departments of rural developments, non government organizations and other organizations working in the areas of rural household poverty reduction and food security.

1.3 OBJECTIVES OF THE STUDY

The aim of this study is to evaluate the sensory acceptance of quality protein maize dishes and willingness to pay for its grain in *Omo Nada* district.

The specific objectives of the study are:

- ✓ To examine farmers' sensory preference of QPM and conventional maize traditional dishes and to investigate if consumers can identify sensory differences between the varieties.
- ✓ To estimate consumers' willingness to pay for QPM grains.
- ✓ To investigate determinants of farmers' sensory preference and willingness to pay for maize traditional dishes and grains.
- ✓ To examine if sensory quality of QPM dishes and QPM nutritional information affects consumers' willingness to pay for its grain.

1.4 RESEARCH HYPOTHESIS

The following research hypothesis were tested on the study:

1. Hypothesis 1: Rural farmers of the study area prefer the sensory characteristics of QPM foods to conventional maize foods.
2. Hypothesis 2: Rural farmers in the study area opt to pay more for QPM than for conventional maize grain.
3. Hypothesis 3: Sensory quality of QPM dishes affects farmers' willingness to pay for its grain in the study area.

4. Hypothesis 4: Provision of QPM nutritional information increases WTP for its grain.
5. Hypothesis 5: Demographic and socio economic factors influences acceptance of traditional foods made of QPM and farmers' willingness to pay for its grain.

1.5 SCOPE AND LIMITATION OF THE STUDY

The study was confined to one of the NuME target zone in Ethiopia: *Jimma* zone. Due to time constraint and due to error sensitivity of the experiment, it was also restricted to one district (*Omo Nada*) and four potential PAs meticulously selected. The study mainly emphasizes on evaluation of farmers' preference of QPM based traditional dishes and willingness to pay for its grain. The experiments used White QPM (BH-760) and Yellow QPM (BH-545) as a treatments and White conventional maize (BH-660) and *Yellow conventional maize*[3] as check or control products.

1.6 ORGANIZATION OF THE THESIS

The thesis has five chapters. Introduction is the first chapter which has been discussed above embracing the background, rationale and statement of the problem, research hypothesis, research objectives, scope and limitations of the study. In chapter two, key concepts like quality protein maize and malnutrition, sensory evaluation techniques, willingness to pay, previous research and trends on sensory evaluation and willingness to pay and conceptual frame work of the study was reviewed clearly.

Chapter three discussed all issues related to data such as survey design, data collection methods, data analysis methods used in this study. Chapter four focuses on interpretation and discussion of descriptive, inferential and econometric results and chapter five summarizes the study and presents conclusions and policy recommendations as well as limitations and suggestions for future research.

[3] Local maize variety available on the hand of few farmers which is yellowish in color

CHAPTER TWO: REVIEW OF LITERATURE

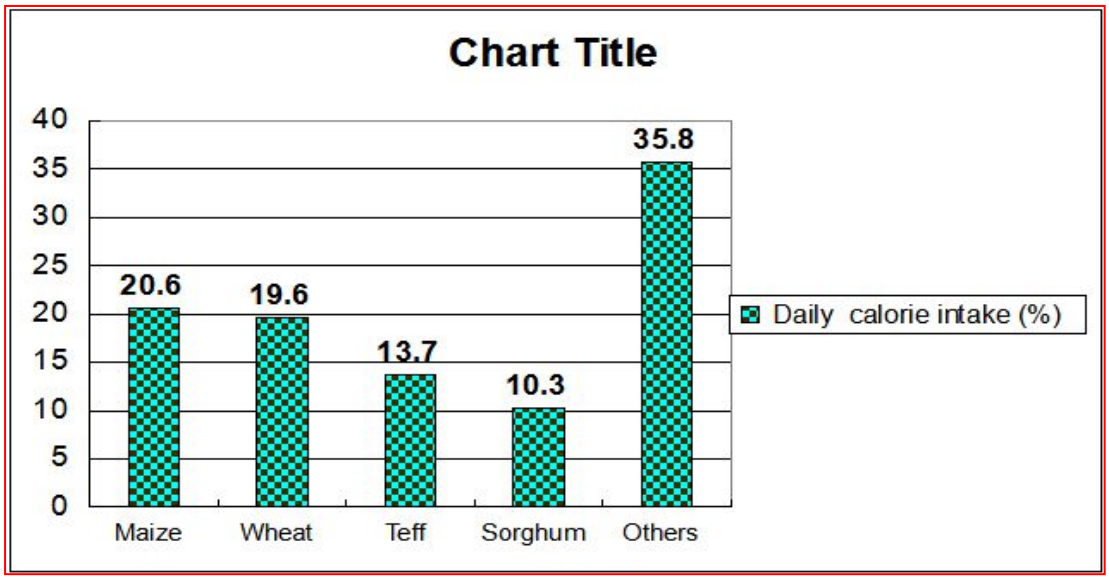
2.1 THEORETICAL LITERATURE

2.1.1 QUALITY PROTEIN MAIZE

Maize, *Zea Mays Linnaeus,* is the third important cereal crop globally after wheat and rice. Its consumption has increased from time to time and especially accounts for 70% of the food consumed in sub-Saharan Africa (FAO, 2007). Ethiopia is the fourth largest maize producing country in Africa and the first in the East African region. More than half of all Ethiopian farmers grow maize mostly for subsistence. Maize is used as a subsistence crop for smallholder farmers while it is the source of cash and market good for few large modern farms. The share of the smallholder sector was about 95% of total maize production (IFPRI, 2010).

Of the total production, 75 % of maize being consumed by the farming household as it is the cheapest source of calorie intake in Ethiopia, providing 20.6 % of per capita calorie intake nationally (IFPRI, 2010; Rashid, 2010).

Figure 1: Importance of staple foods in the diet of Ethiopia



Source: As reported in Rashid (2010), the estimates for Teff are from the CSA and the rest from FAOSTAT

Due to its high yield potential and wide adaptation, maize has been selected as one of the national commodity crop to satisfy the food self-sufficiency and food security program of the country. However, conventional maize which is intensively used as

staple food has poor nutritional value particularly limited essential amino acids: tryptophan and lysine (Truswell and Brock, 1962) which finally exposed to malnutrition in children if not supplemented by other micro nutrient rich food ingredients.

Malnutrition affects all groups in a community, but infants and young children are the most vulnerable because of their high nutritional requirements for growth and development. It is also a factor for low baby birth weight when happened to pregnant women and then causes risk of child morbidity and early mortality. Malnourished girls risk becoming yet another malnourished mother, thus contributing to the inter-generational cycle of malnutrition (Blössner and De Onis, 2005).

Child malnutrition in the long run is a threat to economic growth in developing countries. It undermines educational attainment, lowers non-cognitive skills, leads to low labor productivity during adulthood, and diverts attention and resources away from other development objectives (Save the Children, 2012; Dercon and Sanchez, 2013).

More than 13.7% of Ethiopian populations are children under five years of age. These children and their mothers suffer from poor health and nutrition situation in the country. The national demographic health survey conducted by central statistical agency in 2014 showed that the prevalence of wasting[4], under-weight[5] and stunting[6] was: 9%, 25% and 40%, respectively (CSA, 2014). Protein energy malnutrition, vitamin A deficiency, iodine deficiency disorders, and iron deficiency anemia are the most common forms of malnutrition in Ethiopia (Edris, 2004).

Ministry of healthy reported that 29% malnutrition was prevalent among lactating mothers, 5-15% vitamin A deficiency disease among the pregnant women, 30% iodine deficiency among the general population and 58% child death rate was occurred due

[4] Insufficient weight for height, an indicator of acute under-nutrition (FAO, 1997)

[5] Insufficient weight for age which could be a result of both stunting and wasting (FAO, 1997)

[6] Insufficient height for age indicating chronic under-nutrition (FAO, 1997)

to malnutrition (MoH, 2003) showing the seriousness of the problem.

To tackle the problem of malnutrition in poor nations, four strategies are most commonly used to overcome nutrient deficiencies namely; dietary intervention or diversification, fortification, supplementation and bio-fortification.

Diversification: is the way the quantity, type and range of micro-nutrient rich foods to be consumed are diversified. Increasing dietary diversity entails incorporation of micro-nutrient rich foods like animal products, fruits and vegetables in adequate quantity in the daily diet of the consumers (WHO/FAO, 2006). It is recognized as a sustainable remedy of malnutrition especially among those who are susceptible since it encourages the availability and consumption of different food constituents simultaneously. All lactating women, especially, should consume those diversified and healthful diet even for the health of breast-fed infants. The study conducted in ten countries on the relationship between household dietary diversity scores and dietary energy availability by Hoddinott and Yohannes (2002) witnessed that dietary diversity scores have a potential for monitoring changes in dietary energy availability particularly when resources are lacking for quantitative measurements. However, this remedial measure for malnutrition is unattainable and considered as expensive strategy to maintain on large scale because of economic constraints and seasonality of vegetables and fruits (Meenakshi et al., 2009). The expensive cost of those food types even drive the poor groups to make a source of cash rather than consuming.

Food fortification, the second weapon against malnutrition, sometimes called “enrichment” refers to the method of adding micro nutrients like vitamins and/or minerals to foods to increase its overall nutritional content while processing foods (WHO/FAO, 2006). The aim of fortification is to increase intake of one or more nutrients that are inadequate in the food supply. This can be done in three ways: First, restoring the nutrients lost during food processing by restoring depleted nutrients to their natural level, for example restoring B-vitamins which are lost during milling. Second, increasing the level of essential nutrients, for example, adding extra iron to

wheat flour or extra calcium to milk. Thirdly, adding nutrients that are not normally present in a food item for example putting vitamin A into sugar, or iodine into salt (WFP, 2004; WHO, 2008).

Fortification of staple foods can be used as a measure of addressing malnutrition since it is socially acceptable and does not require active participation of consumers or change in buying, cooking or eating habits (Nestel, 1993). Another reason for the sustainability of this measure is that it does not change customary diet of population and not call for individual compliance and its cost effectiveness as it reaches large numbers of consumers through retail (Johnson, Mannar and Ranum, 2004).

Supplementation is the third malnutrition tackling method and defined as the provision of relatively large doses of micro nutrients, usually in the form of pills, capsules or syrups. It has the advantage of being capable of supplying an optimal amount of a specific nutrient or nutrients in a highly absorb-able form. It is often the fastest way to control deficiency in individuals or population groups that have been identified as being deficient. The purpose of food supplements is to complement diets through the nutrients or other substances that contain or influence the nutritional or physiological functions of people in some other way. They are not meant to be used as substitutes for a varied diet. Products classified as medicinal products under medicines are not food supplements (WHO/FAO, 2006).

Despite cost ineffectiveness, supplementation can be effective on a large scale, for instance as supported by successful eradication of vitamin A deficiency in Vietnam and Indonesia. However, success of supplementation depends on economic, social and political stability (Underwood, 1999). Supplementation usually requires the procurement and purchase of micro nutrients in a relatively expensive prepackaged form, an effective distribution system and a high degree of consumer compliance especially if supplements need to be consumed on a long-term basis. A lack of supplies and poor compliance are also consistently reported by many supplementation program managers as being the main barriers to success (WHO/FAO, 2006).

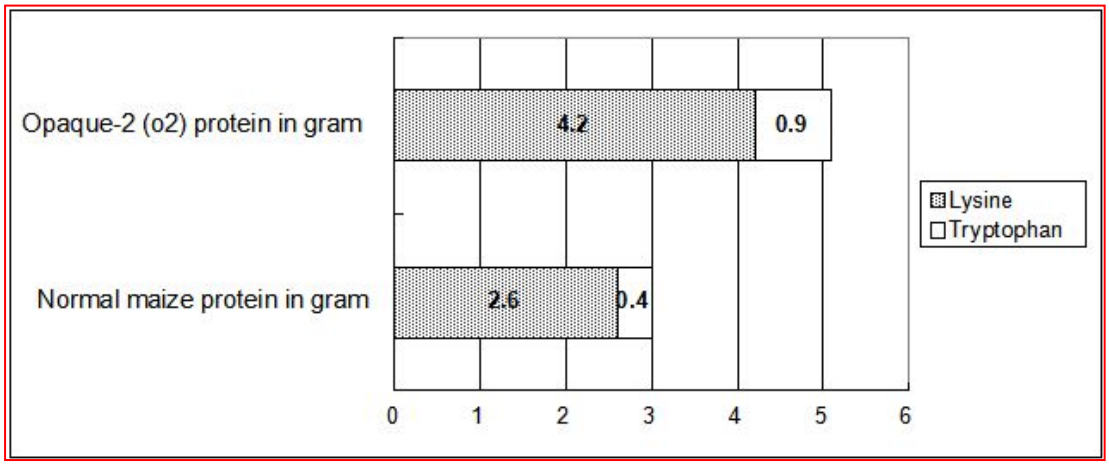
The last remedial measure is bio-fortification. It is the development of micro nutrient dense staple crops using the best traditional breading practices and modern biotechnology (WHO/FAO, 2006).

Bio fortification is the most successful method to address malnutrition because of different reasons. It capitalizes on staples foods daily and regularly consumed by all family members and implicitly targets low income households: women and children. It is highly sustainable strategy meaning after one-time investment is made to develop seeds that fortify themselves, recurrent costs are low and germ plasmas may be shared internationally and nutritionally improved varieties will continue to be grown and consumed year after year, even if government attention and international funding fades (CIAT, IFPRI: 2002). It is also a truly feasible means of reaching malnourished populations in relatively remote rural areas unlike fortification which are more readily available in urban areas. Bio fortified staple foods cannot deliver high level of minerals and vitamins per day as supplements or industrially fortified foods, but they can help by increasing the daily adequacy of micro nutrient intakes among individuals throughout the life cycle (Bouis et al., 2011).

A significant portion of the developing world's population relies largely on one or more of the staple crops such as rice, maize and wheat for their nutrition, and these are the subject of bio fortification projects, both by conventional breeding and by modern biotechnology methods.

Maize is a prominent staple food especially in Eastern and Southern Africa. However, it is nutritionally poor with low lysine and tryptophan (Truswell and Brock, 1962). This drove scientists to search alternative ways to increase lysine and tryptophan content in this staple crop (Vasal et al., 1980). According to Lauderdale (2000), the long run aim of this strategy was to provide lysine and tryptophan concentrated diets for those who daily and regularly produce and consume it and then reduce malnutrition and improve growth and health, particularly in young children. The endeavor started with the discovery of the opaque-2 gene which is a recessive gene that almost doubles lysine and tryptophan content (Mertz et al., 1964).

Figure 2: Comparative average percentages of lysine and tryptophan in opaque-2 and normal (non-opaque-2) maize



Source: *Bressani et.al. , 1969*

However, this invented opaque-2 gene come with inadequacies such as low yield and vulnerability to storage pests despite its concentrated lysine and tryptophan content (Prasanna et al., 2001). Continued efforts by breeders at the international maize and wheat improvement center (CIMMYT) lastly yielded varieties with the opaque-2 gene without the above inadequacies (Vasal, 2000). This variety was called quality protein maize or QPM which is enriched with essential amino acids: lysine and tryptophan and proved to have positive results towards malnutrition. Since the development of the variety, it has been released to a wide range of agro ecological zones of Latin America, Africa and Asia (Krivanek et al., 2007).

Humans and mono-gastric animals need two essential amino acids lysine and tryptophan that have to be supplied by the diet (Flodin, 1997). The level of tryptophan in the brain is determined in part by its competition with other amino acids. The lower the level of neutral amino acids presented to the blood brain barrier, the greater the brain uptake of tryptophan. The greater the uptake of tryptophan, the more serotonin is produced. Elevations in serotonin enhance mood and promote sleepiness (Katz and Friedman, 2008: 355). Niacin produced by tryptophan combats pellagra[7] (Sandik, 1992). Lysine supplemented diet increases intestinal calcium absorption and prevents

[7] Deficiency of niacin or tryptophan (FAO, 1997)

an increase in calcium excretion in the urine after calcium load and improves the health of bone in children and postmenopausal woman since it involved in the cross linking process of bone collagen (Civitelli et al., 1992; Flodin; 1997).

Table 1: Protein quality, lysine and tryptophan contents of QPM and Other Cereals

Cereal	Protein quality [A] (% of casein)	Lysine [B] (g/100gm protein)	Tryptophan [B] (g/100gm protein)
Regular maize	32.1	2.90 [C]	0.51 [C]
Opaque-2 maize	96.8	4.00 [C]	0.70 [C]
QPM	82.1	4.13 [D]	0.97 [D]
Rice	79.3	3.96	1.15
Wheat	38.1	2.79	1.28
Sorghum	32.5	2.24	1.20
Oat	59.0	4.51	3.61

Source: *[**A**] FAO (1992) [**B**] Lasztity (1996) [**C**] Graham et al. (1980) [**D**] Ortega et al. (1986)*

After the discovery of the opaque-2 gene, various studies on the impact of QPM on consumers were conducted in rats, children and adults (Graham et al., 1990, Bressani, 1991). The experimental result on those animals shows that QPM based feed has significant positive result on weight and height than those feed conventional maize (Gunaratna et al., 2008; Burgoon et al., 1992). Despite its superior nutritional and biological value, QPM is essentially interchangeable with normal maize in cultivation and kernel phenotype (Prasanna et al., 2001).

2.1.2 MEASURING CONSUMERS FOOD ACCEPTANCE

Acceptance of a food is basically the result of the interaction between food and man at a certain moment. This sensory and quality characteristic of foods to designate consumers' food acceptance, liking, choice, acceptance and preference is identified by sensory evaluation (Lawless and Heymann, 2010).

The definition of sensory evaluation was prepared by the sensory evaluation division of the institute of food technologists (Anonymous, 1975) quoted as "a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing". The reaction and the outcome of the evaluation such as flavor, taste, appearance, texture,

temperature, color, odor and aroma are said to be sensory attributes (Blades, 2001). Classification of sensory evaluation techniques is based on different factors used by scientists. For instance; based on the goal of the study and criteria/characteristics demanded for the participating panelists, sensory evaluation techniques are divided into: Discrimination analysis, Descriptive analysis and Affective analysis (Lawless and Heymann, 2010) and based the environment in which assessment is conducted, there are three methods of sensory evaluation: laboratory tests (e.g. triangular test), central location tests (CLT) or home-use tests (HUT) (Meilgaard et al., 2007:263).

Discrimination analysis is the simplest and heavily used technique of sensory evaluation (Lawless and Heymann, 2010). It answers the question: "are the products different in any way?" and serves to discover significant difference among samples. Discrimination analysis is divided into two groups: overall difference tests and attribute difference tests. In the case of overall difference tests, participants are asked to discover general and any existing difference between samples while in the attribute difference test case, participants are asked to focus on a specific attribute like ranking degree of sweetness (Meilgaard et al., 2007).

It is preferable for the participants to be familiar with some common test procedure and sensory acuity rather than heavy training in discrimination tests. An adequate sample size, to be able to document clear sensory differences, when performing discrimination tests is 25-40 participants. Nevertheless, some discrimination tests can be performed with as few as six participants if differences between samples are large. Some of the most commonly used techniques of discrimination test are: the triangle test, the duo-trio test and the paired comparison test (Lawless and Heymann, 2010). The overall difference test includes triangle test and the duo-trio test while paired comparison test is an example of an attribute difference test (Meilgaard et al., 2007). In the triangle test one odd sample will be asked to be identified from the three samples blind folded. In the duo-trio test, one reference sample will be evaluated and then participants are asked to identify the sample that matches to the reference sample. In the paired comparison test the participants are asked to tell the sample which is

better in a given sensory attribute, e.g. the sweetest (Lawless and Heymann, 2010).

Descriptive analysis is the most informative and comprehensive, giving a lot of detailed information (Lawless and Heymann, 2010). Descriptive analysis answer the question: "how do products differ in specific sensory characteristics?" and comprises detection and description of both qualitative and quantitative aspects of a product (Meilgaard et al., 2007).

In descriptive analysis, the evaluation questionnaire should be uniquely constructed to suite the product and the question to be answered. Unlike discrimination analysis, here a well-trained panel is always used. The test demands an individual with average to good sensory acuity (Lawless and Heymann, 2010; Meilgaard et al., 2007). When performing descriptive analysis, the panelists must put their personal preferences aside and work as an instrument by focusing on specifying what attributes that are present and at what extent (Lawless and Heymann, 2010). Descriptive analysis demands a sample size of 8-12 participants. However, it is preferable for the researcher to use a sample size up to 100 participants for products with small sensory difference (Meilgaard et al., 2007).

The advantage of descriptive analysis is to characterize a wide variety of product changes and give a detailed specification of a product's sensory attributes and to see exactly how the own product and the competitor product differ in the sensory dimension as well as to identify the sensory problem to be improved. However since it is expensive, they are not commonly used in the day-to-day quality control, but mostly used when troubled with major consumer complains. The spectrum descriptive analysis method, the profile attribute analysis test, the texture profile test and the sensory spectrum procedure are some common examples of descriptive analysis (Meilgaard et al, 2007; Lawless and Heymann, 2010).

Affective analysis is also used to quantify the consumer preference or degree of liking/disliking of a product to evaluate personal response of preference or acceptance from potential consumers concerning a product (Lawless and Classen, 1993). Thus, affective analysis gives answers to: "how well are the product liked or which product

is preferred?" In affective tests, assessors should be untrained and are representative of consuming population. The participants in an affective test should regularly use the product and be familiar with similar products. This makes the participants to frame of reference and thereby can compare the product with similar products that they have tried. It also makes sure that the participants possess reasonable expectations on the product. Consumer often react immediate and perceive the product as a whole pattern, without considering different attributes in detail or putting a great deal of thought into the evaluation. This integrated way of evaluating a product is expressed in liking or disliking of the product (Lawless and Heymann, 2010). An adequate sample size in performing affective tests is around 75-150 individuals (Lawless and Heymann, 2010), or even larger; 100-500 participants because of high variability of individual preference (Meilgaard et al., 2007). The preference of individuals can differ in many different ways and reasons like personal background, experiences, culture, attitudes and habits.

The affective tests are divided into preference tests, acceptance tests and hedonic tests (Watts et al., 1989). Preference tests allow a consumer to express a choice between samples based on preference for one sample over the others. Acceptance tests are used to determine the degree of consumer acceptance for a product by ranking tests and paired comparison tests and hedonic tests measures the degree of liking for the product.

As pointed above another classification criterion is based on testing site or environment in which assessment is conducted (Meilgaard et al., 2007).

Central location test is a way of conducting preference test by assembling potential users of a product in one central place, may be a school, church or in a hall. The products are prepared out of sight and served on uniform plates uniquely labeled. The potential assessors then asked to taste the products and decide their level of likeness. In central location test, conditions are favorable for a high return of responses from a large sample size as the product is usually tested under conditions that are artificial in comparison to normal use at home or in parties or in restaurants (Meilgaard et al., 2007). As central location test is conducted where many potential customers

congregate, its advantages includes lower cost, higher percentage of returned responses and several products may be tested at once. Despite these advantages, the number of questions may be limited so less information is obtained and product is assessed under relatively artificial controlled conditions as compared to normal conditions at home.

Laboratory tests are a technique of conducting sensory testing in a room where temperatures and light are controlled. Color and other visual aspects that may not be fully under control though a prototype can be masked so that subjects can concentrate on the differences in flavor or texture under investigation. Triangular test with blind folded taste is ideal example of this method. An advantage with this methodology is that, product preparation and presentation can be carefully controlled. Moreover, instances where there is a difference in the color of products being tested, but not one of the factors to be tested, the color of the products can be masked so that the subjects wholly concentrate on the other factors (Meilgaard et al., 2007).

Home use taste is a technique in which the product is prepared and tested under its natural conditions of use at home. Unlike central location taste where a product is prepared by one person and tasted by several people, in home use taste every household prepares the product according to their normal way and the respondents have repeated use of the product before the evaluation. When two products are being evaluated, the households are given one product first, which they use for four to seven days. Its corresponding score sheet is completed, after which the second product is supplied and tasted (Meilgaard et al., 2007). Home use test is preferred to the central location test by its two main features. The first is because it uses natural use conditions for product assessment at home. Secondly, the evaluation has sufficient time to thoroughly evaluate the product rather than the first impression as the central location test. However, home use test has also its own drawbacks. It is time consuming and expensive and has high possibility for unreturned responses. On other hands, participates less respondents or smaller sample sets than central location test

due to its time consuming feature. The family opinion may also be influenced by another family decision thus information influence has to be taken into account in home use test (Ratanatriwong et al., 2006). Home use test in which response of the evaluators is given immediately after testing at home is said to be modified home use test (MHUT).

2.1.3 DETERMINANTS OF CONSUMERS FOOD CHOICE AND PREFERENCE

Different factor determines individual's food choice and preference. They are broadly classified in to biological, personal, psychological and cultural factors. Those factors were elaborated by different experts with their own detail reasons shown below.

Biological factors

Factors related to genetic age group, gender, physiological behavior of human beings are said to be biological factors. Biological factors particularly related to how we perceive the basic tastes: sweet, sour, bitter, salty and umami which, together with odor and texture, constitutes the vast array of flavors found in foods (Garcia-Bailo et al., 2009). Age and body weight have been identified as major biological factors affecting food consumption behavior (De Graaf, 1992). Steiner (1979) found that newborns like sweet stimuli and reject bitter stimuli. However, preference for tasty foods decline with age since taste alone guides children`s food preferences and nutritional believes and related factors guides adults` food preference (Drewnowski, 1997). Different factors affects adults` food acceptance while liking alone determine children food preference (Cooke & Wardle, 2005) since children do not eat what they do not like.

Aging process is also a biological factor which affects food preferences. Olfactory sensitivity declines with age which drove elders to prefer less tasty foods (Cowart, 1981). Health and nutritional disorders together with the drugs prescribed to treat them can affect sensory performance. Stress can also influence sensory acuity as can the time of day (Sarah et al, 2009). On other hands, body weight increases food

consumption. This implies obese people may have greater appetite than lean people, thus perpetuating their overweight (Blundell, Hill, and Rogers 1988).

Psychological factors

The second factor, psychological factor, is related to experience and learning behavior. Learned behavior which might be conscious or unconscious is the result of taste experience. Food preferences are a typical example of learned behavior that occurs unconsciously. Learning and experience related to food occurs during the first 5 years of life (Köster, 2009).

There are three psychological reasons why an individual accept or reject food. Those are sensory affective, anticipated consequences and ideational. The results of those psychological reasons yield four types of rejection/acceptance: distaste/good taste, danger/beneficial, inappropriate/appropriate, and disgust/ trans-valued (Rozin, Pelchat and Fallon, 1986). This variation in food preference based on those factors develops culture (Rozin et al., 1986) and leads to rejection of the food when they imply danger (social rejection) and to acceptance of foods when they are beneficial (social acceptance). On other hands, acceptance or rejection of food results from our idea or knowledge of what they are or where they come from.

Costell et al., (2010) also suggests that liking and preference of a particular food might also result from habitual consumption of the food which makes them preferred over equivalent products (Mela, 1999). Another psychological factor to determine food acceptance and preference is expectation towards sensory or hedonic characteristics (Costell et al., 2010) which is resulted from product information and cues regarding product branding. For instance; using more luxurious containers may lead assessors to think products are of higher quality (Sarah et al; 2009). This suggests strong correlation between information received before tasting a food product and hedonic ratings. Consumers` brand knowledge affects the food preference and acceptance positively since directly related to our expectations or experiences for the product (Lawless & Heymann, 2010).

Personal factors

Personality characteristics also affect consumer perception and preferences for food (Jaeger et al., 1998). Private body consciousness is an individual measure of inner body awareness and subjects might be classified as either high or low in private body consciousness. The subjects are classified based on several factors such as sensitivity to changes in body temperature, internal tensions, heart rate, dryness of mouth and throat, and hunger sensations.

Goldberg & Strycker (2002) found that individuals who substitute low-fat food for high-fat food tend to describe themselves in terms that reflect dutifulness, orderliness and conscientiousness and people who avoid foods flavored with fat tended to describe themselves in terms of quickness, alertness and other aspects of intellect. Further, people who try to avoid non-meat types of fat describe themselves in terms of morality, cooperativeness, dutifulness and purposefulness and who consumes fiber rich foods tended to describe themselves in terms of openness to experience which includes imagination, reflection, quickness and poise. Another common personality variables affect our food preference are variety seeking and quality-consciousness. According to Steenkamp and Baumgartner (1992) if a consumer offered variety of food and a single most favored food, he/she select the variety of food presented. Thus, the preference of variety is influential because of attractiveness. However its attractiveness diminishes if it is presented at each meal.

Cultural factors

Cultural factors are factors related to a sort of collective memory that influence individual behaviors. It is related to the environment that is geography, climate and availability of different plant and animal species. Culture is also related to ritual and belief systems and community and family structure which incorporate the degree of innovation, mechanization and experimentation in the society. The degree of mobility which can affect food input exchange in a society or consumer groups may impact the food culture. The historical, economic and political strata within culture also affect

consumers' food choices and preferences (Wright et al., 2000).

Bourdieu (1995) believes that social class affect individual`s food preference. He argued that food consumption determines social, individual, knowledge, aesthetic and value strata and class found among the community. Therefore, liking or disliking alone cannot determine food choice and preference rather habits, attitudes and value exist in the society have huge impact on food preference (Mela, 1999). He also believed that demographic factors such as age, gender, income and level of education also determine individual`s food preference and choice. The level of education, for example, will arguably affect what type of social milieu you inhabit, and then again affect what type of food you are exposed to. The difference in food preference among urban and rural is higher than the preference exists among cities in different countries because of high food supply and availability, and familiarity. Openness of food market result this difference in food preference among urban and rural (Risvik et al., 2006; Jaeger et al., 1998).

On other hands, females prefer to consume vegetables than the men do (Cooke & Wardle, 2005). According to Beardsworth (2002), women are sensitive to moral and ethical concepts to consume animal food than men which drove them to prefer to consume vegetables. Cooke and Wardle (2005) also revealed that females prefer to eat fresh fruit and avoid eating red meat while males prefer to consume crisps, fried foods and processed meat. The possible reasons raised on this regard were females opt to lose weight and feel guilt related to eating which is socially grounded and males more energy requirement which is grounded biologically.

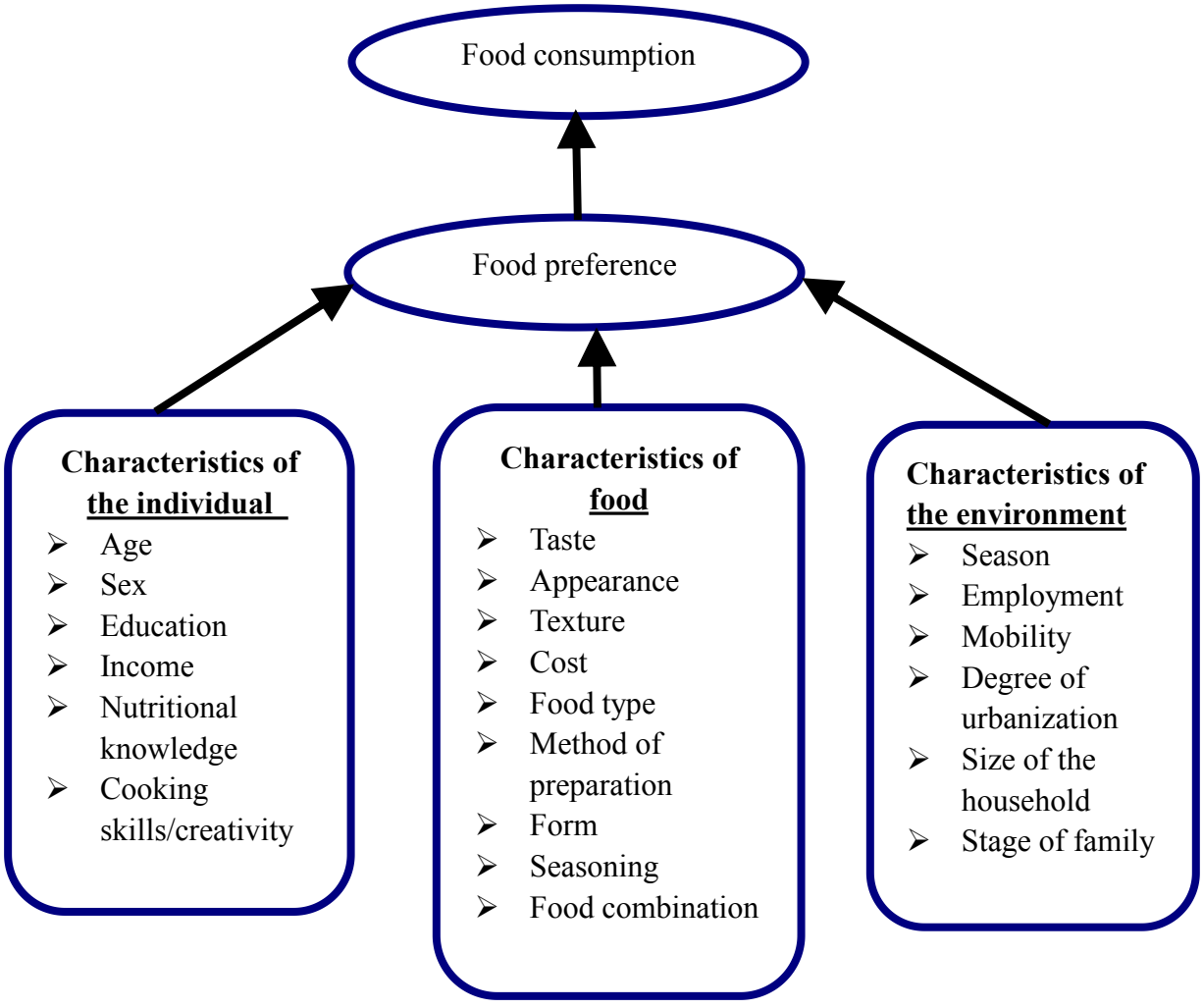
Age also affects food preference according to Goldberg & Strycker (2002). They found that older consumers ate more fiber-rich foods than the younger ones.

What we eat, how it is prepared, the rules and meanings which permeate every aspect of food consumption practices, etc. are all socio-cultural matters, irrespective of their biological, psychological, or economic dimensions which they clearly possess (Fischler, 1988). Moreover, it is believed that adults` food preference is determined by its culture and ethnic group (Rozin et al., 1986). Food preference is adopted culturally based set of beliefs and attitudes about objects in the world with respect to

their edibility. However, believe did not determine its edibility even if the item is considered as food culturally, for instance, pork for Jews and Muslims and beef for Hindus (Fischler, 1988). Price of the product is one of the economic factors that determine its acceptability. The haves have high range of food selection while the non-haves have limited to low cost foods such as cereals (Furst et al., 1996: 254).

Randall and Sanjur (1984) described factors related to food preference partly similar to Khan (1981). Accordingly, individual characteristics, food characteristics and environment are the main factors. See **figure 3 and 4** below.

Figure 3: Factors affect food preference (Randall and Sanjur: 1984)

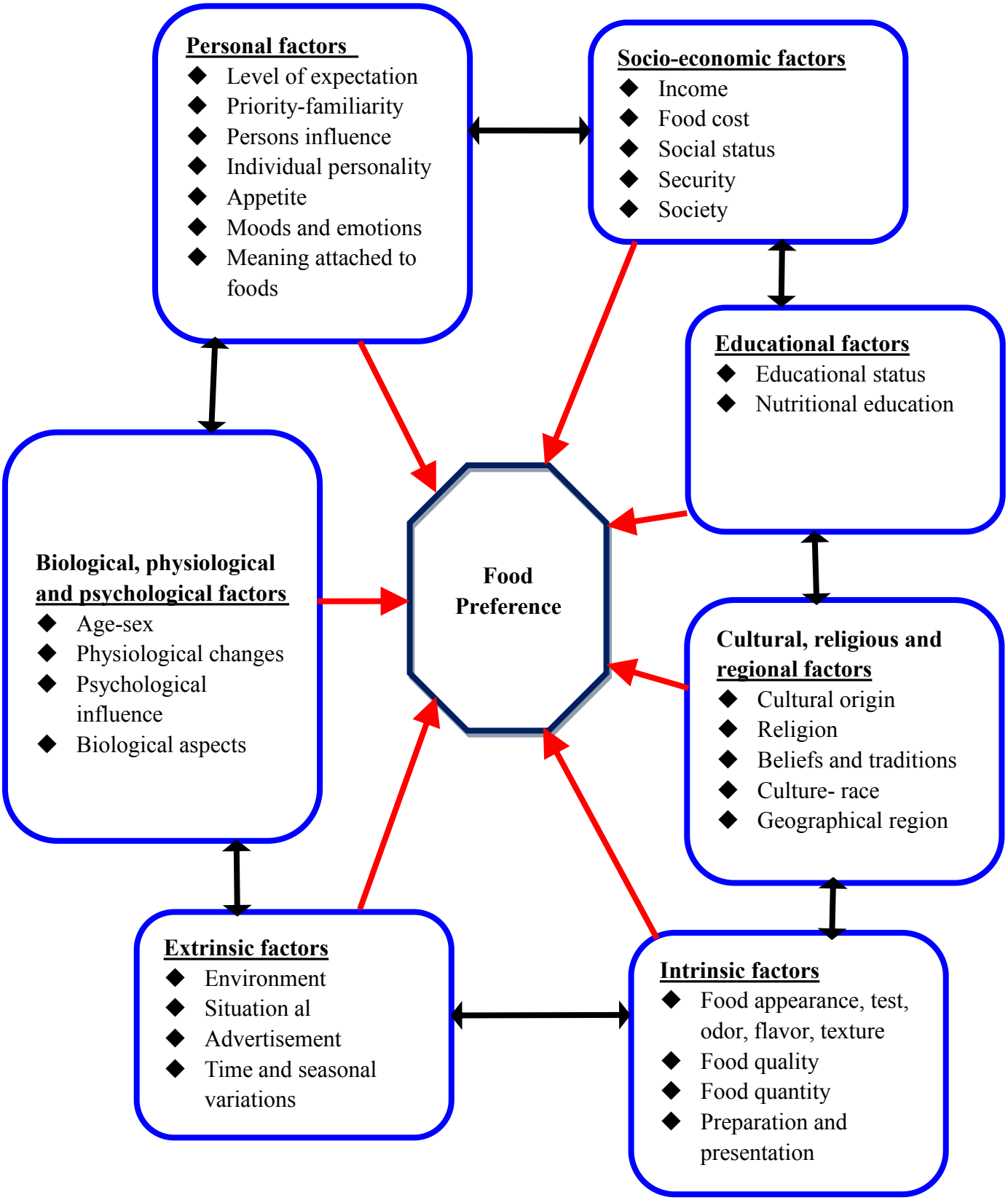


Source: Randall and Sanjur (1984)

Khan (1981) also summarized factors that affect food preference. It was shown that personal, socio-economic, educational biological, physiological, psychological

cultural, religious, and extrinsic and intrinsic factors were main factors.

Figure 4: Summary of factors influence food preference (Khan, 1981)



Source: Khan (1981)

2.1.4 WILLINGNESS TO PAY

Economists, psychologists and marketers are interested in determining the monetary value of non-market goods for a variety of reasons: to carry out cost-benefit analysis, to determine the welfare effects of technological innovation or public policy, to forecast new product success, and to understand individual and consumer behavior (Lusk and Shogren, 2007: 1).

Willingness to pay (WTP) is defined as the maximum price a buyer accepts to pay for a given quantity of goods or services (Wertenbroch and Skiera, 2002). The WTP function identifies the price an individual is willing to pay for a given level of quality, q, given specific levels of price p and utility U (Lusk and Hudson, 2004). Elicitation of WTP is carried out for products in which a market does not yet exist and it is an indicator of the value or quality of the commodity and a determinant of the incentives for product innovation.

Marbeau (1987) distinguishes measurements of WTP as monadic tests and competitive tests. In the former, price information is elicited without considering a competitive context. In the latter, a competitive context is present. Nagle and Holden (2002) also classify techniques for measuring price sensitivity at the highest level into uncontrolled and experimentally controlled measurement of the variables.

Breidert, Hahsler and Reutterer (2006) summarized price eliciting mechanisms in to two main classes: revealed preference and stated preference. The revealed preference method includes market data and experiments which embraces field and laboratory experiments and experimental auctions as a sub division. The stated preference method embraces direct survey and indirect survey and contingent analysis, conjoint analysis and other subdivisions. Direct survey is the system through which respondents are asked to state how much they would be willing to pay for some product. In indirect surveys, willingness to pay will be elicited after some sort of rating or ranking of the product. Conjoint analysis and discrete choice (contingent) analysis are examples of indirect surveying methods (Breidert et al, 2006). Both

conjoint analysis and contingent analysis can be used to calculate both WTP and price elasticity despite basic differences.

In conjoint analysis, the interest lies in revealing compromises made between different product attributes, including price (Kohli and Mahajan, 1991). WTP is derived from evaluations of alternatives: ranking or rating, expression of a preference or choice. It is based on the principle that consumers evaluate the value of a product by combining the separate amounts of value provided by each attribute. In a choice-based conjoint framework, consumers are typically confronted with a choice between alternative products, defined by several attributes such as price and quality (Lusk and Hudson, 2004). The consumers are then asked to choose which product they would purchase, given several product descriptions.

Calculation of WTP is based on simulation of a real market that enables determination of the price at which the product studied is no longer selected over a competitor, using the utility function of the consumer, which can take on different forms depending on the hypotheses formulated by the analyst (Ben-Akiva and Lerman, 1985). WTP can also be expressed directly as the sum of money that leaves respondents indifferent between the product and the money offered (Kalish and Nelson, 1991; Jedidi and Zhang, 2002). However, conjoint analysis is not free from hypothetical bias. This type of bias appears during response collection through questionnaire. The respondent does not take into consideration all the constraints that would affect his choice in a real situation like budget available, financial consequences of a poor choice, availability of the product or competitor's products. Those constraints accompany difference in what the respondent says and what he would accept to pay in a real situation.

Contingent valuation was originally used to value environmental and public goods but has been extended to the determination of WTP for private goods especially those goods in which a market does not yet exist. The method usually requires the use of surveys or questionnaires to elicit the WTP bids. The questionnaires could employ either open-ended or close-ended questions. Single-bounded and double-bounded

dichotomous choice questions have been frequently used to estimate the value of non-market goods and novel food products (Lusk and Hudson, 2004).

In contingent analysis, a method developed in economics (Mitchell and Carson, 1989), respondents are required to directly express his/her WTP for a product–open-ended contingent valuation; for instance "Please indicate the highest price you would accept to pay for this offer" or answer several successive questions on whether he would or would not buy the product at a given price–closed-ended contingent valuation; for instance "Would you be willing to pay X dollars for this offer?"

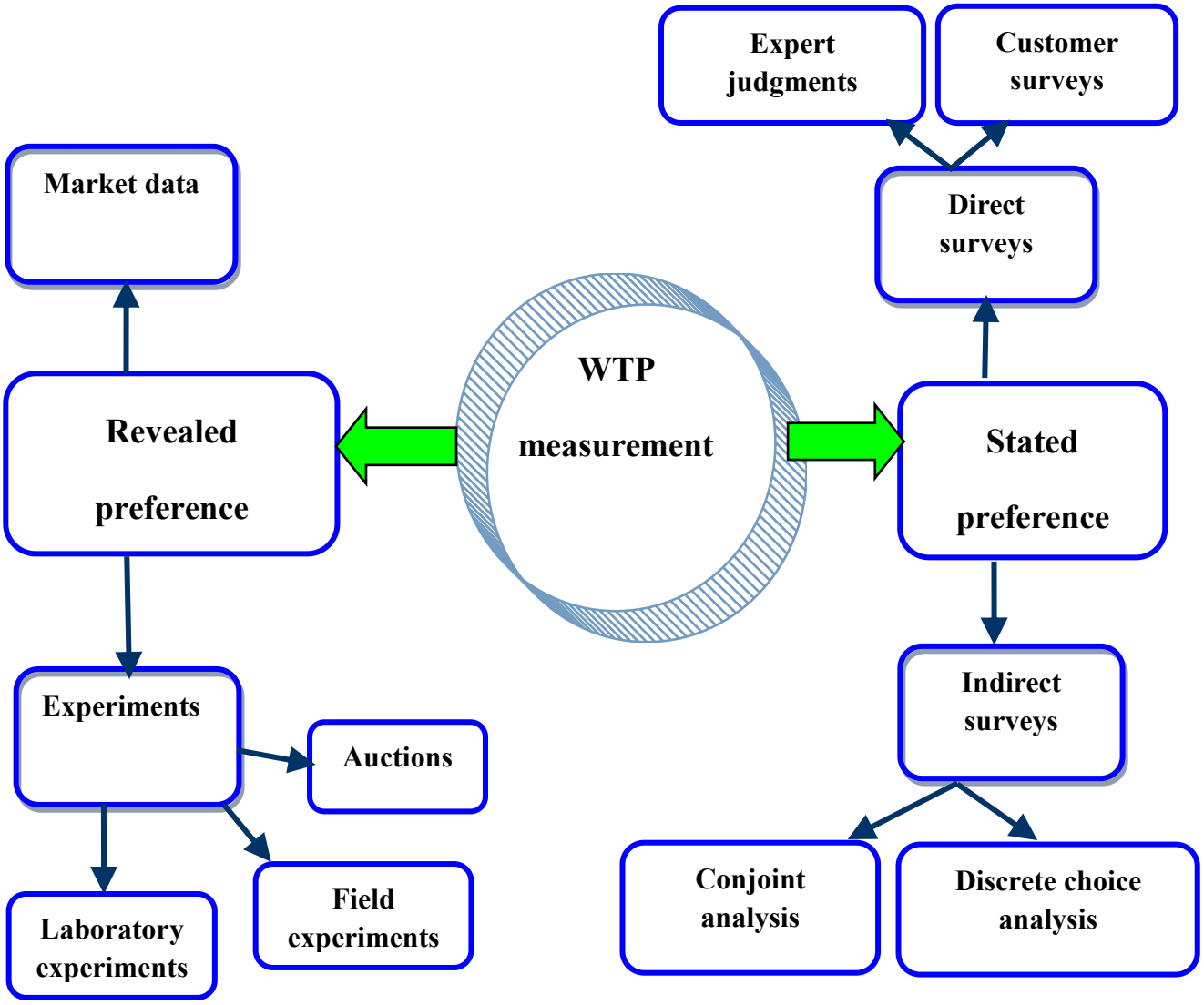
Despite its simplicity to reveal the true WTP (Wertenbroch and Skiera, 2002), it is also not free from hypothetical bias as the conjoint analysis and strategic bias in addition because we are further from the reality when we are tried to elicit WTP without real purchase of the product and deciding own price using open-ended questions. A strategic bias which appears when respondents deliberately formulate their answers to influence the outcome of the survey to further their own interests affects the results. Thus, respondents tend either to overestimate WTP (to influence the launch of the product or service on the market or please the interviewer) or to underestimate it (to push the price down).

Experiments are also one of the systems to elicit WTP and can be divided into laboratory experiments, field experiments and experimental auctions. Laboratory experiment is a system in which an amount of money is given to purchasers as simulation and his/her willingness to spend for specific goods is asked. The result of the experiment is obtained quickly. The goods and prices are varied systematically. The major drawback of this system is the non-biotic context of investigation meaning; the subjects are aware of the experimental situation. This might lead to subjects becoming more rational of their purchase behavior compared to their normal shopping behavior which can lead to low external validity (Nessim and Dodge, 1995, p.74). Another source of bias might be the artificial setup as described above, in which the subjects either do not take real possession of the "purchased" goods, or do not use their own money (Nagle and Holden, 2002; p. 341).

Field experiments or in-store purchase experiments are performed in real world shopping environment thus do not suffer from the problem of the artificial setup. Depending on the experimental conditions, the respondents are aware of participating in an experiment or not. Field experiments are often conducted in form of so called test markets. In different test markets the prices are systematically varied and the consumers' responses are analyzed. A crucial issue in test market analysis is to select small scaled market environments that are representative for the target market under investigation. The drawback of this system is seen in terms of the laboratory test. The system needs higher expenditures and the longer time intervals entailed by monitoring market responses to price changes as compared to laboratory experiment (Nagle and Holden 2002 p. 341).

Another division and special applications of experiments are auctions which can be carried out as laboratory or field experiments. Experimental auctions may be conducted in one of two ways: consumers can be provided with a pre-existing good and then asked to bid to exchange their endowed good for a novel good or consumers can bid directly on several competing goods and a random drawing can be used to determine which good is binding so that the demand for a single unit can be elicited (Lusk and Hudson, 2004). The need for an auction is to gain knowledge of consumers' evaluations of a product or brand. If the true monetary evaluation of a product as perceived by the customer was known, there would be no need for an auction. The offering party would simply sell the good to the bidder with the highest valuation at a price close or equal to that valuation. However, if the seller is uncertain about customers' valuations, an auction can provide valuable insights to sell the item at a fair price.

Figure 5: Summary of methods to measure willingness-to-pay.



Source: Christoph Breidert, Michael Hahsler, Thomas Reutterer (2006)

Researchers use different auction mechanisms to elicit WTP based on their product and their goal set. One of the most important tasks in implementation of experimental auction is decision of which mechanism to employ. The most important factor to consider in this regard is the incentive compatibility of the auction mechanism. An auction mechanism is considered theoretically incentive compatible if an individual's dominant strategy is to bid in such a manner that valuations are truthfully revealed.

In incentive compatible methods, there is no gain from strategic bidding because the market price is independent of a participant's bid. Submitting the bid less than their true value reduce their chances of winning the auctioned good at a potentially

profitable price while submitting a bid more than their true value give the bidder a greater probability of winning, but paying a price that is in excess of what they are willing to pay to obtain the good. Not expressing the true value in incentive compatible auctions may drive the bidders not to benefit but to lose. Hence, bidders in an incentive compatible auction will always be expected to express their true value for the product which encourages the researcher to have accurate data (Nalley et al., 2004:8). The most commonly used auction mechanisms are: ascending bid, second price, vickrey second price, random n^{th} price, first price, fifth price, English, Becker-Dee Groote-Marschak (BDM) and Combinatorial private-collective auctions. Among them English auctions, Vickrey or second price auction, random n^{th} price auction and BDM are theoretically incentive compatible auctions (Lusk et al., 2004:391).

English auction is the most commonly used auction mechanism. Levin, Kagel and Richard (1996) executed an irrevocable exit which is sometimes called ascending price auction or English clock. In this auction mechanism, auction price start at the lowest possible value, V for X_0 and increase continuously. Bidders actively participated on the bidding and individual will stop the game when he/she reached his/her own reservation price and at mean time bidders can observe their rivals drop out of the bidding. The one who is dropped out of the auction is not permitted to return to the game. In English auction, an auctioneer opens the auction at a relatively low price and the competitors offer ascending bids (signaling their willingness to stay in the auction as the prices increase). The auction ends when only one participant is willing to pay the current price and the individual wins the auction and pays the last price offered (Coppinger, Smith & Titus, 1980:3; Vickrey, 1961:10).

In this auction mechanism the profit the last bidder earns is the difference of the bid of the last bidder when dropped out and X_0. One of the main benefits of this auction mechanism is that bidders can understand their rivals' signal value from the drop-out price. According to Milgrom and Weber (1982), this type of auction was also common in Japan. The impact of information and how bidders use information in English auction was also studied by Levin, Kagel and Richard and finally they developed an

econometric model to show the impact. The Nash bidding model developed predicts that first drop-out price will signal the bidders to average their own signal value than intermediate drop-out prices. They also found that as more bidders dropped out, subjects placed less and less weight on their own signal and more weight on the last drop-out price (Kagel and Levin, 2008).

Vickrey or second-price auction is the second auction mechanism recognized as incentive compatible. In Vickrey auction, participants' bids are collected simultaneously and the highest bidder buys the product for the sum of the second-highest bid (Vickrey, 1961). Thus, underestimation of the offer by the bidders can influence the sale price.

The Vickrey auction takes place in sealed form and the purchase price is determined by the second highest bid. A participant in the auction submits a bid containing how much he or she would be willing to pay in sealed form, for example in a closed envelope. If the participant has the highest bid, he or she wins the auction. However, the participant only has to pay the price of the second highest bid. In this mechanism, participants are provided an incentive to reveal their true valuation, because they must buy the good if their bid wins the auction (Vickrey, 1961).

Skiera and Revenstorff (1999) investigated the ability of Vickrey auctions to reveal consumers' WTP. After thorough explanation on the auction mechanism and optimal bidding strategy for students, they were asked whether they understood the mechanism through questionnaires. The result shows that, the subjects seemed to have a good understanding of the mechanism of the auction while the optimal bidding strategy (bid the true valuation) was less clear to the subjects which might be a problem for the method.

In a different experiment Sattler and Nitschke (2003) found that the Vickrey auctions in addition to the first-price auctions (auction where the highest bid wins) both tend to overestimate consumers' WTP. The authors concluded that this overestimation problem was due to the overbidding phenomenon. The overbidding phenomenon occurs when bidders strategically place bids above their true WTP to increase their chance of winning (Kagel et al., 1987).

The random n^{th} price as like as the Vickrey or second price auctions is a situation in which all bidders simultaneously submit sealed bids and the highest bidder wins. That is why the methods are known as sealed-bids. The winner or winners can either pay the second highest bid submitted (Vickrey or second-price auction), or a randomly assigned bid out of all bids (random n^{th} price auction). There is one winner in the second-price auction and (n-1) winners in the n^{th} price auction. For instance, if the monitor randomly selects n = 4, the three highest bidders each purchase one unit of the good priced at the fourth-highest bid. Ex-ante, bidders have low or moderate valuations now have a nontrivial chance to buy the good because the price is determined randomly. This auction increases the probability that dishonest bidding will be costly. The market price in the case of Vickrey or second-price auction is the second highest bid, whereas for the random n^{th} price auction it is the n^{th} bid (Shogren et al., 2001:410; Vickrey, 1961:10).

The key characteristic of the random n^{th} price auction is a random but endogenously determined market-clearing price. Randomness is used to give all participants a positive probability of being a purchaser of the auctioned good; the endogenous price guarantees the market-clearing price is related to the bidders' private values.

Becker-De Groote-Marschak or BDM Lotteries is an auction mechanism in which bidders/participants/ submits an offer price to purchase a product simultaneously. Each participant sets a maximum price for the product offered. A randomly drawn price (for example, by drawing a ball with the price marked on it from an urn) from a distribution of prices will be a selling price in this mechanism. The possible prices cover an interval from zero to a price greater than the anticipated maximum price, which any bidder would submit. The bidders whose bids are greater than the sale price receive a unit of the good and pay an amount equal to the sale price; otherwise the participant cannot buy the product (Becker, De Groote & Marschak, 1964:227). Two things differs BDM mechanism from other incentive compatible methods. First, a participant bid is compared to the randomly generated number rather than with one another (Becker et al., 1964: 228). Second, although BDM auctions in groups are possible and have been reported, the BDM approach can be executed individually,

which may be more convenient for researchers (Monchuk et al., 2007:96).

The BDM procedure was tested by a number of researchers for its ability to forecast WTP. Wertenbroch and Skiera (2002) tested it together with a Vickrey auction in a field experiment with a purchase obligation for the participants. The participants of the experiment easily understood the BDM method and hardly any of the approached individuals refused to participate. Validity was determined by relating the estimated WTP to data from an additional questionnaire asking the respondents to rate their desire of the tested products. After the experiment, the participants rated how satisfied they were with their purchase. The buyers as well as the non-buyers were extremely satisfied with the outcome of the BDM experiment. This result indicates that BDM does not suffer from the overbidding bias, which is found in Vickrey auctions. BDM mechanism is more efficient and faster to implement (De Groote et al., 2010:4) as compared to Vickrey auctions.

Vickrey auctions and BDM lotteries place participants in a situation where their bids cannot influence the sale price. Theoretically, a rational bidder is encouraged to reveal his real WTP, thus limiting the occurrence of strategic bias (McAfee and McMillan, 1987; Shogren et al 2001). Another major advantage of this procedure is they can be applied to real choice situations, notably the point of sale (Wertenbroch and Skiera, 2002).

In a study published by Noussair et al. (2004), the Vickrey auction is compared with the BDM mechanism, with the aim to test which method converges towards the optimal bidding strategy (bidding the true valuation) more rapidly. The authors found that under the Vickrey auction the bias from the true valuation is more rapidly reduced and the dispersion of bids is narrowed down more rapidly. That is, the subjects learn the best bidding strategy more quickly. The authors argue that the reason for this difference lies in the fact that a deviation from the optimal strategy is more costly under the Vickrey auction than under the BDM mechanism. With respect to these results Noussair et al., (2004) concluded that Vickrey auctions are superior to the BDM procedure for elicitation of WTP towards private goods. Berry et al., (2012) also tried to investigate whether BDM provides an accurate measure of an individual's

willingness to pay comparing with take-it-or-leave-it method through the sales of point-of-use water filters in Ghana. They found the usefulness of BDM in measuring heterogeneous treatment effects and testing for screening and sunk-cost effects.

Table 2: Summary of the incentive compatible auction mechanisms

Descriptions	**Vickrey/Second price auction**	**Random n^{th} price auction**	**English auction**	**BDM auction**
Participant procedure	Simultaneously submit sealed bids	Simultaneously submit sealed bids	Sequentially offer ascending bid	Simultaneously submit sealed bids
Winning bidder	Participant with the highest bid	All participants with bid greater than a randomly drawn (n^{th}) bid	Participant who offer the last bid	All participants with bid greater than a randomly drawn bid
Number of winners	1	n-1	1	0 to all participants
Market price	Second highest bid	n^{th} highest bid	Last bid offered	Randomly drawn price
Market feedback	Yes, with multiple rounds	Yes, with multiple rounds	Yes	No
❖ Source	Vickrey 1961 and Shogren et al., 2001b	Shogren et al., 2001b	Vickrey, 1961 Coppinger, Smith and Titus (1980)	Becker, De Groote, Marschak(1964) Irwin et al.,(1998)

2.2 EMPIRICAL LITERATURE

2.2.1 TRENDS ON SENSORY TESTING OF FOOD

Studying consumption characteristics of new varieties is a relatively new area in adoption research in Africa since most of the research attention was on support of agronomic characteristics of new varieties. Here are some trends on sensory test preference of researchers in different countries on different commodities.

Central location test was used in USA to evaluate acceptance of corn chips by urban consumers. About 305 adults were participated to test eight types of commercial corn chips using a seven-point category scale. The finding shows that the purchase of the

corn chips was highly driven by the degree of liking of the corn flavor, saltiness and greasiness. Health issues related to the consumers' attitudes towards the level of fat in the diet came second in the order of importance of factors that they considered when choosing the corn chips (Tepper & Trail, 1998:270).

Ouma et al., (2006) also used central location test to evaluate g*itheri* made from conventional and QPM maize in Kenya. The participants received a small plastic dish with a sample of one *githeri* mixtures at a time. They were asked to taste the first sample, and evaluate for all the criteria (taste, appearance, texture, overall) on a five level scale. The finding show that overall QPM based "g*itheri*" was more preferred than conventional based food preparation. The QPM based preparation was also better in taste and texture than the control. However, on appearance, QPM based preparation was perceived to be equal to the control.

Central location test was used in Tanzania to evaluate the flavor profile and consumer acceptability of four sweet potato cultivars that differed in β-carotene content. The study was undertaken with 94 school children and 59 mothers with preschool children between two cultivars of orange fleshed sweet potatoes and the other two of pale-fleshed sweet potatoes. The study found that the orange fleshed sweet potatoes and pale-fleshed sweet potatoes have distinct differences in sensory profile. Accordingly, the former was more acceptable than the traditional cultivars used in that study. However, Mothers, ranked orange fleshed sweet potatoes higher than did the preschool children (Tomlins et al, 2007: 2440).

Central location test was used in Ghana to evaluate consumer acceptance and affordability of prototype parboiled rice in relation to three local samples and a high-value imported one. The study participated 300 consumers in three urban centers and revealed that the new rice variety (prototype parboiled rice) was very acceptable among the urban consumers of Ghana, and it had a similar flavor profile to high-value imported parboiled rice (Tomlins et al, 2007:1567-1574).

In Mozambique, a study on consumer acceptance of pro-vitamin-A bio fortified maize was undertaken in a market place, with 201 urban consumers participating in the sensory evaluation of maize meal stiff porridge. The results indicated that the bio

fortified maize was acceptable to many consumers in Maputo, and they were willing to trade local white maize meal for meal from the bio fortified maize (Stevens & Winter-Nelson, 2008:346).

About 279 households participated on home use test and 208 rural consumers participated on central location test for the study on acceptability of pro-vitamin-A orange maize undertaken to determine the consumer acceptance of bio fortified maize in rural Zambia (Meenakshi et al., 2010:12-16). The results from both central location test and home-use test revealed that orange maize was liked by the rural consumers in Zambia and the negative perception of yellow maize did not affect the acceptability of orange maize. Moreover, similar findings from home use testing and central location testing suggests that giving consumers more time to evaluate the product at home did not affect the outcome.

On the study in Tanzania, triangular test, modified home use test and central location test between conventional maize and QPM stiff porridge were conducted by 30, 30 and 120 assessors respectively. The result from both CLT and modified MHUT revealed that there was a significant score difference between QPM and conventional maize in all attributes except for appearance. Of the 30 respondents who participated in the triangle testing, 21 correctly identified the odd sample suggests that there was a significant sensory difference between QPM and conventional maize, at 1% level of significance (Kiria, 2010).

Five point likert scale (from 1= very poor, to 5=very good) test was used to evaluate the sensory difference of different maize varieties in Ghana. On the study, the participants were asked to evaluate *kenkey* made from three different maize varieties: a white, a yellow and an orange variety. *Kenkey* is the main maize preparation in Ghana. A piece of each of the three products was presented on a plate, and marked with a three-digit code, randomly assigned. Each participant was asked to evaluate the three products, one by one, in a randomly assigned order, for four characteristics: appearance, aroma, texture and taste, and also for overall acceptance. No participants scored any kenkey sample below 3 (average) on the overall evaluation, but strong regional differences. Only the difference between white and orange *kenkey* were

significant ($p<0.01$) (De Groote et al., 2010).

Talsma et al., (2013) conducted a study in Eastern Kenya to determine the sensory and cultural acceptability of pro-vitamin-A rich cassava. About 30 children (7-12 years) and 30 caretakers (18-45 years) from three primary schools were participated to examine sensory acceptability of pro-vitamin-A rich cassava by using replicated discrimination tests and paired preference tests. Additional 140 caretakers of children aged 6 to 12 years on one primary school were participated to identify cultural acceptability using questionnaire concerning theory of planned behavior and the health belief. The result shows both caretakers and children preferred pro-vitamin-A rich cassava over white cassava because of its sweet test, soft texture and attractive color. Knowledge about pro-vitamin A rich cassava and its relation to health, worries related to bitter taste and color and information about pro-vitamin-A rich cassava and recommendations from health workers were the best predictors of intention to consume pro-vitamin-A rich cassava.

In Ethiopia, the five-point scale was used to evaluate sensory preference of farmers between QPM and conventional maize varieties. The scores with the highest proportion of responses were "good" (30%) and "fair" (36%), with a similar proportion of "very poor" (4%), although with a substantially higher proportion of "very good" (24%). This distribution was similar across all criteria. The results of the short ordinal regression show that Ethiopian consumers had a strong preference for *Enjera*[8] made from *Teff*. This drop was measured by the coefficient of the binary variable "maize", indicating the use of a maize-*Teff* mixture as compared to *Enjera* from pure *Teff*, and was significant for all criteria, including overall evaluation, and independent of the maize proportion, either 50% or 80% (with 50% being the reference category). There was a substantial difference between the conventional varieties, however, with BH-540 scoring significantly better than Melkassa-2 on all criteria. When QPM instead of conventional maize is substituted for Teff, the drop in acceptance is less pronounced, as the significant coefficient for QPM. There is,

[8] fermented thin flat bread with evenly distributed pores

however, a big difference between the two QPM varieties, and BHQP-542 is substantially more appreciated than Melkassa-6Q. The last variety's scores are actually similar to those of BH-540 (De Groote et al., 2014).

Oparinde et.al, (2015) on their working paper used home use test to investigate consumers' evaluation of red iron bean and white iron bean varieties relative to a popular red mottled local variety in the rural areas of Rwanda's Northern Province. The result shows that participants` liking for the attributes of each of the iron bean varieties significantly increases their premium.

Home use-test was used to assess women`s and children`s acceptance of and preference for food from QPM in southern Ethiopia. The study participate 61 mothers aged 18-45 years old and children aged 7-24 months. The flour of QPM and CM was provided to consumers and was evaluated for one week and women were asked to rate their own and children`s liking and preference based on five-point scale for the six sensory characteristics including the overall. The result indicated that QPM based porridge was scored higher for its texture in hand and mouth, while its scores for appearance, aroma and taste were not statistically different from that of porridge made from conventional maize. Overall acceptance of the two varieties by both mothers and children was also not significantly different (Gunaratna et al., 2015).

2.2.2 TRENDS ON CONSUMERS WILLINGNESS TO PAY

Different types of auction mechanisms were used to elicit the WTP for different products on different countries. BDM mechanism was used in a study undertaken in the mid-western USA to elicit consumers WTP for tender steak. The study was undertaken with individual shoppers at three urban retail grocery stores between red (guaranteed tender) and blue (probably tough) with and without information (Lusk et al., 2001b:544). Results of the study showed that majority of the respondents preferred the tender stake but many were not willing to pay more to exchange their tough stake for a tender one.

Second-price or vickrey auction was used at the Ohio State University to elicit the willingness to pay for a new orange juice processed with the pulsed electric field

processing technology and also to find out whether the product tasting altered the consumers WTP (Chern, Kaneko & Tarakcioglu, 2003:9). A total of 27 students participated in bidding for four types of orange juice: unprocessed/fresh juice, pulsed electric field processed juice, pasteurized juice but not-from-concentrate and pasteurized juice from concentrate. The result shows consumers were willing to pay higher for unprocessed and pulsed electric field processed juices than the rest juices.

Vickrey or second-price auction procedure was used to elicit consumer WTP for food trace-ability information for the different types of products in Canada. Participants were given a beef sandwich, and had an opportunity to bid to exchange their sandwich for one with additional verifiable characteristics. Four alternative sandwiches were used in the auction: animal welfare assurance, meat that was traceable to the farm of origin, extra food safety assurance and a sandwich that combined all the three attributes. Consumers preferred products that have both trace-ability information and positive quality assurance (Hobbs, Bailey, Dickinson & Hangiri, and 2005:56).

In assessing rural consumer's WTP for orange bio fortified maize in Ghana the researchers used BDM method to elicit WTP. The result shows that a significant difference of WTP for yellow maize in Eastern region, and a marginal effect of WTP for orange in central and eastern region ($p< 0.2$) (De Groote et al., 2010).

BDM individual auction mechanism was used to elicit WTP by rural consumers in Kenya between yellow versus fortified maize meal. The consumers were presented with three types of maize meal: plain white, plain yellow and fortified white, then requested to bid for the different one (De Groote et al., 2010:4). This study revealed that Kenyan maize consumers were highly interested in nutritionally enhanced maize. Consumers were willing to pay a premium of 24% for maize fortified with minerals and vitamins. In addition, consumers from one of the study zones where yellow maize is most commonly preferred, showed higher preference for the yellow plain maize meal than white plain maize meal and were even willing to pay a premium of 4.9% for the yellow plain maize meal.

On the study in Tanzania, BDM mechanism had been used to elicit the WTP between conventional and QPM maize with and without information. The respondents who

received information on QPM were assumed to make their bids based on the affective test as well as on the information that QPM has a higher nutritional quality than conventional maize and is possibly based on previous knowledge of QPM. The result was an increase in WTP for QPM and a reduction in WTP for conventional maize. The information provided increased respondent's WTP for QPM by 5%, but it reduced their WTP for conventional maize by 10%, leading to an overall premium of 39% (De Groote et al., 2014).

Consumers WTP for red and white iron bean varieties relative to popular red mottled local variety was examined in rural areas of Rwanda using Becker-De Groote-Marschak (BDM) mechanism. The impact of information on participants` WTP of iron bean varieties was also investigated. The result indicated that without an information campaign about the nutritional benefits of iron bean varieties, the white iron bean variety was assessed at a large discount, compared with the local variety. In contrast, the red iron bean variety captures a large premium in the absence of information about its nutritional benefits revealing that; it can compete favorably with the popular local variety in the absence of information. However, providing information about the nutritional benefits of iron bean varieties significantly increases the participant premium for the red iron bean variety and significantly lowers the participant discount for the white iron bean variety (Oparinde et.al, 2015).

2.2.3 DETERMINANTS OF WILLINGNESS TO PAY

Failure in agricultural intensification which then leads to inefficiency and lower productivity is one of many problems of African agriculture demonstrated by different studies. The size of market and the use of fertilizer for instance were constrained by its high cost which did not considered the farmers' willingness to pay for it (Jayne et al., 2003). Thus, it is essential to know consumers' WTP for agricultural technologies and factors related to it among different consumers for future development of the technologies. However, different studies revealed that the magnitude of consumers' WTP for agricultural technologies and the type of payment vary with the nature of the technology. The studies related to willingness to pay for genetically modified crop and

QPM is very scant and it is reviewed as follows.

Kimenju and De Groote (2008) on their study in Kenya on consumer willingness to pay for genetically modified food indicated that consumer perceptions had an effect on WTP. Awareness and positive perceptions of the technology did not have significant effects. Negative perceptions, in particular perceived negative effects on health, had a clear negative effect on WTP. Trust in the government's ability to ensure food quality had a positive influence on WTP. Among socioeconomic factors, only income and education significantly influenced WTP. They affect positively meaning the higher the income and education level, the higher the WTP for genetically modified foods. Consumers' demographic characteristics such as age, gender, and presence of children had no significant effects on WTP according to the study.

The study in Tanzania on QPM by Kiria (2010) also shows that the age of the respondents positively and significantly related to WTP means that older people have higher WTP for both QPM and conventional maize flour and sensory quality of stiff porridge had a positive effect on WTP for maize flour. The result also witnessed that difference in WTP among different geographical locations.

2.3 CONCEPTUAL FRAMEWORK OF THE STUDY

2.3.1 CONSUMER CHOICE AND UTILITY THEORY

According to rational choice behavior, decision maker can rank possible alternatives in order of preference, and will always choose from these the option which he or she considers most desirable, given taste and the relevant constraints placed on the decision making (Domencich & McFadden, 1975). The theory of rational behavior assumes that for two products there is completeness in preference or there are three possibilities in the preference relation: either product A is preferred to product B, or product B is preferred to product A, or both product A and B are equally attractive. Consumers rank their preferences in order of possible situations from the least desirable to the most desirable. If a consumer prefers product A to product B, then it means that the level of utility derived from product A exceeds that from product B

(Nicholson, 2005:78). When a consumer is given a chance to evaluate the sensory characteristics of a product, perceiving these does not necessarily mean that he or she will or will not choose to consume it. Rather, it is an individual likes of specific attributes in a particular product that will be the determining factor. Among factors that affect consumer choice for food, the amount of chemicals it contains, such as protein or carbohydrate, is one of them. Others include marketing and economic variables, as well as social, cultural, religious and demographic factors (Shepherd, 1999).

2.3.2 THEORETICAL MODEL

Ordinal responses are common in market survey, opinion polls and consumer preferences (Coe, 2002). The response is rated based on arbitrary scale; a 5-point hedonic scale from 1=very bad to 5=very good. However, a product rated 4 is not necessarily twice as well liked as product rated 2. Let "u" indicates the general appreciation of maize varieties that falls in one of "*j"* order categories (1-5). If **u** is some cutoff which is labeled K_1, the respondent chooses the answer "very bad". If u is K_4 then the answer is "good" and the cut off goes up to K_{j-1} (Train, 2009). This is represented by the following general formula:

$y=j$ if $k_{j-1}<=u$

$y=1$ if $u<k_4$

$y=2$ if $k_4 \leq u \leq k_3$

$y=3$ if $k_3 \leq u \leq k_2$

$y=4$ if $k_2 \leq u \leq k_1$

$y=5$ if $k_1 \leq u$

Since the latent u is a continuous variable, regression technique can be used. The value of y (consumers' choice) is influenced by observed and non-observed factors. Hence, u can be decomposed in to observed and unobserved components (Train, 2009).

$u_i = \beta' x_i + \varepsilon_i$.....(1)

Where $\beta' x_i$ represent all observed factors such as income and gender while ε_i

represents unobserved factors. The cumulative density function of the standard logistic distribution is given by:

$$f(\varepsilon) = \frac{\exp(\in)}{1+\exp(\in)} \quad \text{.....(2)}$$

The distribution of unobserved factors determines the probability of the possible value of y; thus:

$P(y=1) = p(u<k_4)$

$= p(\beta'' x + \varepsilon < k_4)$

$= p(\varepsilon < k_4 - \beta'' x)$

$$= \frac{e^{k4-Bx}}{1+e^{k4-Bx}} \quad \text{..... (3)}$$

$P(y=2) = p(k_4 < u < k_3)$

$= P(k_4 < \beta'' x + \varepsilon < k_3)$

$= p(k_4 - \beta'' x < \varepsilon < k_3 - \beta'' x)$

$= p(\varepsilon < k_3 - \beta'' x) - p(\varepsilon < k_4 - \beta'' x)$

$$= \frac{e^{k3-Bx}}{1+e^{k3-Bx}} - \frac{e^{k4-Bx}}{1+e^{k4-Bx}}$$ and so forth (Train, 2009)

Even though the interpretation is cumbersome, the coefficients quantify the effect of explanatory variables on consumer's preference. However, it is much easier if the odds of the cumulative probabilities are considered. The odds of an event occurring is estimated as the probability that the event occurs/success/ divided by the probability that the event does not occur/failure/ (Agresti, 1996). Mathematically indicated as:

$$\text{Odds} = \frac{prob(q)}{1-prob(q)} \quad \text{..... (4)}$$

For instance the odds of highest score to occur (score=5) will be:

$$\text{Odds (y=5)} = \frac{prob(y=5)}{1-prob(y=5)}$$; then the cumulative odds ratio is equal to the odds that a score y falls at or below a certain level of *j*.

$$\text{Cumulative odds} = \frac{prob(y \le j)}{1-prob(y \le j)} \quad \text{..... (5)}$$

But; $\frac{prob(y \le j)}{1 - prob(y \le j)} = \frac{e^{kj - B'x}}{1 + e^{kj - B'x}} / \frac{1 - e^{kj - B'x}}{1 + e^{kj - B'x}}$

$$= \frac{-e^{kj - B'x}}{1 + e^{kj - B'x}}$$

$$= \frac{e^{kj - B'x}}{1 + e^{kj - B'x}} * \frac{1 + e^{kj - B'x}}{1}$$

$$= e^{kj - B'x}$$

Taking the natural log of both sides, the log of cumulative odds ratio is found to be the linear function of independent variables;

$$\text{Ln}\left(\frac{prob(y \le j)}{1 - prob(y \le j)}\right) = \text{Ln}\left(e^{kj - B'x}\right)$$

$$= kj - B'x \quad \text{..... (6)}$$

The effect of change in variable X can be calculated from equation (6) above. For example, when X changes from x_3 to x_4 the effect of the change can be calculated as:

$$\textbf{Ln}\left(\frac{p(y \le j / x = x_4) \,/\, 1 - p(y \le j / x = x_4)}{p(y \le j / x = x_3) \,/\, 1 - p(y \le j / x = x_3)}\right)$$

$$= \beta' x_4 - x_3 \quad \text{..... (7)}$$

The coefficient β can be interpreted as the change in the log of odds ratio for a unit change in the explanatory variable x. If the independent variable x is a binary variable, such as maize variety when only two maize varieties are present, the interpretation of the coefficient β becomes different. In such a case, β will represent the change in the log's odds, which is mathematically explained as the log of the ratio of the odds of that variety having a high score rather than a low score to the odds of control variety having a high score rather than low. This ratio is called the log odds ratio. The exponential of the log odds ratio ($e^{\beta i}$) represents the odds that one technology is rated higher over the same odds for another technology (Bellon, Adaro, Becerril & Mindek, 2006).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA: *OMO NADA* DISTRICT

Jimma zone is located 352 km away from Addis Ababa. Currently, the zone is divided in to 18 districts or *woreda*[9] and one urban administration: *Jimma*. *Jimma* town is the capital of the zone. *Omo Nada Woreda*, one of 18 districts of the zone, is found at 72 km away from *Jimma* town. The total area is 1687 km^2 that accounted for 9% of the total area of *Jimma* zone. The district has 39 PAs or *kebele*[10] and two urban centers. The vast area of the *woreda* annual rainfall varies between 1300 and 1700 mm. The altitude ranges between 880 meters of the lowest and 3344 meters at the highest peak. The total population of the district is 278,216 which is the aggregate of 141,021 female populations and 137,195 male populations. There are 47, 646 households in the district. Accordingly, 5.8 is the average family size. *Woyna Dega*[11], *Dega*[12] *and kola*[13] agro-climates do respectively constitute 75%, 15%and 10% of the district areas. Cereal (86.7%), pulses (12.5%) and oil seed occupies (0.8%) of the total cultivated land 46,811hectares and maize covers 27% of total cultivated land. The district also has a total livestock population of 347,766, poultry 207,901 and beehives 20,500 (source: *Omo Nada Woreda* agriculture office, 2014 data).

3.2 DATA TYPE AND SOURCES

The source of data for this specific study was primary data from deliberately selected four *Kebeles* of *Omo Nada* district. The data was collected since March 2015 by well-trained enumerators. In addition to experimental data, demographic and socioeconomic data such as age, education level, family and farm size, annual income and expenditure and livestock ownership of the respondents were collected. Some secondary data were also collected from the district agricultural office to supplement the primary data.

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[9] Medium sized administrative unit of Ethiopia pooled and made zone
[10] Small administrative unit pooled and made *woreda*
[11] Sub-tropical climate
[12] Temperate climate
[13] Tropical climate

3.3 SAMPLING PROCEDURE

A three stage sampling procedure was followed to select sample households. In the first stage, maize potential *district* has been identified in collaboration to CIMMYT staff; *Omo Nada district* was selected intentionally. In the second stage, four potential *Kebeles* were selected collaborated with concerned experts of the district office of agriculture. Lastly, a random of rural households was identified with development agents of the respective peasant association.

The total number of households (n) to be participated on central location test and modified home-use test was determined using the simple formula:

$$n = \frac{N}{1 + N(e^2)} \quad \text{..... (8)}$$

Where: **n** is Sample size to be taken for the study, **N** is the total number of households living in the district and **e** is desired margin of error

Accordingly, *Omo Nada district* has 47, 646 households according to the data from *Woreda* agricultural office. With a desired margin of error of 0.072, a total of **192** respondents for the central location test have been selected to represent the total population. Then, this number was equally distributed between four *Kebeles* of the *district*. Finally respondents for a survey were selected by using simple random sampling method from the lists of the household of the *Kebele*.

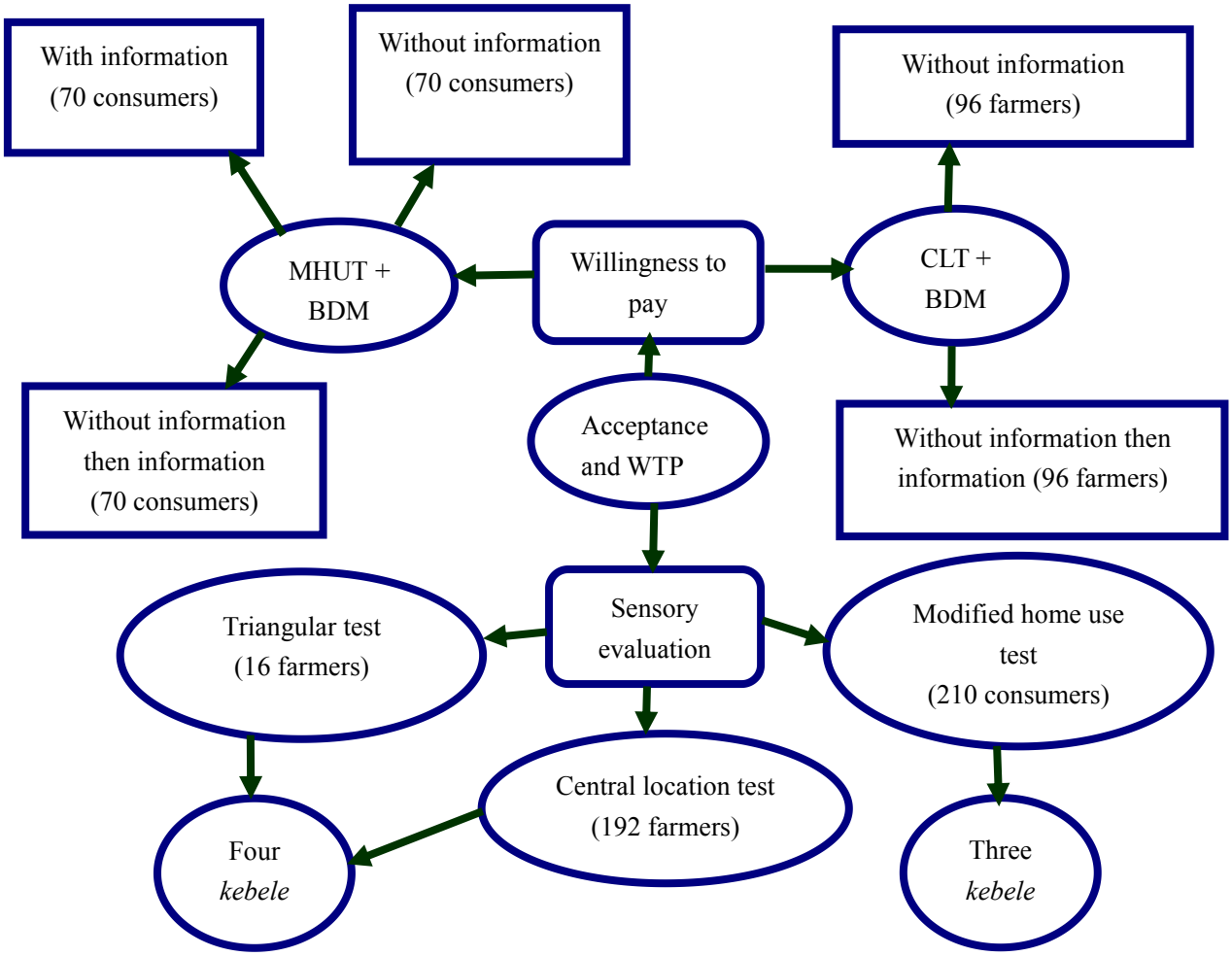
For home-use test, reducing the desired margin of error to 0.068, a total of 210 mothers having 6-23 month children were randomly selected according to population size in collaboration with DA and health extension personnel of respective *kebeles*. The desired margin of error has been reduced because of the withdrawal of one *kebele* from the selected four *kebeles*.

For triangular test "Risk tables for discrimination tests" of Schlich P., (1993) was considered. The number of assessors for triangular test is identified based on significance level required or (α-risk), risk level (β-risk) and the proportion of assessments in which a perceptible difference is detected between the foods samples/products (p_d). Accordingly for 0.05 significance level (α) and 0.2 risk levels

(β) and at 50% p_d the table yielded 16 assessors which were selected to participate on triangular test; four farmers from each *Kebeles* were selected randomly from a list of *Kebele* households.

Note: As α-risk or β-risk goes from 0.1(10%) to 0.001(0.1%), the evidence of the existence of difference between the samples increases. However, the maximum allowable proportion of distinguishes, p_d, falls into three ranges: p_d<25 % represent small values; 25 % < p_d< 35 % represent medium sized values; and p_d>35 % represent large values.

Figure 6: Research design flow chart



3.4 SENSORY DATA COLLECTION TECHNIQUES

Central location test, modified home use test and triangular test were employed evaluation techniques to investigate the sensory characteristics of QPM against the control product based traditional dishes.

3.4.1 CENTRAL LOCATION TEST

Central location test (CLT) is a type of qualitative research technique. It is the face to face methodology in which respondents are invited to take part in the predefined tasks and tests. It involves assembling potential producers of a product in one central place, may be a school, church or in a hall (Meilgaard et al., 2007). About 192 assessors from four *Kebeles,* 48 for each*,* were selected randomly with *kebeles* development agents. On this study, the test was undergone on *Kebele* administration hall and FTC (farmers training center) hall. Farmers were requested to evaluate four types of *dabo:* white QPM, yellow QPM, white conventional and yellow conventional maize. The *dabo* was prepared out of sight and served on uniform dishes labeled the shape of "triangle", "rhombus", "square" and "circle". Neither the consumers nor the enumerators know the difference between the samples for the sake of bias.

Then, the selected potential assessors have been asked to evaluate the products and evaluate for its acceptability on the format prepared for it. The attributes tested in the central location sensory test were aroma, appearance, taste, hand feel, mouth feel and overall evaluation based on five and seven level hedonic scales. A seven point hedonic scale [1=Dislike very much, 2=Dislike moderately, 3=Dislike slightly, 4=Neither like nor dislike, 5=Like slightly, 6=Like moderately, 7=Like very much] was used on two *kebeles* (*Doyo Yaya* and *Biso Gombo*) and a five point hedonic scale [1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5=like very much] was used on the rest two (*Waktola* and *Burka Asendabo*).

3.4.2 MODIFIED HOME USE TEST

Data for modified home use test was collected from 210 randomly selected women who have 6-23 month aged children. Sensory testing with children can provide valuable data in basic research or product development. However, children must be treated as a special population and the appropriate testing environment and protocol must be used because children show a wide range of cognitive abilities and attention spans. Semi-quantitative measures such as facial expressions, measures of sucking

behavior or behavior interpretation by the primary caretaker or mother may be used to monitor the responses of newborns, infants and toddlers (Guinard, 2001)

The study was between *genfo* prepared from white QPM and white conventional maize and yellow QPM and yellow conventional maize types. Half kilogram of two varieties were provided to the women and they prepared local food *genfo* (porridge) and feed their young children at home. Then, they gave their response based of facial language the children responded in addition to their own evaluation. The response was recorded on format prepared using score of ordered but arbitrary scale: a 5-point hedonic scale [1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5=like very much]. The attributes tested in the modified home use test were appearance, hand feel, mouth feel, taste, aroma and overall. During the experiment, either the consumers or the enumerators had no any information from which maize type the *genfo* was made from.

3.4.3 TRIANGULAR TEST DATA

A triangle test is a method used to determine whether a sensory difference exists between two products (Meilgaard et al., 2007). The evaluation and the experiment was between white conventional maize and white QPM, yellow conventional maize and yellow QPM, white conventional maize and yellow conventional maize and white QPM and yellow QPM by 16 consumers on four *kebeles*. Each respondents were given three samples of *dabo* labeling them differently after informing them the existence of two the same sample and one different sample. Then, they were ordered to identify the odd sample from these three samples served. The respondents have been informed that they could use any method of sensory evaluation like tasting, smelling, checking the hand/mouth texture except sight (blind folded).

3.5 EXPERIMENTAL AUCTION DATA COLLECTION

Data collection for experimental auction was combined with central location test and modified home use test so that each consumer participated on both experiments were asked to elicit their willingness to pay using BDM auction mechanism.

During central location test, half of respondents were provided QPM nutritional information while half were not. Experimental auction combined with MHUT has been conducted in three ways with equal distribution of participants: auction without QPM nutritional information (33.3%), auction after QPM nutritional information (33.3%), and before and after provision of QPM nutritional information (33.3%).

To help the farmers understand the BDM procedure, a test round with biscuits was first organized. The respondents was provided with show price and asked to bid for two types of different brand biscuits, one at a time. Then, the respondents were asked to make a bid for the first type of biscuit, which was written down, and the procedure was repeated for the rest. The bid for one of the rounds was compared to a number randomly drawn from a normal distribution. When the bid was higher, the respondent bought the biscuit at the bid price offered.

After test round (practice round), they were intentionally given enough money for the actual auction to tackle cash-in-hand effect and then presented with a kilogram or four *tasa*[14] of each of four types of maize grain for central location test and two types of maize grain for modified home use test. The grain has been provided on the front of the codded respective meals in alternate order to avoid selection bias.

Finally respondents were asked to make a bid for the first product, which was recorded, and the procedure was repeated for the rest of products. To reduce the auction costs and to avoid the effects of reduced marginal utility of maize grain, only one of the auctions, randomly selected at the end, was made binding and executed. The bid of that round was compared to a number randomly drawn from a normal distribution with mean ETB 4[15]. If the respondent's bid was higher than the random number, the purchase took place at the random number and money was exchanged for product.

3.6 DATA ANALYSIS TECHNIQUES

For all experiments, data entrance and analysis were done using SPSS-20. The data from CLT was analyzed using paired sample t-test. The score given by assessors for

[14] Local measurement of grain approximately equals to 250 gm.
[15] Local market price of four *tasa* of maize grain on march 2015

each attributes were compared for the food prepared from the two varieties. The data from the modified home use test was also analyzed using descriptive statistics and paired sample t-test to compare the scores of each variety.

For triangular test, the number of rightly identified odd sample was counted and the minimum number of correct responses required for significance at the stated α-risk level for the corresponding number of assessors, n, can be computed from table of critical value specifically prepared for triangular test. The table of critical number of correct responses in a triangle test provides numbers that are compared with the number of correctly identified odd sample, depending on the number of respondents. The assumption of "no difference" is rejected if the number of correct responses is greater than or equal to the tabled value. If the n number used did not exist on the table we can use the following formula (Meilgaard M., Civille G.V., Carr B.T. 1991, p. 338).

$$x = \frac{n}{3} + z\sqrt{\frac{2n}{9}} \quad \text{..... (9)}$$

Where x is the minimum number of correct response expected, n is number of assessors and z varies with the significance level (α). Accordingly the value of z is 0.84 for α=0.20, 1.28 for α=0.10, 1.64 for α=0.05, 2.33 for α=0.01 and 3.09 for α=0.001.

In triangle test to confirm that a difference exists between samples, the conclusion is conducted based on tabular value. For sample size (n) do not exist on the table, the following formula could be used (Meilgaard M., Civille G.V., Carr B.T. 1991, p. 338).

$$r = [\frac{1.5(x)}{n} - 0.5] - 1.5\,zB\sqrt{\frac{(nx - x^2)}{n^3}} \quad \text{..... (10)}$$

Where **r** is the upper confidence level to conclude that the samples are different, **x** is number of correct answers, **n** is the number of assessors and **zB** varies with the significance level (α). Accordingly the value of zB is 0.84 for α=0.20, 1.28 for α=0.10, 1.64 for α=0.05, 2.33 for α=0.01 and 3.09 for α=0.001 (Meilgaard M., Civille G.V.,

Carr B.T. 1991, p. 338).

Alternatively, data from triangular test was also analyzed by binominal distribution. The binomial distribution is frequently used to model the number of successes in a sample of size *n* drawn with replacement from a population of size *N. T*he binomial distribution with parameters *n* and *p* is the discrete probability distribution of the number of successes in a sequence of *n* independent yes/no experiments, each of which yields success with probability *p*.

Data from the individual experimental auction was analyzed using SPSS 20. The average bids for the different maize grain varieties were compared using paired-samples t-test method and the mean differences between average bids of QPM and conventional maize grain were also analyzed.

Factors affect farmers` preference of maize dishes was analyzed using ordinal logistic model. Ordinal logistic regression is used to predict an ordinal dependent variable given one or more independent variables. It enables us to determine which of our independent variables have a statistically significant effect on our dependent variable (Long & Freese, 2006). For categorical independent variables; we can interpret the odds that one "group" has a higher or lower score on our dependent variable. For continuous independent variables, we are able to interpret how a single unit increase or decrease in that variable, is associated with the odds of our dependent variable having a higher or lower value. When consumers score two products, for example QPM and conventional maize, the odds ratio is the ratio of the odds of one maize variety receiving a higher score over the odds that the other maize variety receives a higher score. The odds ratio can be calculated as the anti-log of the estimated coefficient, the log odds ratio, and indicates how one product was evaluated compared to another one (Meullenet, Xiong & Findlay, 2007). We can also determine how well our ordinal regression model predicts the dependent variable.

When a dependent variable is ordinal, we face a quandary. Hence, we have to use proportional odds model.

The model is: $y^* = x_i\beta+\epsilon_i$..... (11)

However, since the dependent variable is categorized, we must instead use:

$C_x(x) = \text{Ln}\left[\frac{p(y<j)/x)}{p(y>j)/x)}\right]$ and

$= \text{Ln}\left[\frac{\sum p(event)}{1-\sum p(event)}\right] = \beta_0+\beta_1x_1+\beta_2x_2+\ldots\ldots\ldots\beta_kx_k$

$= \text{Ln}\left[\frac{\sum p(y<j)/x)}{1-\sum p(y>j)/x)}\right] = \alpha_j + \beta_i x_i$ ..... (12)

i = 1, 2, 3 …k

j = 1, 2, 3… p-1

Where, α_j or β_0 = thresh hold; β_1 = parameters; x_i, $_1$ = sets of factor or predictors.

Farmers' willingness to pay(y) differs among products, income group, consumers, location and knowledge of QPM nutritional importance. Random effects model has been run using STATA 12.1 to estimate farmers` WTP and factors related to WTP.

The following model summarizes the effect of those variables on willingness to pay for i consumers and j product with their own disturbance terms, u_i and v_i respectively.

$$y_{ij} = \alpha + \alpha' x_j + \beta' f_i + \gamma' d_i + \rho' z_j + x'_j Af_i + x'_j Bd_i + x'_j Cz_j + d'_j Dz_j + \mu_i + \nu_{ij} \quad \text{.....(13)}$$

Where: Vector *fi* of K to include consumers characteristics like gender, age, sex, years of formal education, vector d_i to include location effect, vector z_i to include QPM nutrition information effect, Matrix A to include cross effects of income on WTP for different products, matrix B to include cross effects of location on WTP for different products, matrix C to include cross effects nutritional information on WTP for different products, matrix D to include cross effects of information on consumers` WTP for different location characteristics (De Groote et al., 2010).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 SOCIO ECONOMIC CHARACTERISTICS OF RESPONDENTS

Different demographic and socio-economic data related to each household was taken before the evaluation of traditional dishes and willingness to pay during central location test, triangular test and modified home-use test.

4.1.1 RESPONDENTS OF CENTRAL LOCATION AND TRIANGULAR TEST

Data collected from respondents of central location test shows that age of assessors' ranges from 19 to 65 with a mean age of 39 years and their education composition embraces illiterate to grade 10. The average land ownership of the farmers was 1.24 hectares. Of the mean total land, the farmers used to produce maize on 0.51 hectares (41%) of land on average. This shows that maize is prominent crop of the area by land coverage. The total annual net income of the individual respondents also ranges from ETB 1000 (49.1$US) to ETB 16600(815.5$US) with the average of ETB 5015 (246.4$US).

Table 3: Socio economic features of respondent of central location test

Variables	Minimum	Maximum	Mean	S.D
Age of respondent	19	65	38.96	10.4
Education level	0	10	2.48	2.94
Family size	1	18	6.71	2.76
Land	0	5	1.24	0.85
Cultivated land	0	5	0.93	0.67
Uncultivated land	0	2	0.32	039
Maize land	0	4	0.51	0.41
Net annual income i $US	49.1	815.5	246.4	158.3
N=192; 1 USD = 20.3557 ETB on March; 2015				

Source: Own computation; 2015

The descriptive results also shows that *Waktola kebele* respondents have relatively large mean age and *Burka Asendabo kebele* farmers have relatively large mean of total maize land (44%) whereas the least maize producing *kebele* was *Biso Gombo* (37.5%) relative to their total land. *Waktola kebele* farmers used to cultivate more of their total land meaning less uncultivated land (12%) and *Biso Gombo kebele*

respondents have more uncultivated land (34%) relatively.

Table 4: Demographic and socio economic features by *kebele*

Mean	**Peasant association**			
	Biso Gombo	***Burka Asendabo***	***Doyo Yaya***	***Waktola***
Age of respondent	39	37	35	44
Family size	7	7	6	7
Land	1.28	1.41	0.97	1.32
Cultivated land	0.84	0.99	0.72	1.15
Uncultivated land	0.44	0.41	0.25	0.16
Maize land	0.48	0.62	0.38	0.56
Net annual income i $US	260	220	269	237
N=192; 1 USD = 20.3557 ETB on March; 2015				

Source: Own computation; 2015

As most of other Ethiopian localities, the farmers of the study areas are also engaged on rearing livestock aside crop production. Accordingly, a farmer has on average four cattle and four chickens with insignificant number of sheep and goat. The highest number of cattle was found in *Burka Asendabo* and *Doyo Yaya* where mean large uncultivated land existed. It seems they use uncultivated land as grazing land as they have relatively large livestock.

Table 5: Livestock ownership of the respondents by PAs

Live stock	**Peasant association**			
	Biso Gombo	***Burka Asendabo***	***Doyo Yaya***	***Waktola***
Cattle	178	233	182	176
Sheep	63	11	25	34
Goat	63	51	53	64
Donkey	12	9	19	14
Chicken	209	190	198	240
N=192				

Source: Own computation; 2015

The triangular test data was also collected from 16 farmers; 8 men and 8 women with equal distribution among *kebeles*. The participants were randomly selected from those who were selected to participate on central location test. The age of participants ranges from 20 to 60, with mean of 36 years. The average family size of the participants was 6 and participants education ranges from illiterate to grade 10.

4.1.2 RESPONDENTS OF MODIFIED HOME USE TEST

The descriptive result of the study shows that the mean age of mothers at *Doyo Yaya kebele* was 32 years which is higher than the rest two *kebeles.* The average number of living children of mothers on the study area was four which is high on *Waktola kebele* (4.58) and low on *Doyo Yaya* (3.54). The highest education level attained by mothers ranges from illiterate to grade 10. The result also shows, of 210 children participated on evaluation, 55.7% of them were females. The mean age of children was also high on *Doyo Yaya kebele* which was 21.4 months and lowest on *Biso Gombo* which was 18.27 months and the overall mean was 19.5 months. Table **(6)** summarizes some economic and demographic features of the respondents by *kebeles*.

Table 6: Socio-economic features of home use test participants

Description	*Kebele*						Overall mean	
	Biso Gombo		*Doyo Yaya*		*Waktola*			
	Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
Mother's age	29.67	6.32	32.07	5.95	28.65	4.31	30.0	5.77
Child's age in months	18.27	5.66	21.4	4.61	18.43	5.71	19.5	5.54
Number of living children	3.7	2.09	3.54	1.73	4.58	2.18	4.0	2.06
Land holding	1.08	1.04	0.77	0.52	0.65	0.64	0.83	0.79
Maize land	0.51	0.46	0.37	0.21	0.32	0.25	0.39	0.33
Livestock	7.05	5.94	7.68	6.48	8.41	6.61	7.72	6.37
N=210								

Source: Own computation; 2015

4.2 RESULTS AND DISCUSSIONS OF SENSORY EVALUATION

4.2.1 TRIANGULAR TEST

Descriptive result of the triangular test shows that 81.25% and 62.5% of women and men correctly identified the odd sample respectively showing women are good examiners than men possibly due to the experience the women have as they are responsible to prepare the food for the family members.

About 75% of farmers of *Doyo Yaya*, *Biso Gombo* and *Burka Asendabo kebele*

identified the odd samples. *Waktola kebele* respondents were the least in identifying the odd samples (62.5%). The result shows that 11 of 16 consumers identified the odd sample of white QPM and white CM and 15, 12 and 8 of respondents identified the odd sample of yellow QPM and yellow CM, white QPM and yellow QPM and yellow CM and white CM respectively and all are statistically significant except the last sample between yellow CM and white CM.

Table 7: Triangular test result

Samples	Number of respondents	Correct response	Incorrect response	P-value
White QPM vs. white CM	16	11	5	0.004***
White QPM vs. yellow QPM	16	12	4	0.001***
Yellow QPM vs. yellow CM	16	15	1	0.000***
White CM vs. yellow CM	16	8	8	0.127

N=16

***=Statistically significant at 1%; **=Statistically significant at 5%; *=Statistically significant at 10%

Source: Own computation; 2015

The tabled critical number for the sample size 16 is 11 (at 1% significance level). Since the number of the correctly identified odd sample for the samples of white QPM and white CM 11 is equals the critical number (11), the assumption of "no difference" is rejected, and it is concluded that there is a significant sensory difference between *dabo* prepared from white QPM and white conventional maize. The finding is consistent with Kiria, (2010). The result suggests the existence of the significant difference between QPM and conventional maize stiff porridge at 1% level of significance.

There is tabular value of lower confidence interval to conclude that two samples are different but for n=16 it is not available and we have to **use equation 10 (on section 3.6)**. Based on the equation, we are 99 % confident that at least 13 % of the population can perceive a difference between *dabo* prepared from white QPM and white conventional maize.

For the samples of *dabo* of yellow QPM vs. yellow CM and white QPM and yellow QPM, of the 16 respondents who participated on the triangle test, 15 and 12 has correctly identified the odd samples respectively. The tabled critical number is 12 (for a significance of 0.1%). Since the number of the correctly identified odd samples 12 and 15 are greater than or equals to the critical number (12), the assumption of "no difference" is rejected. Thus, there is a significant sensory difference between yellow QPM vs. yellow CM *dabo* and white QPM vs. yellow QPM *dabo* and we are 99.9% confident that, at least 63 % and 12.5% of the population can perceive a difference of yellow QPM vs. yellow CM *dabo* and white QPM vs. yellow QPM *dabo* respectively.

For the last sample particularly between yellow conventional vs. white CM, only half of the whole respondents identified the odd sample. Since the number of correctly identified odds 8 is less than 11 of the critical number, we did not reject the null hypothesis and we conclude that there is no significant sensory difference between the samples at 1%, 5% and/or 10% significance level rather at 20% significance level. This implies we are at most 80% confident that only 9.25% of population can identify the odd sample between two CM *dabo* which is not enough to conclude that the two samples are different.

4.2.2 CENTRAL LOCATION TEST

The paired sample t-test result shows that the mean scores of two QPM *dabo* were consistently higher than the two conventional maize *dabo* for aroma, taste, texture in the mouth and texture in the hand, and therefore more appreciated than conventional maize.

Accordingly, the highest mean difference has been seen on texture in hand(0.75) and on taste (0.81) for 5 point likert scale and 7 point likert scales respectively and the difference between the two varieties in all attributes were significant at 0.1% significance level except for appearance which is expected because of the same color of two maize grains.

Table 8: Mean score of *dabo* prepared from white QPM and white CM

Attributes	5-point likert scale mean score			7-point likert scale mean score		
	White QPM	White CM	P-value	White QPM	White CM	P-value
Appearance	4.30	4.27	0.72	6.09	6.00	0.451
Texture in hand	4.19	3.61	0.000***	5.96	5.29	0.000***
Aroma	4.20	3.57	0.000***	5.94	5.17	0.000***
Texture in mouth	4.17	3.56	0.000***	5.85	5.06	0.000***
Taste	4.17	3.56	0.000***	5.85	5.04	0.000***
Overall	4.19	3.58	0.000***	5.93	5.13	0.000***
N=96 Meaning of scores: Dislike very much(1) to Like very much(5)				N=96 Meaning of scares: Dislike very much(1) to Like very much(7)		

*** = Statistically significant at 1%; ** = Statistically significant at 5%; * = Statistically significant at 10%

Source: Own computation; 2015

The experiment also investigated that yellow QPM *dabo* was more appreciated than *dabo* of yellow CM. For the samples, the high mean difference has been seen on the appearance (0.96) and on overall of *dabo* (1.23) on 5 and 7 point likert scales respectively.

Table 9: Mean score of *dabo* prepared from yellow QPM and yellow CM

Attributes	5-point likert scale mean score			7-point likert scale mean score		
	Yellow QPM	Yellow CM	P-value	Yellow QPM	Yellow CM	P-value
Appearance	4.71	3.75	0.000***	6.54	5.44	0.000***
Texture in hand	4.60	3.73	0.000***	6.40	5.35	0.000***
Aroma	4.53	3.67	0.000***	6.30	5.22	0.000***
Texture in mouth	4.57	3.67	0.000***	6.24	5.19	0.000***
Taste	4.55	3.71	0.000***	6.26	5.11	0.000***
Overall	4.58	3.74	0.000***	6.31	5.19	0.000***
N=96 Meaning of scores: Dislike very much(1) to Like very much(5)				N=96 Meaning of scares: Dislike very much(1) to Like very much(7)		

*** = Statistically significant at 1%; ** = Statistically significant at 5%; * = Statistically significant at 10%

Source: Own computation; 2015

For the comparison between *dabo* of two QPM types(white and yellow), yellow QPM *dabo* was more appreciated than the white one in all attributes for both 5 and 7 point likert scales at 1% and 5% significance level respectively.

Table 10: Mean score of *dabo* prepared from white and yellow QPM

Attributes	5-point likert scale mean score			7-point likert scale mean score		
	White QPM	Yellow QPM	P-value	White QPM	Yellow QPM	P-value
Appearance	4.30	4.71	0.000***	6.07	6.54	0.01**
Texture in hand	4.19	4.60	0.000***	5.96	6.40	0.04**
Aroma	4.20	4.53	0.000***	5.94	6.30	0.013**
Texture in mouth	4.17	4.57	0.000***	5.85	6.24	0.013**
Taste	4.17	4.55	0.000***	5.85	6.26	0.007***
Overall	4.19	4.58	0.000***	5.93	6.31	0.01**
N=96 Meaning of scores: Dislike very much(1) to Like very much(5)				N=96 Meaning of scares: Dislike very much(1) to Like very much(7)		
*** = Statistically significant at 1%; ** = Statistically significant at 5%; * = Statistically significant at 10%						

Source: Own computation; 2015

The result of the study also showed that *dabo of* yellow conventional maize was more appreciated than the white conventional maize but there was no significant difference between the sensory properties of the *dabo* prepared from them except for the appearance. The appearance of white conventional maize *dabo* was more appreciable than the unattractive light yellow colored conventional maize *dabo* at 1% significance level on both 5 and 7 point likert scales.

Table 11: Mean score of *dabo* prepared from white and yellow CM

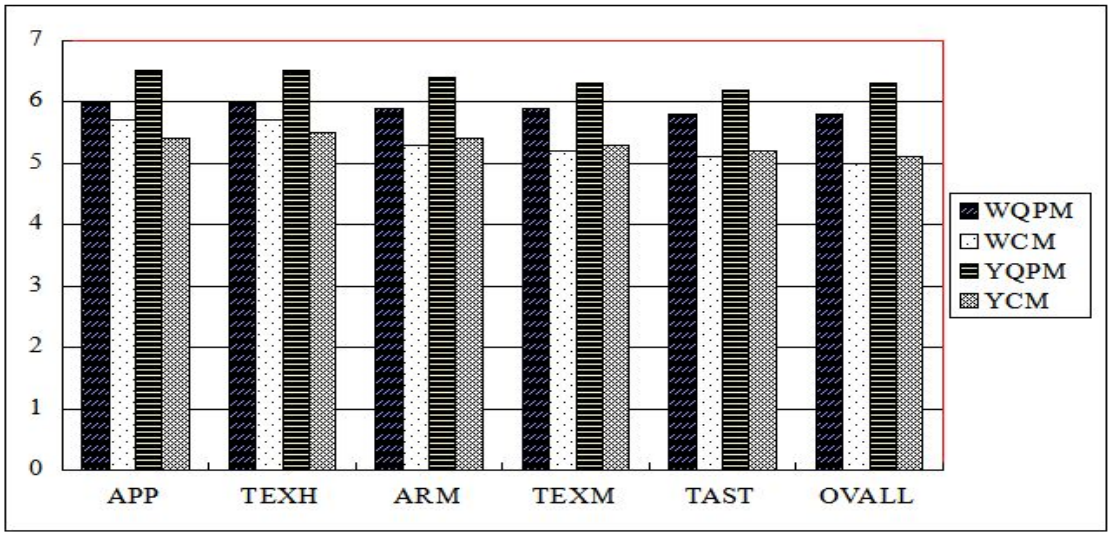
Attributes	5-point likert scale mean score			7-point likert scale mean score		
	White CM	Yellow CM	P-value	White CM	Yellow CM	P-value
Appearance	4.27	3.75	0.000***	6.00	5.44	0.000***
Texture in hand	3.61	3.73	0.27	5.29	5.35	0.681
Aroma	3.57	3.67	0.38	5.17	5.22	0.744
Texture in mouth	3.56	3.67	0.29	5.06	5.19	0.428
Taste	3.56	3.71	0.14	5.04	5.11	0.645
Overall	3.58	3.74	0.12	5.13	5.19	0.689
N=96 Meaning of scores: Dislike very much(1) to Like very much(5)				N=96 Meaning of scares: Dislike very much(1) to Like very much(7)		
*** = Statistically significant at 1%; ** = Statistically significant at 5%; * = Statistically significant at 10%						

Source: Own computation; 2015

The figure below summarizes that yellow QPM maize *dabo* was appreciated in all attributes. White QPM and white conventional maize *dabo* were almost the same with appearance while white QPM *dabo* was significantly appreciated than the white

conventional *dabo* in the rest of attributes. The yellow conventional maize was relatively appreciated by other attributes except the appearance relative to the white conventional *dabo.*

Figure 7: Mean sensory scores of the *dabo* of four maize varieties with seven level hedonic scales during central location test



Source: Own computation; 2015

The descriptive result also shows that about 8.3% and 5.2% of farmers dislike overall sensory property of white conventional and yellow conventional maize *dabo* respectively and more than 52% of respondents liked overall property of white QPM *dabo* while 14.6% neither liked nor disliked it. About 60.4% of farmers gave the score "like very much" for the overall attribute of yellow QPM *dabo* and only 3.1% neither liked nor disliked. The overall sensory property of white conventional maize *dabo* scored more "neither like nor dislike" (29.2%) relatively and only 3.1% of consumers liked it very much. When we see the difference by gender, neither of men nor women gave dislike very much for any of *dabo* of maize varieties and 35.4% and 56.2% of women consumers liked white QPM and yellow QPM *dabo* very much respectively while 31.2% and 64.6% of men liked white QPM and yellow QPM very much respectively. This describes that men have high appreciation for yellow QPM *dabo* than women while women have high appreciation for white QPM than yellow QPM *dabo* as compared to men.

Table 12: Overall preference of *dabo* by gender during central location test with 5 point likert scales

Likert scale	Overall of white QPM (%)			Overall of yellow QPM (%)			Overall of white CM (%)			Overall of yellow CM (%)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Dislike very much	0	0	0	0	0	0	0	0	0	0	0	0
Dislike	0	0	0	0	0	0	12.5	4.2	8.3	8.3	2.1	5.2
Neither like nor dislike	20.8	8.3	14.6	4.2	2.1	3.1	25.0	33.3	29.2	35.4	12.5	24.0
Like	47.9	56.2	52.1	31.2	41.7	36.5	58.3	60.4	59.4	47.9	77.1	62.5
Like very much	31.2	35.4	33.3	64.6	56.2	60.4	4.2	2.1	3.1	8.3	8.3	8.3
N=96												

Source: Own computation; 2015

Among *kebeles*, about 58.33% of *Burka Asendabo kebele* farmers appreciated yellow QPM *dabo* while 48% of them gave "like very much" score for white QPM *dabo*. The significant difference, in this regard, has been seen, at *Waktola kebele*. The result shows that; more than 64% of respondents gave " like very much" for yellow QPM *dabo* and only 18.75% and 2.01% of them gave "like very much" for white QPM and white conventional *dabo* respectively summarized below by table.

Table 13: Overall preference of *dabo* by *Kebeles* during central location test with 5 point likert scales

Likert scale	*Burka Asendabo* (%)				*Waktola* (%)			
	White QPM	Yellow QPM	White CM	Yellow CM	White QPM	Yellow QPM	White CM	Yellow CM
Dislike very much	0	0	0	0	0	0	0	0
Dislike	0	0	2.0	8.33	0	0	12.5	2.01
Neither like nor dislike	0	2.0	14.6	20.8	29.2	4.2	45.8	27.1
Like	52.1	39.7	79.2	66.67	52.1	31.3	39.6	58.4
Like very much	47.9	58.3	4.2	4.2	18.7	64.5	2.01	12.5
N=96								

Source: Own computation; 2015

Using the 7 point hedonic scale, *Biso Gombo* and *Doyo Yaya kebeles* appreciated yellow QPM *dabo* almost equally; more than 60% and 62% of the respondents gave

the score “like very much” respectively. *Biso Gombo kebele* gave more “like very much” score for the two conventional maize *dabo* relative to *Doyo Yaya kebele*.

Table 14: Overall preference of *dabo* by *Kebele* with 7 point likert scales

Likert scale	***Biso Gombo* (%)**				***Doyo Yaya* (%)**			
	White QPM	**Yellow QPM**	**White CM**	**Yellow CM**	**White QPM**	**Yellow QPM**	**White CM**	**Yellow CM**
Dislike very much	0	0	0	0	0	2.08	0	0
Dislike slightly	0	0	0	0	0	0	2.08	4.2
Dislike moderately	0	0	0	2.08	0	2.08	8.33	12.5
Neither like nor dislike	4.2	6.25	27.1	10.4	2.08	10.4	27.1	27.1
Like slightly	14.6	4.2	29.2	31.25	37.5	6.25	27.1	20.8
Like moderately	45.8	29.2	29.2	37.5	45.8	16.67	27.1	29.2
Like very much	35.4	60.4	14.6	18.75	14.7	62.5	8.33	6.25
N=96								

Source: Own computation; 2015

To summarize the inferential and descriptive result from central location test, QPM based *dabo was* more appreciated by all sensory attributes except by appearance than conventional maize based *dabo* using both five and seven point likert scales. Particularly, yellow QPM *dabo* was more appreciated than white QPM *dabo* by all sensory attributes ($p<0.000$) while no significant difference between white and yellow conventional maize *dabo* except for appearance. The appearance of white conventional maize *dabo* was more appreciated than the yellow conventional maize at 10% significance level.

4.2.3 MODIFIED HOME-USE TEST

The descriptive sensory result shows that all mothers of *Biso Gombo*, *Doyo Yaya* and *Waktola kebele* gave high overall score for yellow QPM *genfo* which is 4.47, 4.86 and 4.80 respectively and children of *Biso Gombo* and *Doyo Yaya kebeles* gave high overall score for yellow QPM *genfo* while *Waktola kebele* children gave the highest overall score for white QPM *genfo*. Mother’s lowest overall score was seen on *Waktola* and *Doyo Yaya kebele* for yellow conventional maize *genfo* and on *Biso Gombo* for white conventional maize *genfo*. The relative score given by mothers of

Biso Gombo kebele was low almost for all *genfo* types evaluated. However, children lowest overall score has been seen for yellow conventional maize *genfo* on each three *kebeles*.

Table 15: Overall score of *genfo* given by mother and child during modified home use test by *kebeles*

Sample type	*Biso Gombo*		*Doyo Yaya*		*Waktola*	
	Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
White QPM/mother	4.06	0.54	4.68	0.53	4.46	0.56
White CM/mother	3.80	0.53	4.06	0.68	4.08	0.44
Yellow QPM/mother	4.47	0.56	4.86	0.36	4.80	0.41
Yellow CM/mother	3.86	0.55	3.71	0.52	3.66	0.48
White QPM/child	3.91	0.61	4.60	0.60	4.51	0.56
White CM/child	3.68	0.58	3.71	0.86	4.02	0.45
Yellow QPM/child	4.71	0.45	4.80	0.41	4.22	0.49
Yellow CM/child	3.43	0.85	3.21	088	3.31	0.83
N=210						

Source: Own computation; 2015

The overall rating within a varieties also shows that more “like very much” by mothers were rated for yellow QPM *genfo* (81.9%) and the lowest “like very much” was for yellow conventional (3.8%) *genfo*. White QPM *genfo* rated “like very much” by 46.3% of mothers while about 1.9% of mothers disliked white CM *genfo* and 1% disliked white QPM *genfo*. However, no any type of *genfo* rated “dislike very much” by both mothers and children. Children rating were also the same as mothers rating with only different magnitude. Accordingly, yellow QPM and white QPM *genfo* rated “like very much” by 59% and 44.8% of child while 66.7% and 51.4% of child rated “like” for white and yellow conventional maize *genfo* respectively.

Table 16: Overall rating of mother and child during modified home use test in %

Sample type	Dislike very much	dislike	Neither like nor dislike	Like	Like very much
White QPM/mother	0	1	4.8	47.6	46.3
White CM/mother	0	1.9	11.4	73.3	13.3
Yellow QPM/mother	0	0	1.9	16.2	81.9
Yellow CM/mother	0	0	29.5	66.7	3.8
White QPM/child	0	0	10.5	44.8	44.8
White CM/child	0	4.8	19.0	66.7	9.5
Yellow QPM/child	0	0	1	40.0	59.0
Yellow CM/child	0	22.9	23.8	51.4	1.9
N=210					

Source: Own computation; 2015

The detail score of attributes given for the *genfo* shows the highest mean score for white QPM *genfo* given by mothers were taste (4.41) and the highest mean score for white conventional maize *genfo* given by mothers were appearance (4.26). Inferential statistics shows that there was a significant difference between white QPM and white conventional maize *genfo* in overall score of children and aroma, texture in mouth, taste and overall attributes of mother during modified home use test. However, there was no statistical evidence to conclude that appearance and texture in hand of two maize varieties *genfo* were different.

Table 17: Paired sample t-test result between white QPM and white CM *genfo* during modified home use test

Attributes	White QPM		White CM			P-value
	Mean	S.D	Mean	S.D	t	
Appearance/mother	4.37	0.59	4.26	0.63	3.16	0.158
Texture in hand /mother	4.31	0.63	4.23	0.58	3.61	0.223
Aroma/mother	4.37	0.64	4.00	0.57	4.27	0.000***
Texture in mouth /mother	4.40	0.63	3.98	0.61	4.91	0.000***
Taste/mother	4.41	0.65	3.97	0.59	5.02	0.000***
Overall/mother	4.40	0.63	3.98	0.57	4.91	0.000***
Overall (child)	4.34	0.66	3.81	0.66	5.74	0.000***
N=210						

Source: Own computation; 2015

The highest mean score of both yellow QPM *genfo* and yellow conventional *genfo* were seen on overall attribute which is 4.80 and 3.74 respectively. The result also shows that there was significant difference between attributes of yellow QPM and

yellow conventional maize *genfo* evaluated both by mothers and child (see summary below).

Table 18: Paired sample t-test result between yellow QPM and yellow CM *genfo* during modified home-use test

Attributes	yellow QPM		yellow CM		t	P-value
	Mean	S.D	Mean	S.D		
Appearance/mother	4.68	0.51	3.74	0.55	13.2	0.000***
Texture in hand /mother	4.63	0.50	3.71	0.57	11.9	0.000***
Aroma/mother	4.71	0.49	3.68	0.59	12.7	0.000***
Texture in mouth /mother	4.79	0.43	3.71	0.55	14.6	0.000***
Taste/mother	4.79	0.47	3.73	0.52	14.1	0.000***
Overall/mother	4.80	0.44	3.74	0.52	14.1	0.000***
Overall(child)	4.58	0.51	3.32	0.85	13.6	0.000***
N=210						

Source: Own computation; 2015

To conclude the sensory evaluation test between QPM and conventional maize *genfo* at home explored that *genfo* (porridge) of the white QPM is more appreciated than the white conventional one in terms of aroma, texture in mouth, taste and overall while no significant difference in appearance and texture in hand which is expected because similarity of the two varieties specially in color. More interestingly, *genfo* prepared from yellow QPM is highly appreciated in all attributes by mothers and child than the conventional counterpart. They were asked the reason why they appreciated and most of them responded as it is simply detached from cooking pot and its good appearance and aroma. However the result of the study conducted in southern Ethiopia shows that QPM-based porridge was scored higher for its texture in the hand and mouth, while its scores for appearance, aroma, and taste were not statistically different from those of porridge made from conventional maize. Overall acceptance of the two varieties by both mothers and children was also not significantly different (Gunaratna et al., 2015).

Those results from both central location and modified home-use tests proved the first hypothesis which stated that “Rural farmers of the study area prefer the sensory characteristics of QPM foods to conventional maize foods”. The finding is consistent with the study conducted in Tanzania on stiff porridge of white QPM and white

conventional maize varieties. According to the result of the study, QPM stiff porridge had collected significantly higher scores ($p<0.01$) in terms of the overall sensory profile, aroma, taste and mouth than conventional maize stiff porridge evaluated. However, there was no difference between appearance of QPM stiff porridge and conventional maize stiff porridge (Kiria, 2010). Ouma et al (2006) also found that overall QPM based "g*itheri"* was more preferred than conventional *githeri* in taste and texture than the control. However, on appearance, QPM based preparation was perceived to be equal to the control. On another study, QPM *ugali* was generally preferred over its CM counterpart: in the overall evaluation it received, and it also scored better for all criteria except appearance. The scores for QPM was significantly larger for texture in mouth, for taste, and to a lesser extent for the related aroma (De Groote et. al., 2014).

4.3 RESULT AND DISCUSSION OF EXPERIMENTAL AUCTION

BDM mechanism; an experimental auction technique, was combined with central location test and modified home use test to elicit consumers` true WTP for QPM grain. The result from both experiments has been briefly discussed below.

4.3.1 BDM RESULT OF CENTRAL LOCATION TEST

The result from experimental auction during central location test shows that consumers were willing to pay more for QPM maize grain than for the conventional one. The average market price of one kilogram or four *tasa* of maize was ETB 4.00 (on March, 2015) and the mean willingness to pay for one kilogram of maize grain based on the bid conducted on the study area was ETB 5.48 and ETB 6.22 for white and yellow QPM and ETB 4.85 and ETB 4.88 for white and yellow conventional maize grain respectively without provision of QPM nutritional information. The difference in the mean bids is statistically significant at 1% significance level except for the mean bids between two conventional varieties. Specifically, consumers were willing to pay a discount of 12.98% for white CM grain over the white QPM and willing to pay a premium of 27.25 % for the yellow QPM over the yellow CM grain.

Despite high premium for QPM grains, there was difference with in a color. It was explored that consumers were willing to pay more for the yellow QPM than the white grain at a premium of 11.73%.

Table 19: Mean bids of maize grains on central location test without provision of nutritional information

Between maize varieties	Mean	Mean difference	P-value	Discount/premium in %
White QPM	5.48	-0.63	0.000***	-12.98
White CM	4.85			
White QPM	5.48	0.73	0.000***	11.73
Yellow QPM	6.22			
Yellow QPM	6.22	-1.33	0.000***	-27.25
Yellow CM	4.88			
White CM	4.85	0.31	0.786	6.39
Yellow CM	4.88			
N=192				
*** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%				

Source: Own computation; 2015

Geographically, *Waktola kebele* bid more (ETB 6.78) for yellow QPM grain while *Doyo Yaya kebele* bid highest value (ETB 6.05) for white QPM grain. The most interesting part of the study was, consumers at all *kebeles* were willing to pay more for yellow QPM grain than any other grains as summarized by table below.

Table 20: Bids of farmers by *kebele* during central location test without information

Varieties	*Biso Gombo*		*Doyo Yaya*		*Burka Asendabo*		*Waktola*		Overall mean	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
White QPM(a)	5.27	1.36	6.05	1.91	5.44	1.88	5.18	1.96	5.48	1.81
Yellow QPM(b)	5.51	1.96	6.60	1.88	5.98	2.48	6.78	2.28	6.22	2.21
White CM(c)	4.98	1.47	5.22	1.64	4.65	1.78	4.56	1.75	4.85	1.67
Yellow CM(d)	4.91	1.65	5.60	1.88	4.13	1.31	4.89	1.97	4.88	1.79
N=192										

Source: Own computation; 2015

The willingness to pay for the grains was different in different *kebeles*. Farmers preferred yellow QPM to white and were willing to pay; particularly 30.8% premium on *Waktola kebele* and 9.9%, 9.1% and 4.6% premium on *Burka Asendabo*, *Doyo Yaya* and *Biso Gombo kebeles* respectively. The result also showed that consumers were willing to pay less for white CM grain relative to white QPM grain without having any nutritional information of each maize grains at a discount of 16.9%, 15.9% and 13.6% at *Burka Asendabo*, *Doyo Yaya* and *Waktola kebeles* respectively. The lowest discount was seen at *Biso Gombo kebele* (5.8% discount). Symmetrically, farmers were willing to pay less for yellow conventional than yellow QPM grain and were willing to pay relatively more for white conventional than yellow conventional grain.

Table 21: Mean difference and % of premium/discount between varieties without nutritional information

WTP between varieties and colors	***Biso Gombo***	***Doyo Yaya***	***Burka Asendabo***	***Waktola***
White QPM and yellow QPM (b-a)	0.24	0.55	0.54	1.6
	4.6%	9.1%	9.9%	30.8%
White QPM and white CM (c-a)	-0.29	-0.83	-0.79	-0.62
	-5.8%	-15.9%	-16.9%	-13.6%
Yellow QPM and yellow CM (d-b)	-0.60	-1.0	-1.85	-1.89
	-12.2%	-17.9%	-44.8%	-38.7%
White CM and yellow CM (d-c)	-0.07	0.38	-0.52	0.33
	-1.4%	7.3%	-12.6%	7.2%
N=192				

Source: Own computation; 2015

The experiment was also tried to explore the difference in willingness to pay among gender groups. Accordingly, women were willing to pay more for white QPM grain (3.5% premium), Yellow QPM grain (2.4% premium) and Yellow conventional grain (6.6% premium) and relatively less for white conventional grain at a discount of 0.2% than men.

Table 22: Mean willingness to pay for our *tasa* (1kg) of grain by gender in ETB without information

Varieties	Male (e)	Female(f)	Difference (e-f)	% discount/premium
White QPM(a)	5.39	5.58	0.19	3.5%
Yellow QPM(b)	6.14	6.29	0.15	2.4%
White CM(c)	4.86	4.85	-0.01	-0.2%
Yellow CM(d)	4.73	5.04	0.31	6.6%
N=192				

Source: Own computation; 2015

The study also tried to show the difference existed between mean bid of farmers and random number drawn. The average of random numbers drawn for the maize grain was 3.72, 3.94, 4.93 and 4.11 for white QPM, yellow QPM, white conventional and yellow conventional maize grain respectively. The paired sample t-test result shows there was statistically significant difference between mean bids of QPM grains and its own mean random number drawn at 1% significance level. The bid of yellow conventional maize was also statistically different from that of the random number drawn. However, the bid for white conventional maize was not different from the mean of random numbers drawn.

4.3.2 BDM RESULT OF MODIFIED HOME USE TEST

The result from modified home-use test shows that even without provision of any QPM nutritional information, consumers were interested to pay more for yellow QPM and white QPM than the two CM grains. *Biso Gombo kebele* was interested to pay more for yellow QPM and white QPM over the CM grains with a premium of 44.5% and 4.13% respectively while *Doyo Yaya kebele was* willingness to pay for white QPM which is less by 0.04 cents over the conventional one but interested to pay more for yellow QPM with a premium of 11.1% over the yellow counterpart. The highest premium for both QPM grains has been seen on *Waktola kebele* before and without provision of QPM nutritional information.

Table 23: WTP within *kebeles*, color and maize grain type without QPM information

Kebele	Color	Maize type	Before and without information	Mean difference	Discount/ premium in %
Biso Gombo	white	QPM	5.29	-0.21	-4.13
		CM	5.08		
	yellow	QPM	5.68	-1.75	-44.5
		CM	3.93		
Doyo Yaya	white	QPM	5.34	0.04	0.075
		CM	5.38		
	yellow	QPM	5.55	-0.91	-19.61
		CM	4.64		
Waktola	white	QPM	5.00	-0.50	-11.11
		CM	4.50		
	yellow	QPM	5.67	-1.84	-48.04
		CM	3.83		
N=140					

Source: Own computation; 2015

Comparison has also been conducted between maize varieties and colors before offering any nutritional information for the consumers. The result shows consumers were interested to pay more for the yellow QPM and white QPM grain over the conventional for the premium of 36.7% and 4.2% respectively.

Table 24: willingness to pay for grain within color and maize type before and without nutritional information

Maize grain color	Type	WTP	Mean difference	Discount or premium %
white	QPM	5.21	-0.21	-4.20
	CM	5.00		
Yellow	QPM	5.63	-1.51	-36.7
	CM	4.12		
N=140				

Source: Own computation; 2015

4.4 INTERACTION BETWEEN OVERALL SCORE AND OTHER ATTRIBUTES

The study also tried to identify which attribute specially affects mothers' overall score during modified home-use test using ordinal logistic regression and the result has been shown below.

Table 25: Relation between overall score and other sensory attributes during modified home use taste

Variables		Estimate	Standard error	Significance
Threshold	[mother overall score = 2.00]	22.844	1.710	0.000
	[mother overall score = 3.00]	34.313	2.101	0.000
	[mother overall score = 4.00]	44.705	2.607	0.000
Mother's appearance score		1.186	0.364	0.001***
Mother's texture in hand score		1.456	0.396	0.000***
Mother's aroma score		0.690	0.353	0.051*
Mother's texture in mouth score		1.730	0.395	0.000***
Mother's taste score		4.896	0.417	0.000***
Model	Pseudo R^2 (Naglekerke) = 95.7			
	Pearson-chi-square =0.000***			
	N= 210			

*** = Statistically significant at 1%; ** = Statistically significant at 5%; * = Statistically significant at 10%

Source: Own computation; 2015

Table above shows all attributes are significantly related to overall score of the *genfo.* However, taste and texture in mouth highly affect mothers' overall ratings than any of other attributes as relatively large coefficients on the attributes.

On similar study conducted in three east African countries: Tanzania, Kenya and Ethiopia, different sensory characteristics of foods affect the overall rating of the food in different manner and magnitude based on the dishes and cultural preference. It was found that all evaluated sensory characteristics contributed to the overall evaluation except for aroma and appearance of *ugali* in Tanzania. Taste and texture were important to overall acceptance, with taste being the biggest contributor to acceptance in Tanzania and Ethiopia. In Kenya, taste was also important but texture and appearance were more important since *githeri* is a mixture of boiled maize and beans, and the maize kernels are clearly visible. In Ethiopia, all other criteria apart from taste

made a significant contribution to the overall acceptance of *Enjera*, but the coefficients were relatively small (De Groote et al., 2014). The study in southern Ethiopia also indicated that mothers` overall scores were positively and significantly related to acceptability of aroma and taste (Gunaratna et al., 2015).

4.5 FACTORS AFFECT SENSORY PREFERENCE OF MAIZE DISHES

Ordinal regression model was used to analyze factors related to sensory appreciation using main effect, cross affect and color effect. Different demographic, socio-economic and technology specific factors like maize type and maize color were taken in to consideration to identify factors affect sensory appreciation among the consumers.

The main effect result from **mother's** evaluation showed that QPM *genfo* was evaluated better than the conventional maize during the MHUT. The log odds ratio of QPM *genfo* was 2.76, which was translated to an odds ratio of approximately 16 (16:1) when the exponent was taken. The result implied QPM *genfo* was appreciated by rural consumers sixteen (16) times more than the *genfo* of conventional maize which is consistent with the descriptive result seen above. This finding is also in line with the findings on literature of Ouma et al., (2006), Kiria, (2010) and De Groote et al., (2010).

Total livestock ownership by the consumers affect the sensory preference negatively (0.96=odds ratio) which corroborate with Kiria, (2010) finding while total income have positive and significant coefficient (1=odds ratio). *Doyo Yaya kebele* gave high score and *Biso Gombo kebele* gave low score for *genfo* during evaluation for respective positive and negative coefficients.

The other factor seen to affect the score of the samples was order of the samples during evaluation. Accordingly, it has positive coefficient (0.742) meaning being first order increases the likelihood of collecting better score by 2.1 times (exponent of 0.742). The result concurs with the study conducted in Ethiopia where acceptance scores was significantly higher in the first round than in the second and illustrates the importance of presenting food samples in random order (De Groote et al., 2014). On

another study Morawetz et.al., (2011) found the individual dummy for plain yellow meal presented before fortified white was significant at the 10% significance level. Gunaratna et al., (2015) also found that for all sensory characteristics, the variety that was evaluated first received significantly higher scores.

The cross effect result shows that age has positive relation to QPM *genfo* preference which might be resulted from cooking and tasting experience and is consistent with the study conducted in Tanzania and Ethiopia (Kiria, 2010; Gunaratna et al., 2015). Similarly, highest education level attained and income have positive coefficients meaning as education level and income increases appreciation of QPM *genfo* increases while livestock ownership have negative coefficient on cross effect too. The cross effect result also shows that *Doyo Yaya kebele* appreciated QPM *genfo* highly and *Biso Gombo kebele* gave low score for QPM *genfo* during modified home use test with an odds ratio of 1.57 and 0.41 respectively which concurs with the finding on the descriptive result. On other hand, order has positive impact on QPM *genfo* score by increasing the score rate by 1.6 (exponent of 0.464). Descriptive result of home use test and central location test revealed yellow QPM *genfo* was more appreciated than white QPM *genfo*. The cross effect result also confirmed that white QPM *genfo* was given less score than the yellow QPM *genfo* with negative coefficient of the white (0.17=odds ratio).

It was also tried to investigate what factors drive to the preference of color using color effect. The result shows yellow QPM *genfo* was more appreciated by consumers with the coefficient of white QPM *genfo* -0.324(odds ratio=0.72) which means white maize *genfo* was appreciated but not as high as the yellow *genfo*. The results were consistent with the result seen on the paired wise test and the central location test. On other hands, age was positively and significantly related to yellow QPM *genfo* preference. High age group liked the yellow QPM *genfo* than the white QPM *genfo* for the positive coefficient of yellow QPM *genfo* (0.149).

Table 26: Ordinal regression model result for mothers overall rating during MHUT

	Variables	Estimates	Standard error	Significance
Threshold	[Mother overall score = 2.00]	-4.374	0.387	0.000
	[Mother overall score = 3.00]	-1.242	0.215	0.000
	[Mother overall score= 4.00]	2.293	0.229	0.000
Main effect	Mother education	0.022	0.023	0.341
	Number of living children	-0.049	0.032	0.129
	Total livestock	-0.040	0.010	0.000***
	Total income	0.000	0.000	0.000***
	[*kebele=Biso Gombo*]	-0.493	0.146	0.001***
	[*kebele=Doyo Yaya*]	0.296	0.158	0.061*
	[maize type =QPM]	2.762	0.148	0.000***
	[maize color=white]	-0.324	0.120	0.007***
	[sample order= first]	0.742	0.122	0.000***
Cross effects	QPM * mother age	0.029	0.017	0.092*
	QPM * mother education	0.071	0.037	0.051*
	QPM * total livestock	-0.058	0.015	0.000***
	QPM * total income	0.000	0.000	0.008*
	QPM * [sample order =first]	0.464	0.189	0.014**
	QPM * [*kebele=Biso Gombo*]	-0.896	0.221	0.000***
	QPM * [*kebele=Doyo Yaya*]	0.452	0.253	0.074*
	QPM * [color=white]	-1.751	0.197	0.000***
Color preference	[maize color=white]	-0.324	0.120	0.007***
	yellow QPM * mother age	0.149	0.036	0.000***
	Yellow QPM * total maize land	1.562	0.985	0.113
Model	Pseudo R^2 (Naglekerke) = 48.7			
	Pearson-chi-square = 5110.74 ***			
	N = 210			

*** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%

Source: Own computation; 2015

Main effect result of ordinal regression of overall score of the **children** also shows that positive relation between child overall score and mothers` overall score with a coefficient of 0.892 which corroborates with the finding in Ethiopia (Gunaratna et al.,

2015). The finding states that children`s overall score was related to their mother's score on appearance. Age of children positively and significantly affect the preference of maize varieties. Child with relatively large age appreciated the *genfo* and male children gave high overall score for *genfo* evaluated. Sample order was also a factor considered to affect sensory score given to the *genfo*. Accordingly, being first sample increases the likelihood to scored better (1.59=odds ratio).

Doyo Yaya children appreciated the sample *genfo* highly and significantly and QPM *genfo* has been appreciated than the conventional maize more than eight times (exponent of 2.11) while white maize *genfo* has been less appreciated than the yellow QPM 0.755 times (exponent of -0.28).

The cross effects also shows that mothers overall score affect the preference of QPM *genfo* positively and age of the children also positively related to QPM preference as its coefficient is positive (0.05) meaning age increases QPM *genfo* appreciation. Being first order has positive impact on score given to QPM *genfo* with 1.40 odds ratio and white QPM *genfo* was appreciated less than the yellow counterpart for its negative coefficient (-0.721). *Doyo Yaya kebele* appreciated the yellow QPM *genfo* relative to other *kebeles*.

The color effect result also shows that yellow QPM *genfo was* appreciated on both *Doyo Yaya* and *Biso Gombo kebeles* significantly with an odds ratio of 1.41 and 10.29 respectively.

Table 27: Ordinal regression result during modified home use test for child

Variable		Estimate	Standard error	Significance
Threshold	[Child overall score= 2.00]	2.410	0.467	0.000
	[Child overall score= 3.00]	3.823	0.470	0.000
	[Child overall score= 4.00]	7.225	0.511	0.000
Main effect	Mother overall score	0.892	0.104	0.000***
	Child age	0.036	0.011	0.001***
	[*kebele=Biso Gombo*]	-0.026	0.138	0.852
	[*kebele=Doyo Yaya*]	0.254	0.143	0.076*
	[child sex=male]	-0.273	0.116	0.018**
	[maize color=white]	-0.280	0.115	0.016**
	[maize type =QPM]	2.111	0.160	0.000***
	[sample order=first]	0.461	0.116	0.000***
Cross effects	QPM * Mother overall	0.363	0.158	0.022**
	QPM * Child age	0.050	0.016	0.001**
	QPM * [*kebele=Biso Gombo*]	0.033	0.198	0.867
	QPM * [*kebele=Doyo Yaya*]	1.167	0.217	0.000***
	QPM * [child sex=male]	-0.280	0.170	0.100
	QPM * [maize color=white]	-0.721	0.185	0.000***
	QPM * [sample order = first]	0.339	0.170	0.046**
Color preference	Yellow QPM * mother overall score	0.282	0.298	0.345
	Yellow QPM * [order=first]	0.505	0.285	0.076*
	Yellow QPM * [*kebele= Biso Gombo*]	2.233	0.343	0.000***
	Yellow QPM * [*kebele=Doyo Yaya*]	2.331	0.367	0.000***
Model	Pseudo R^2 (Naglekerke) = 44.1			
	Pearson-chi-square 2616.833 ***			
	N= 210			

*** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%

Source: Own computation; 2015

4.6 FACTORS AFFECT CONSUMERS WTP FOR QPM GRAIN

Before collecting the sensory data, farmers were asked some socio economic and demographic features to investigate whether those factors affect their true willingness to pay using generalized least square (GLS) random effect model. The analysis result included the main effect, cross effect, color effect, order and information effect.

The main effect result shows that *Waktola kebele* paid less for sample grains during experimental auction on modified home-use test which is in line with the descriptive result. Livestock ownership was positively and significantly related to the WTP for the grains as it is related to income. The *woreda* is farming dominated area and peoples who have more livestock are recognized as better income group. That was the reason why WTP and livestock positively related. It was also confirmed that *Waktola kebele* who have less average livestock ownership wants to pay less money than the other *kebeles*. Negative coefficient (-2.37) of conventional maize indicates that the consumers paid more premium for QPM grain than the conventional one. The result is consistent with the finding from descriptive result of both central location test and home-use test and also in line with the study in Tanzania (Kiria, 2010; De Groote et al., 2014). However, high willingness to pay was seen for yellow grain than the white counterparts as positive coefficient of yellow grain(0.45) which is in line with the finding on the central location test. The study in Kenya also showed that consumers from one of the study zones where yellow maize is most commonly preferred, showed higher preference for the yellow plain maize meal than white plain maize meal and were even willing to pay a premium of 4.9% for the yellow plain maize meal (De Groote et al., 2010:4).

Another interesting result that affirms the descriptive result was the relation between sensory quality and willingness to pay. The result shows positive and significant relation between sensory quality of maize *genfo* represented as mother's overall rating and willingness to pay for its grain with a positive coefficient(0.74) which concurs with the study in Tanzania (Kiria, 2010).

The cross effect result also shows *Waktola kebele* bid less money for QPM relative to other *kebeles* represented by negative coefficient(-0.318) and net annual income was positively related to the WTP for the QPM grain. The result also explored positive relationship between mother's overall rating for QPM *genfo* and WTP for its grain. Lastly, the cross effect investigated yellow QPM paid more than the white QPM since

positive coefficient of yellow QPM (0.73).

Another core finding was effect of color of the grain */genfo/* on the willingness to pay. Number of living children the mothers have was negatively and significantly related to WTP for yellow QPM. The reason seems, it is directly related to income constraint of households having large family size.

Order was also another category considered as the factor to affect the willingness to pay for maize grains. It is directly related to the randomization of the sample of food and grain. The result shows negative coefficient of order in the main effect and cross effect too. The main effect result implies being the second order sample increases the likelihood to paid less and being the first order sample increases the probability to paid more relative to the second sample.

The cross effect result shows making QPM first order increased the willingness to pay more though insignificant result. Its insignificant result is related to the thorough randomization during the experiment on the field. The last category to affect the willingness to pay was provision of QPM nutritional information to the sample consumers. See section **4.7** "effect of information".

Table 28: Determinants of willingness to pay by random effect model on the data of modified home-use test

Random-effects GLS regression		Number of obs = 1260		
R-square: within = 0.6791		Number of groups = 210		
between = 0.3159		Observation per group = 6		
overall = 0.5592		LR chi^2 = 2307.30		
corr(u_i, X) = 0 (assumed)		Prob > chi^2 = 0.0000		
	Variables	Coefficients	Std. Err.	P>|z|
Main effect	*Kebele* [*Waktola*]	-0.3279	0.0931	0.000***
	Mother age	-0.0018	0.0162	0.911
	Number of children	0.0047	0.0469	0.920
	Total livestock	0.0223	0.0127	0.079*
	Total net income	0.0000	0.0000	0.265
	Maize type [CM]	-2.3799	0.0827	0.000***
	Maize color [Yellow]	0.4548	0.1509	0.003***
	Mother overall score	0.7415	0.0712	0.000***
Cross effect	*Kebele* [*Waktola*] * QPM	-0.3183	0.1322	0.016**
	Mother age * QPM	-0.0103	0.0186	0.578
	Total income * QPM	0.0000	0.0000	0.083*
	Color [yellow] * QPM	0.7275	0.2261	0.001***
	Mother overall * QPM	0.4020	0.2036	0.048**
Color effect	Mother age *Yellow QPM	0.0534	0.0355	0.133
	Number of child *Yellow QPM	-0.165	0.0968	0.088*
	Total livestock *Yellow QPM	0.0361	0.0247	0.145
Order effect	Order [second]	-0.1891	0.0666	0.005***
	Order [second] * QPM	-0.4608	0.2185	0.352
Information effect	Information	0.7225	0.0938	0.000***
	Information * QPM	1.5222	0.1326	0.000***
	Information *Yellow QPM	1.7119	0.1974	0.000***
Constant		4.8873	0.6872	0.000***
Sigma_u	0.98294256			
sigma_e	1.1473336			
rho	0.42328793 (fraction of variance due to u_i)			

Source: Own computation; 2015

4.7 EFFECT OF QPM NUTRITIONAL INFORMATION ON WTP

For the bidders of central location test, QPM nutritional information was provided to two *kebeles* meaning 96 farmers while the rest does not provided any information. However, the bidders of modified home-use test were participated in three forms: Quarter of consumers was conducted the auction with full QPM nutritional

information, quarter of consumers didn't provide any information regarding maize varieties and quarter of consumers bid first without information and then provided information on QPM.

The result from central location test shows that information has increased the bid of white QPM grain and yellow QPM grain by more than 35.5% (ETB 2.01) and 32.8%(ETB 1.99) respectively and both are significant at 0.1 significance level. Surprisingly, information has reduced the willingness to pay for white conventional maize grain and yellow conventional maize grain bid by 7.4% (ETB 0.35) and 3.9% (ETB 0.64) significant at 1% and 0.1% significance level respectively.

Table 29: Impact of information on willingness to pay during central location test

Maize grains	Without information		With information		Difference		P-value	Discount or premium
	Mean	S.D	Mean	S.D	Mean	S.D		In %
White QPM	5.66	1.69	7.67	1.63	-2.01	1.76	0.000***	35.5
Yellow QPM	6.06	1.99	8.05	1.65	-1.99	1.75	0.000***	32.8
White CM	5.10	1.55	4.75	1.00	0.35	1.255	0.007***	-7.4
Yellow CM	5.26	1.79	4.62	1.09	0.64	1.334	0.000***	-3.9

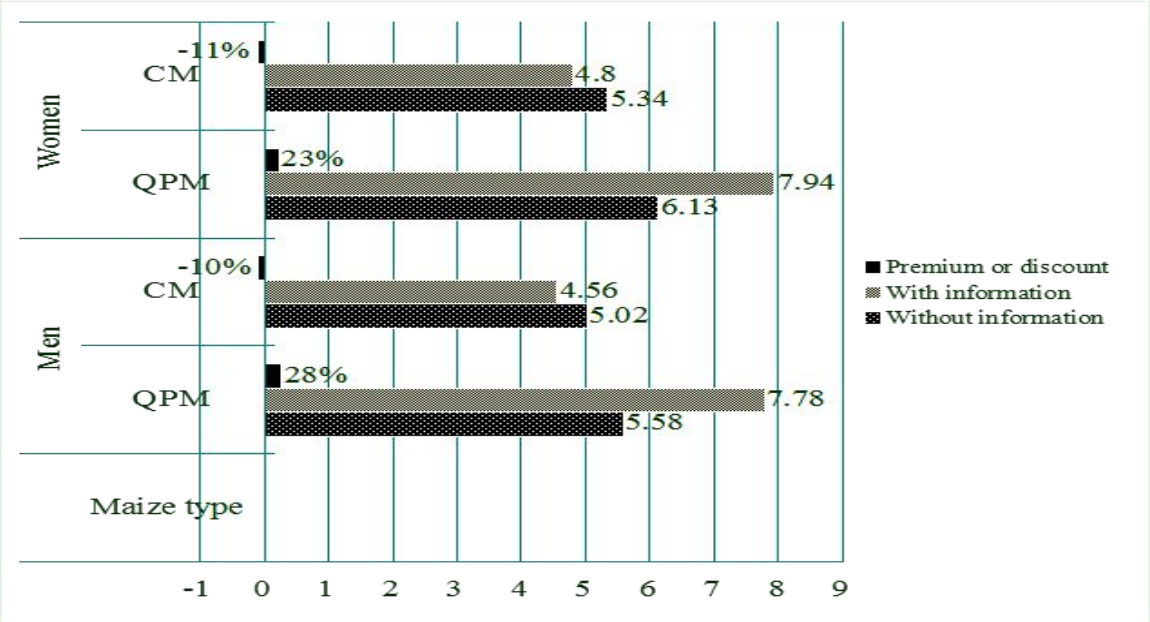
N= 192 for "without information" and N= 96 for "with information"

***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Own computation; 2015

When we see the impact of information among gender group, men gave large premium (28%) for QPM than women (23%). On other hand information has drove the women to give high discount (-11%) for conventional maize grain relative to men (-10%) summarized below by figure **[8]** showing impact of information on changing consumers mind to decide how much to pay particularly among gender groups.

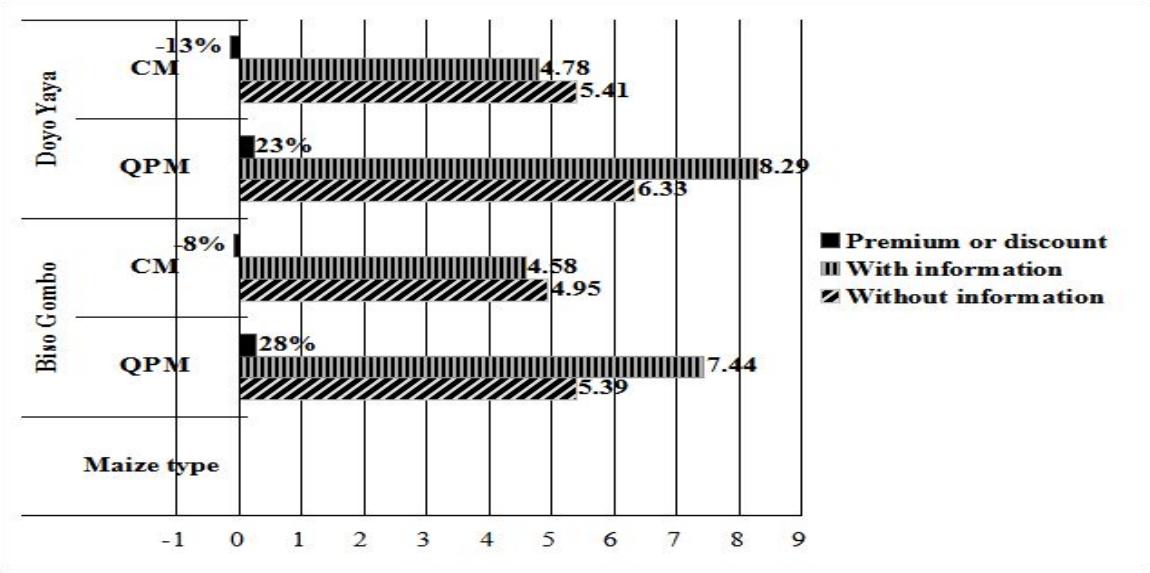
Figure 8: Effect of information on WTP among gender group



Source: Own computation; 2015

The information effect has also been seen geographically during the study. *Biso Gombo kebele* pay high premium after information (28%) relative to *Doyo Yaya kebele* (23%). On other hands, *Doyo Yaya kebele* made a high discount for conventional maize (-13%) after provision of QPM nutritional information relative to *Biso Gombo* (-8%). This shows that impact of information on willingness to pay for grains is different among different localities.

Figure 9: Effect of information on WTP among *kebele*



Source: Own computation; 2015

The descriptive result from modified home-use test also shows information has increased the WTP for white QPM by a premium of 55.96%, 49.81% and 43.6% on *Biso Gombo*, *Doyo Yaya* and *Waktola kebeles* respectively while increased the WTP for yellow QPM by a premium of 70.24%, 57.66% and 60.14% on the respective *kebeles*. On other hands, it has declined the WTP for white conventional maize grain by a discount of 17.32%, 23.39% and 16.58% on *Biso Gombo*, *Doyo Yaya* and *Waktola kebeles* respectively. However, the result was ambiguous on yellow conventional maize grain as it declined the WTP on *Doyo Yaya kebele* by a discount of 4.98% and raised *Biso Gombo* and *Waktola kebeles* by a premium of 24.17% and 28.53% respectively.

To generalize, information has increased the bids for white and yellow QPM by 50.1% and 62.88% respectively and declined the bid for white conventional maize by 20.1%. However, information has increased the bid for yellow conventional grain bid by 15%. Three possible reasons for the increment on yellow conventional maize bid. Firstly, no information was provided about the nutritional value of conventional maize grains and secondly, the appearance of yellow conventional maize grain is light yellow and in some extent similar to yellow QPM grain. Thirdly the grain size of yellow conventional maize is a very large than other grain which may be the possible reason. The finding of Kassie et al., (2014) supports this idea which revealed that maize grain size is positively and significantly related to farmers willing to pay.

The impact of information among *kebele*, maize type and color also identified that *Biso Gombo kebele* increased a premium of 56% for white QPM after provision of information while information has reduced WTP for white CM by a discount of 17% over the bid done before information. On other hand information has drove to increase WTP for yellow QPM by 70%.

Table 30: Impact of information on WTP on different sample grain by *kebeles* during modified home-use test

Kebele	Maize Color	Maize type	Mean WTP			Premium or discount % (C Vs A)
			(A)	(B)	(C)	
Biso Gombo	white	QPM	5.29	7.82	8.25	55.96
		CM	5.08	4.05	4.33	-17.32
	yellow	QPM	5.68	8.92	9.67	70.24
		CM	3.93	4.92	4.88	24.17
Doyo Yaya	white	QPM	5.34	9.09	8.00	49.81
		CM	5.38	4.82	4.36	-23.39
	yellow	QPM	5.55	8.92	8.75	57.66
		CM	4.64	5.00	4.42	-4.98
Waktola	white	QPM	5.00	6.75	7.18	43.6
		CM	4.50	3.29	3.86	-16.58
	yellow	QPM	5.67	8.59	9.08	60.14
		CM	3.83	3.82	4.92	28.53

Note: A= Before and without information, B= with information , C= Without information then information

N=210

Source: Own computation; 2015

From the table above, we can understand, *Doyo Yaya kebele* consumers were willing to pay a premium of 50% and 58% for white QPM and yellow QPM due to provision of nutritional information while they were willing to pay at a discount of 23% and 5% for white CM and yellow CM due to provision of information about QPM.

Lastly, the study used independent sample t-test to affirm whether information has impact on willingness to pay for QPM grain using three status of information afforded to the consumers regarding QPM: no information, information, before and after information. The result shows significant bid difference between with information and without information; and before and after information. However, there was no significant bid difference between with information and after information summarized below.

Table 31: Mean bids among information statuses during modified home use test

Information status	Mean	S.D	Sign.	Mean difference	Discount or premium%
No information (alone)	4.99	1.44	0.000***	1.34	26.85
With information (alone)	6.33	2.45			
Before information	4.99	1.43	0.000***	1.50	30.06
After information	6.49	2.42			
With information (alone)	6.33	2.45	0.335	0.16	2.527
After information	6.49	2.42			

N=210

***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Own computation; 2015

Random effect model result **(Table: 28)** also affirms the impact of information on WTP. The result from the main effect shows that information has affected the willingness to pay positively and significantly at 1% significance level (coefficient = 0.722) which is consistent with the finding on descriptive result. The cross effect result was also positive sign implies that information has increased the willingness to pay for QPM grain relative to non-informants (coefficient=1.522) and increased the WTP for yellow QPM (coefficient=1.711). When we consider the above coefficients, the main effect coefficient (0.722) is smaller as compared to the cross effect coefficient and color effect coefficient (1.522 and 1.711). This describes the decline of the bid for CM after provision of information decreased the impact of the information of the aggregate. Meaning, the decrease in WTP for conventional maize was not such higher than the increase in WTP for QPM grain, hence leading to a relatively less coefficient on information variable.

The implication behind these results is that nutritional knowledge can be an influential factor in consumer WTP for food products. Furthermore, the QPM nutritional information provided was extensive and it made consumers aware of almost all the benefits of QPM. To promote the marketability of QPM, therefore, awareness of its nutrient value should first be increased among the consumers. The result is consistent with the finding of Meenakshi et al., (2010) where provision of orange maize nutritional information has increased the acceptance for orange variety and a lowers

acceptance of white maize on the study in Zambia. It is also consistent with the finding of Kiria, (2010) and Dee Groote, et al., (2010b) on the study in Tanzania and Ghana respectively.

Oparinde et.al., (2015) also found that without an information campaign about the nutritional benefits of iron bean varieties, the white iron bean variety was assessed at a large discount, compared with the local variety and the red iron bean variety captures a large premium in the absence of information about its nutritional benefits. However, after provision of information about the nutritional benefits of iron bean varieties participants significantly increased premium for the red iron bean variety and significantly declined discount for the white iron bean variety.

To sum up, this finding proved the second hypothesis set as "Rural farmers in the study area opt to pay more for QPM grain than for conventional maize grain" and it has socio economic implication for seed multipliers, seed supplying cooperatives and enterprises, food processors and industries, retailers and traders.

4.8 IMPACT OF SENSORY QUALITY OF QPM DISHES ON GRAIN WTP

The random effect model which incorporates the aroma, appearance, texture in mouth and test as independent variables and willingness to pay before information as dependent variable was conducted to investigate whether there were a relationship between sensory quality and WTP and to identify the attribute most encourage the WTP for the grain.

The result shows positive impact of all attributes on WTP and texture in hand and test was statistically significant at 10% and 1% significance level respectively. The regression was conducted for the auction without provision of QPM nutritional information to exclude effect of information.

Table 32: Relation between sensory quality of QPM and WTP for its grain

Random-effects GLS regression		Number of obs =	384
Group variable: code		Number of groups =	96
R^2: within = 0.3390		Obs per group: min =	4
		Wald $chi^2(4)$=150.56	
corr(u_i, X) = 0 (assumed)		Prob > chi2 =	0.0000
WTP	Coefficients	Std. Err.	P>|z|
Aroma	0.117	0.2014	0.560
Texture in hand	0.362	0.2040	0.076*
Appearance	0.119	0.1813	0.510
Taste	0.625	0.1952	0.001***
Constant	0.280	0.4392	0.524
Sigma_u = 1.462			
Sigma_e = 1.252			
rho = 0.5769			
N=96			
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%			

Source: Own computation; 2015

Though positive coefficients of all attributes, they are very small. Moreover, texture in hand and Taste of *dabo* significantly influenced the WTP. This study is in line with what was found in Tanzania in which sensory quality of stiff porridge of maize positively affects WTP for maize flour (Kiria, 2010) and proves the third hypothesis which states that "Sensory quality of QPM affects farmers' willingness to pay for its grain". Oparinde et al., (2015) also found that participants` liking for the attributes of each of the iron bean varieties significantly increases their premium.

CHAPTER FIVE: SUMMURY, CONCLUSIONS AND RECOMMEDATIONS

5.1 SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

The aim of the study was to explore the sensory difference and acceptance exists between QPM and conventional maize traditional dishes and to elicit the magnitude of the willingness to pay for QPM grain among farmers in southwest Ethiopia in *Jimma* zone using different research techniques namely sensory evaluation and experimental auction techniques.

The sensory evaluation techniques used on this study were triangular test, central location test and modified home use test and the experimental auction technique used was Becker-De Groote-Marschak (BDM) auction mechanism.

The result of triangular test shows the existence of statistically significant sensory difference between *dabo* made of white QPM and white conventional maize; and yellow QPM and yellow conventional maize at 5% and 0.1% significance level respectively. Paradoxically, there was no clear and significant sensory difference between *dabo* prepared of two conventional maize grains.

The result of central location test also identified that the mean scores of *dabo* prepared from white QPM was consistently higher than that of white conventional maize in all attributes except for appearance. Similarly *dabo* from yellow QPM was significantly appreciated than the yellow conventional, white QPM and white conventional maize based *dabo* almost in all attributes.

The sensory evaluation test between porridge of white QPM and white conventional maize and yellow QPM and yellow conventional maize at home during modified home use test also examined that the mean score of *genfo* prepared from white QPM was significantly higher than the white conventional one in terms of texture in mouth, aroma, taste and overall. However, no significant differences in appearance and texture in hand as similarity in color of the grain between white QPM and white conventional maize *genfo*. On other hands, *genfo* from yellow QPM was highly and

significantly appreciated than the yellow conventional maize counterpart in all attributes. Alike mothers, children evaluation of *genfo* made of QPM and conventional maize shows that children`s mean overall score for both color QPM was significantly higher than both color conventional maize *genfo*.

The results suggested that QPM based dishes are different from that of the conventional maize dishes at least in one sensory characteristic. This sensory characteristic that differ QPM dish from the conventional maize dish during triangular test drove QPM dish to be appreciated and liked by consumers during central location test and modified home-use test. Thus; researchers, extensionists and organizations working in the area of food security and poverty reduction should use this sensory acceptance of QPM to disseminate and diffuse the technology. This encourages production and consumption of QPM among rural households and finally tackles malnutrition.

The experimental auction conducted using Becker-Dee Groote-Marschak mechanism also revealed that sample respondents were willing to pay more for QPM maize grain than for the conventional one on both modified home-use test and central location tests. Consumers' willingness to pay more for QPM grain encourages maize farmers, seed multipliers, seed supplying cooperatives and enterprises, food processors and industries, retailers and traders. Market acceptability of the technology drives those stakeholders to profitability and then facilitates its adoption and then indirectly fights malnutrition.

Another interesting result from both central location test and modified home-use test was the superiority of yellow QPM dishes. The result revealed that mean score of yellow QPM based dish was significantly higher than both white QPM and yellow conventional maize based traditional dishes. The result from experimental auction also confirms that bidders participated on both central location and modified home-use test opted to pay more premium for yellow QPM than other grains. Thus researchers and extensionists should emphasize on yellow QPM aside the white one due to its good sensory acceptance and its high market potential.

The result also shows significant difference between mean bids of consumers with

information and without information. Information has boosted bids for white and yellow QPM grain and reduced the bids of white and yellow conventional maize grains. This finding has two important notions: first the finding implies that the nutritious value of maize is the concern of consumers and they were voluntary to spend more for the nutritious maize grain. Second, information has immediate effect in changing consumers' mind to pay more for nutritious agricultural products. Therefore, concerning bodies should emphasize on formal and non-formal information dissemination mechanisms such as meetings, training, demonstrations, group discussion, advertisements and media to aware rural community, traders, industries and food processors about the nutritional value of QPM for its wider adoption and dissemination.

The information is expected to raise QPM farmers, new traders and food processors to fortify QPM with other related products. In order to increase adoption and subsequently increase consumption of QPM in rural areas, QPM seed has to be available to farmers. Farmers were asking about the availability of the seed during the experiment too. Thus, nutritious maize for Ethiopian (NuME) projects with concerning bodies like national and regional research institution and seed enterprises should encourage seed multiplication, seed value chain and dissemination of the QPM seed in addition to biological and agronomic studies for the demand which might be agitated after awareness.

Another core output of the study was relation between sensory score and WTP for QPM. The econometric result shows the main driving factor for more willingness to pay for QPM was its sensory quality seen on both central location and modified home-use tests. Thus, the marketers and food processors could use QPM favorable sensory characteristics to penetrate in to the market.

The result from experimental auction during random effect model shows family size is negatively and significantly related to willingness to pay. It is directly related to income constraint of households having large family size. Thus, government should consider those poor groups of households having large family size and constrained by income to use the technology.

The order of sample presentation had significant impact on both sensory evaluation and willingness to pay observed during the experiments. It is related to randomization of samples and thus, great care and attention should be given for the randomization of the sample dishes as well as the grain for future similar experiments.

The study used two local foods made of maize which are common in daily dishes of the society of the study area. The local food *dabo* was used on central location test and triangular test, and *genfo* was used on modified home-use test. However, the result of both experiments yielded that QPM dishes were more appreciated than the conventional maize dishes. The implication is that even if different food types was used, the result is the same and QPM based *dabo* and *genfo* was liked by evaluators in the same manner.

To sum up, consumers` sensory acceptance is the main tool for the adoption of new food related agricultural technologies. It is an important tool for new product development, improvement, assessment of market potential of the technology and for different decisions. The study was appreciated by farmers and it was a channel to discover their own true sensory ability, preference and willingness to pay for what they preferred. The researcher has identified three general issues from the study: consumers` sensory characteristics, consumers` true willingness to pay and socio economic and demographic factors related to their sensory preference and WTP decisions. More over the study investigated the consistency of the research methods such as triangular test, central location test, modified home-use test and Becker-De Groote-Marschak mechanisms and research methodologies like ordinal logistic model and random effect model to achieve the research objectives.

5.2 LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

The study was conducted in *Jimma* zone and *Omo Nada woreda*. Four *kebeles* were also selected to perform the job to achieve the goal set. However, during the study

different limitations was identified and appropriate recommendation has been given.

Due to time constraint, the study was limited to only one maize potential zone in Ethiopia which is found in southwest part of the country. The study covered one district and four peasant associations (PA) with satisfactory sample size. However, one zone is too few and cannot represent the rest of maize potential zones of the country since large socio cultural diversity and difference among regions and zones. Thus, the study should be extended to other maize producing areas of the country to supplement and support the findings of this study.

The study used both five and seven level hedonic scales and most of respondents were illiterates specially women. They were struggled to understand the complexity of seven level hedonic scales. Thus, it is more preferable to use the five point likert scale for non educated individuals especially for rural community since no significant score difference seen on samples and attributes evaluated by the scales.

The target group used on modified home-use test experiment was women and children aged 6-23 months. However, it was difficult to identify sensory preference of children especially when age of the children is below 12 months. Mothers were sometimes responding their own feelings during the evaluation when the children did not responded and faced difficulty of reading her child's facial satisfaction or dissatisfaction. Thus, modification should be made for future studies on the lower limit of the age of children for the reliability of the data.

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APPENDICES

Appendix I: Informed Consent Information Sheet

To the Enumerator: *Convey the complete information below to the respondent. Then ask the respondent if he/she has any questions, and answer these questions accordingly. If the respondent agrees to participate in the survey, please document their verbal informed consent prior to administering the questionnaire.*

You are being asked to participate in a research study. A member of the research team will describe the study to you and answer all your questions. Please listen to the information and ask questions about anything you do not understand before deciding whether or not to participate.

Why is this study being done?

This study will provide initial information to assess the impact of our project, Nutritious Maize for Ethiopia (NuME). In this project, we will be developing and promoting new maize varieties that provide better nutrition for people, especially mothers and young children. We are currently at the beginning of this project and would like to first understand the agricultural and nutritional situation in our target areas. You have been selected to participate because you are living in a target area. The results of this survey will also contribute to the success of future interventions in this area. The decision on your involvement will be made by you and only you.

What happens if you participate in this study?

If you participate in this study, you and your spouse will be asked questions on your household's agricultural and nutritional situation. You will complete your participation in one session.

Risks or discomforts

You or your household will not be exposed to any risks by participating in this study. You may possibly feel discomfort in discussing the income and food consumption of your household. A trained enumerator will help you to discuss any concerns you may have and to answer your questions.

Benefits

The results of this study will be used to guide NuME project and can provide useful information for the implementation of future interventions to improve agriculture, nutrition, and health in Ethiopia.

Confidentiality

All information about your household will be kept strictly confidential and will not be shared with people or institutions that are not involved in the research. You or your household will not be personally identified in any study report or publications.

Participation

Participation in this study is voluntary. You have the right to refuse to participate in this study. If you choose to participate, you have the right to stop at any time and to not answer certain questions in the questionnaire. If you refuse or stop your participation at any time, there will be no consequences.

Appendix II: Triangular test format for "*Dabo*" (traditional bread)

Introduction – Head of household

Dear Sir/Madam, we work for EIAR. We would like to ask you some questions on maize production and utilization. Taking part in this study is voluntary; you do not have to participate. If you choose to take part, you have the right to stop at any time and there will be no consequences. We would like to thank you for your full cooperation in advance.

1. Date of evaluation (dd/mm/yy) _____/_____/2015
2. *Woreda*_____
3. *Kebele*_____
4. Name of enumerator _____
5. Participant name_____
6. Sex_____age_____
7. Completed years of education _____(years)
8. Highest level attained_____
9. Marital status **1. Unmarried 2. Married 3. Divorced 4. Widow 5. Other**
10. Family size (member)_____
11. Occupation? **1. Farming 2.employed 3.self-employed off-farm 4. casual labor 5.student 6.others(specify)**
12. Land owner ship

Total land	cultivated	uncultivated	maize	QPM	Other crops

13. Livestock owner ship

cattle	sheep	goat	horse	mule	Donkey	Chicken	Total

14. Annual income in Birr

Live stock sale	Crop output sale	other sources	Total annual income

15. Triangular test

- Among the three types of *Dabo* given below, two are the same and one is different
- Please evaluate the three products, using any sensory method, and identify the one that is different (the odd one out).
- If no difference is apparent, you must guess.

- Types of codes: three random numbers on the paper or on the dish.

16. Respondent code _____

I. Sample code **S1**	
● Order of tasting:	Sample 1._____ Sample 2._____ Sample 3._____
● Which one of the three codes is different _____	
II. Sample code **S2**	
● Order of tasting:	Sample 1._____ Sample 2._____ Sample 3._____
● Which one of the three codes is different _____	
III. Sample code **S3**	
● Order of tasting:	Sample 1._____ Sample 2._____ Sample 3._____
● Which one of the three codes is different _____	
IV. Sample code **S4**	
● Order of tasting:	Sample 1._____ Sample 2._____ Sample 3._____
● Which one of the three codes is different _____	

I have described to the respondent this research study, its purpose, risks and benefits of participation, steps that will be taken to protect the privacy of the respondent and his/her household, and the voluntary nature of participation. The respondent was given the opportunity to ask questions regarding the study, and I have provided all answers to the respondent's satisfaction. I confirm that the respondent has freely consented to participate in this study.

Enumerator's name_____ signature _____date ___/____/____

Appendix III: Central location test format for *Dabo* (traditional bread)

Introduction – Head of household

Dear Sir/Madam, we work for EIAR. We would like to ask you some questions on maize production and utilization. Taking part in this study is voluntary; you do not have to participate. If you choose to take part, you have the right to stop at any time and there will be no consequences. We would like to thank you for your full cooperation in advance.

1. Date of evaluation (dd/mm/yy) _____/_____/_____
2. *Woreda*_____
3. *Kebele*_____
4. Name of enumerator _____
5. Participant code_____
6. Participant name_____
7. Sex _____age _____
8. Completed years of education _____ (years)
9. Highest education level attained:_____
10. Marital status **1. Unmarried 2. Married 3. Divorced 4. Widow 5. Other**
11. Family size (members)_____
12. Occupation? **1. Farming 2.employed 3.self-employed off-farm 4. casual labor 5.student 6.others(specify)**

13. Land owner ship (Timad)

Total land	cultivated	uncultivated	maize	Other crops

14. Livestock owner ship

cattle	sheep	goat	horse	mule	Donkey	Chicken	Total

15. Annual income in Birr (cash)

Live stock sale	Crop sale	other sources	Total annual income

16. Please evaluate each food preparation in the order that it is presented to you. Please completely finish your evaluation of one food preparation before moving to the next food preparation. For each attribute, please indicate your score with tick marks **(X)** in the tables below using codes comes with the Bread

A. Table for five point likert scale

Food Code	Attribute	Dislike very much 	Dislike 	Neither like nor dislike 	Like 	Like very much 
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					

B. Table for seven point likert scale

Food Code	Attribute	 Dislike very much	 Dislike moderately	 Dislike slightly	 neither like nor dislike	 Like slightly	 Like moderately	 Like very much
	Appearance							
	Texture in hand							
	Aroma							
	Texture in mouth							
	Taste							
	Overall							
	Appearance							
	Texture in hand							
	Aroma							
	Texture in mouth							
	Taste							
	Overall							
	Appearance							
	Texture in hand							
	Aroma							
	Texture in mouth							
	Taste							
	Overall							
	Appearance							
	Texture in hand							
	Aroma							
	Texture in mouth							
	Taste							
	Overall							

18. Experimental auction

18.1 Experimental auction test round

- Do tests round with another product that does not affect the cash-in-hand much Biscuit 1.25 (2 types).
- Explain that it is in the best interest of the participant to bid his or her true WTP. Give: 2 Birr.

- Ask to make bids for each
- Randomly select one of the products (draw cards with 1 (first product) or 2 (second product).
- Draw a series of number from 0.25, 0.5; 0.75, 1.00; 1.25; 1.50; 1.75 and 2.00

18.2 Experimental auction without any information

- Here under are the codes of two different varieties of maize grain you tested above.
- I will show you a bag with four *Tasas* of the four differently coded maize grain you just tasted, one at a time and ask you how much you are willing to pay for each .
- I will ask you to make bid for each bag and I will write your four bids down
- Then you will draw a number from 1 to 4 to determine the binding product with the binding bid.
- You will then pick a random number from a distribution to determine the winning price for the binding product.
- If the bid you offered is higher than or equal to the randomly drawn price, you win the auction and you have to buy the grain at the price of the random number you picked. Otherwise you lose the auction and you do not purchase the maize.
- Kindly note that it will be to your own benefit that your bid is the true amount that you are willing to pay for the maize grain. In this kind of auction, if you give a lower bid than your true willingness to pay (for example you bid 2 Birr when your WTP is 4 Birr), you might lose an opportunity to buy when you draw a number of 3 Birr. If your bid is too high, for example 5 Birr and you draw the number 5, you have to buy at that price. At your true WTP when the number /higher bid than your true value, you are the one who ends up losing.

- Now let start our bidding

Maize type	Bid in Birr
Bid for product 1	
Bid for product 2	
Bid for product 3	
Bid for product 4	

Randomly assign binding product: _____ (number between 1 and 4), or use the symbols:

Random number drawn:_____ (from the set of random numbers)

Is the bid higher than the random number? _____ 1.Yes 2.no

If yes, the participant buys the product at the random price/number

If no, the participant does not buy any maize.

18.3 Experimental auction with information

- We will have four types of maize Grain; white and yellow QPM and white and yellow conventional maize.
- QPM package labeled **QPM** and conventional maize is labeled **CONVENTIONAL**.
- I will show you four ***Tasa*** of all QPM and CONVENTIONAL maize grains, one at a time and ask you how much you can pay to have each.
- I will ask you to bid for each maize grain and I will write your two bids down,
- You will then pick random number from a distribution to determine the winning price for each maize type.
- If the bid you set is higher than or equal to the randomly picked winning price, you win the auction and you have to buy the grain at the price of the random number you picked. Otherwise will not have any maize grain.
- Kindly note that it will be to your own benefit that your bid is the true amount that you are willing to pay for the maize grain. In this kind of auction, if you give a lower/higher bid than your true value, you are the one who ends up losing.

❖ Now let us start our bidding

Maize type	Bid in Birr
Bid for white **QPM**	
Bid for yellow QPM	
Bid for white conventional	
Bid for yellow conventional	

Randomly assign binding product: _____(number between 1-4), or use the symbols:

Random number drawn:_____ (from the set of random numbers)

Is the bid higher than the random number?_____ 1.Yes 2.no

If yes, the participant buys the product at the random price/number. If no, the participant does not buy any maize.

I have described to the respondent this research study, its purpose, risks and benefits of participation, steps that will be taken to protect the privacy of the respondent and his/her household, and the voluntary nature of participation. The respondent was given the opportunity to ask questions regarding the study, and I have provided all answers to the respondent's satisfaction. I confirm that the respondent has freely consented to participate in this study.

Enumerator name_____ signature_____ date_____

Appendix IV: Modified home use test format for *genfo* (porridge)

Introduction – Respondent mother

Dear Madam, we work for EIAR. We would like to ask you some questions on your acceptance and willingness to pay for different varieties of maize, which are now being promoted and grown in this region. Taking part in this study is voluntarily: you do not have to participate. If you choose to take part, you have the right to stop at any time and there will be no consequences. Every effort will be made to ensure that any information you share with study staff is kept private and confidential. You can refuse to answer any question, and you will not be personally identified in any reports about this study. Your responses will help us to understand which varieties are preferred and

why, especially among mothers of young children, and this will guide future research and promotion of new varieties. We are happy to answer any questions you have, and we would like to thank you for your participation in advance.

1. Date of evaluation (dd/mm/yy) _____/_____/_____
2. *Woreda*_____
3. *Kebele*_____
4. Enumerator's name_____
5. Participant code(mother)_____
6. Participant name(mother)_____
7. Age of mother(years)_____
8. Completed years of education _____
9. Marital status **1. Unmarried 2. Married 3. Divorced 4. Widow 5. Other**
10. Number of living children_____
11. Occupation? **1. Farming 2.employed 3.self-employed off-farm 4. casual labor 5.student 6.others(specify)_____**
12. Land owner ship (Timad)

Total land	Cultivated	Uncultivated	Maize	Other crops

13. Livestock owner ship

Cattle	Sheep	Goat	Horse	Mule	Donkey	Chicken	Total

14. Annual cash income in Birr

Live stock sale	Crop sale	Other sources	Total annual income

15. Index child name_____
16. Index child sex____17. Index child age (months) _____
18. Practice round for consumers acceptance of two types of Biscuits (1and 2)

Please indicate how you evaluate each biscuit for the five attributes and overall, by ticking in the correct space:

Biscuit code		Dislike very much 	Dislike 	Neither like nor dislike 	Like 	Like very much 
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					
Main reason for mother's overall rating:_____						
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					

Main reason for mother's overall rating:_____

Dislike very much ----------baay'ee jibbisiisaadha

Dislike----------jibbisiisaadha

Neither like nor dislike----------hin jaalannes hin jibbines

Like----------jaaladheera

Like very much----------baay'ee jaaladheera

19. How the *Genfo* was prepared (include quantities of maize, water, fat, sugar, salt, and other ingredients):_____

_____

20. Mother's rating: Please evaluate each food preparation in the order that it is prepared. Please completely finish your evaluation of one food preparation before moving to the next food preparation. For each attribute, please indicate your score with tick **(X)** in the tables below based on codes come with the *Genfo.*

   

21. Sample type _____and _____

Genfo Code	Attribute	Dislike very much 	Dislike 	Neither like nor dislike 	Like 	Like very much 
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					
Main reason for mother's overall rating:_____ _____						
	Appearance					
	Texture in hand					
	Aroma					
	Texture in mouth					
	Taste					
	Overall					

Main reason for mother's overall rating:_____

Dislike very much ----------baay'ee jibbisiisaadha

Dislike----------jibbisiisaadha

Neither like nor dislike----------hin jaalannes hin jibbines

Like----------jaaladheera

Like very much----------baay'ee jaaladheera

22. Child's rating (Mother's remarks on child's reaction to the food preparation)

Food Code	Attribute	Dislike very much 	Dislike 	Neither like nor dislike 	Like 	Like very much 
	Overall					
	Overall					

Dislike very much ----------baay'ee jibbisiisaadha
Dislike----------jibbisiisaadha
Neither like nor dislike----------hin jaalannes hin jibbines
Like----------jaaladheera
Like very much----------baay'ee jaaladheera

23. Experimental auction (Mother)

23.1 Experimental auction test round

- Here I will provide two different types of biscuit and show up money for the auction.
- You are expected to bid your true WTP.
- After you submit your true WTP, Randomly select one of the products (draw cards with 1 (first product) or 2 (second product) to select binding product.
- You will draw a random number from a series of 0.25 to 2 ETB (so 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75 and 2.00)
- If your bid is greater than or equal to random number drawn, you will win, pay the amount that was drawn, and take the biscuit. However, if your bid is less than the random number drawn, you are not going to buy it.

- Let us start our auction now.

Biscuit	Bid in Birr (ETB)
Bid for: biscuit _____	
Bid for : biscuit _____	
Randomly assign binding product : _____ (number between 1 and 2) or symbols Random number drawn:_____ Is the bid higher than the random number? _____ 1.Yes 2.no	

23.2 Experimental auction without information (before information)

- Here under are the codes of two different varieties of maize grain you tested above.
- I will show you a bag with four *Tasas* of the two differently coded maize grain you just tasted, one at a time and ask you how much you are willing to pay for each .
- I will ask you to make bid for each bag and I will write your two bids down.
- Then you will draw a number 1 and 2 (symbols) to determine the binding product with the binding bid.
- You will then pick a random number from a distribution to determine the winning price for the binding product.
- If the bid you offered is higher than or equal to the randomly drawn price, you win the auction and you have to buy the grain at the price of the random number you picked. Otherwise you lose the auction and you do not purchase the maize.
- Kindly note that it will be your own benefit that your bid is the true amount that you are willing to pay for the maize grain. In this kind of auction, if you give a lower bid than your true willingness to pay (for example you bid 2 birr when your WTP is 4 Birr), you might lose an opportunity to buy when you draw a number of 3 Birr. If your bid is too high, for example 5 Birr and you draw the number 5, you have to buy at that price. In this kind of auction, if you give a lower or higher bid than your true value, you are the one who ends up losing.

- Now let start our bidding by sign _____ vs _____codes

Maize type	Bid in Birr (ETB)
Bid for code:	
Bid for code :	

23.3 Experimental auction with information

- To the enumerator (provide information given to you regarding QPM)
- We will have two types of maize Grain; one is QPM and the other is conventional maize.
- QPM package labeled **QPM** and conventional maize is labeled **CONVENTIONAL**.
- I will show you four ***Tasa*** of QPM and CONVENTIONAL maize grain, one at a time and ask you how much you can pay to have each.
- I will ask you to bid for each maize grain and I will write your two bids down,
- You will then pick random number from a distribution to determine the winning price for each maize type.
- If the bid you offered is higher than or equal to the randomly drawn price, you win the auction and you have to buy the grain at the price of the random number you picked. Otherwise you lose the auction and you do not purchase the maize.
- Kindly note that it will be to your own benefit that your bid is the true amount that you are willing to pay for the maize grain. In this kind of auction, if you give a lower or higher bid than your true value, you are the one who ends up losing. Now let us start our bidding

Maize type	Bid in Birr (ETB)
Bid for **QPM**	
Bid for **CONVENTIONAL**	
Randomly assign binding product : _____(1 or 2)Random number drawn:_____ (Birr) Is the bid higher than the random number? _____ 1.Yes 2.no	

I have described to the respondent this research study, its purpose, risks and benefits of participation, steps that will be taken to protect the privacy of the respondent and his/her household, and the voluntary nature of participation. The respondent was given the opportunity to ask questions regarding the study, and I have provided all answers to the respondent's satisfaction. I confirm that the respondent has freely consented to participate in this study.

Enumerator's name: _____signature _____Date_____/_____/ 2015

Appendix V: Information provided on quality protein maize (QPM)

(This is the English translation of the text which was actually read to the respondents in Oromiffa)

Quality protein maize (QPM) is improved maize varieties that were bred for higher lysine and tryptophan levels, essential nutrients for growth and health. QPM is not genetically modified; it is a product of conventional breeding.

Lysine and tryptophan are important because they are used to make proteins. Proteins are very important: they constitute about 25% of the body weight of adults and they are the building blocks of the body. A chronic lack of protein in the diet leads to *kwashiorkor*. Good protein sources include animal source foods (such as meat, milk, eggs, and fish) or legumes (such as beans and peas), but these foods can be more expensive.

QPM contains nearly twice as much usable protein as conventional maize because it produces 70%-100% more lysine and tryptophan than conventional maize varieties. These two amino acids allow the body to manufacture complete proteins, thereby reducing the risk of *kwashiorkor*. Young children consuming QPM grow better and are at a lower risk of malnutrition disorders such as *kwashiorkor*.

Mono-gastric animals (e.g., pigs, chicken, etc.) fed on QPM experience faster weight gain and are ready for market sooner or can provide an additional quality protein source for small farm families.

Appendix VI: Pictures during the experiments

Picture 1: Triangular test

Picture 2: Central location test

Picture 3: Modified home-use test

Picture 4: Experimental auction during central location test