ASSESSMENT OF WILLINGNESS TO PAY FOR QUALITY SWEETPOTATO PLANTING MATERIALS: THE CASE OF SMALLHOLDER FARMERS IN TANZANIA

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DECLARATION

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

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To my loving parents Samuel Mwiti and Hellen Ntinyari for their invaluable investment in my life.

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ACRONYMS AND ABBREVIATIONS

VAD:	Vitamin A deficiency
OFSP:	Orange fleshed sweetpotato.
NON-OFSP:	Non-orange fleshed sweetpotato
FBR:	Foliate biofortified Rice
WTP:	Willingness to Pay
BDM:	Becker-DeGroot-Marschak
CV:	Contingent valuation
CIP:	International Potato Centre
REPOA:	Research on Poverty Alleviation.
FAO:	Food and Agriculture Organization.
SPVD:	Sweetpotato Viral Disease.
DVM:	Decentralized vine multipliers.
MD:	Mass distribution.
PHC:	Population and Housing Census of Tanzania

ABSTRACT

In Africa, malnutrition and hunger continue to be major problems affecting developing countries, especially those in Sub-Sahara Africa. One of the major nutritional problems facing developing countries is micronutrient deficiency, vitamin A in particular. Biofortification, especially in staples can reduce prevalence of vitamin A deficiency and food insecurity. One of the biofortified staple is the Orange Fleshed Sweetpotato (OFSP). Recent interventions targeting reduction of Vitamin A deficiency have therefore promoted the growing and consumption of OFSP. However, sweetpotato growers face a major challenge of access to quality planting materials (defined as planting materials free from pest and diseases). Therefore, there have been efforts to supply cleaned vines of these biofortified crops in some countries, including Mozambique, Malawi, Rwanda, Ghana, Kenya, Uganda and Tanzania. However, biofortification of sweetpotato changes its color, taste and dry matter content. A study conducted in Uganda found that farmers are willing to pay for biofortified products, but only when they have information about the benefits such products deliver. The effects of changes in dry matter content and taste on farmers willingness to pay clean vines of biofortified crops are however unknown. This study analyzes willingness to pay (WTP) for quality planting materials of biofortified and non-biofortified varieties of sweetpotato and the factors that influence WTP for such materials. It also assesses differences in WTP by variety, region and agro-ecological zone between the biofortified and non-biofortified clean planting materials. The factors affecting WTP for quality planting materials were assessed using seemingly unrelated regression (SUR) model in order to accounts for possible correlation in the error terms. Analysis of variance method (ANOVA) was used to compare WTP by region, agro ecological zone and across different varieties. The data used in this study was collected from 732 farm households stratified by participation in a sweetpotato project implemented in Tanzania between 2009 and 2013. The results reveal that consumers are willing to pay highest for clean planting materials of New Polista, followed by Kabode and then New Ukerewe, Ejumula and lowest for Jewel indicating higher demand for clean planting materials of non-biofortified variety. Results of the SUR model indicated that farmer-specific factors (e.g., age and education), location factors (e.g., distance to markets), asset endowments factors (e.g., wealth and income), and varietal attributes (e.g., taste and yield) affect willingness to pay for clean planting materials but the effect is variety specific. This study concludes that willingness to pay for quality planting materials of biofortified OFSP and the non-OFSP varieties differs by region, agro ecological zones and varieties. It also concludes that farmers are willing to pay for quality planting materials of non-biofortified varieties, especially New Polista, than for the biofortified OFSP varieties. The implications of these findings are that farmers' demand for clean planting materials of non-OFSP varieties is still stronger than for the OFSP varieties. Therefore, projects and programs that promote the production of OFSP should not ignore the importance of popular local varieties, such as New Polista, to the farmers. The finding that distance to source of quality planting materials reduces demand for such materials supports the need to decentralize multiplication and make it available locally and closer to the farmers and the finding that a number of varietal attributes affect the demand for quality planting materials implies the need to focus breeding on varietal attributes in addition to the agronomic attributes.

1.0: INTRODUCTION

Micronutrient malnutrition and hunger are major problems affecting developing countries, especially those in Sub-Saharan Africa (FAO, 2012). According to FAO (2012) almost 870 million people were chronically undernourished in 2010–12 and the number of hungry people in the world is still unacceptably high. One of the major nutritional problems facing these countries is micronutrient deficiency, in particular of vitamin A (West and Darnton-Hill, 2001), which mostly affects low-income groups (Micronutrient Initiative, 2005).Vitamin A deficiency (VAD) leads to vision problems and impaired immune systems. It is estimated that nearly 127 million preschool children worldwide suffer from vitamin A deficiency. According to the World Health Organization (2002), between 250,000 and 500,000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight. Since Vitamin A is essential to the body in supporting the immune system, its deficiency increases the risk of disease and death. Each year, it is estimated that 670,000 children die and 350,000 go blind due to vitamin A deficiency (VAD). Vitamin A deficiency can also increase the risk of illness and death from diseases such as malaria and measles.

In Tanzania, the level of malnutrition among children is quite high. It is estimated that about 40% of children less than five years of age are stunted, implying that they are too short for their age, which is an indicator of chronic under-nutrition (Tanzania Demographic and Health Survey, 2004). The Tanzanian National Bureau of Statistics (TNBS) (2005) further indicates that about 3% of children are wasted (that is, they have low weight-for-height ratio) hence suffer from acute under-nutrition. Moreover, Research on Poverty Alleviation (REPOA) (2009) concluded that despite improvements between 1999 and 2004/05, data shows that the prevalence of children under nutrition remains high in Tanzania.

The adverse effects of vitamin A deficiency are intense in areas and regions where poverty prevents people from growing and eating more nutritious food or purchasing food supplements. According to UN Food and Agriculture Organization (2011), high food prices have forced millions of people into poverty and hunger and exacerbated the problem of malnutrition. As food prices rise, families cut back on purchasing fruits, vegetables and meat products and instead increase the purchase cereal staples. However, staple crops such as wheat, maize and rice are low in micronutrients such as vitamin A, iron and zinc. Similarly, Okello et al., (2013) argue that low diet diversity among low-income populations and greater reliance on cereals contributed to inadequate intake of Vitamin A in Rwanda.

Biofortification is emerging as a new intervention that can have significant impact on malnutrition through the introduction of locally adapted staple foods that are bred to be high in micronutrients (Bouis, 1999). Biofortification seeks to improve the nutritional quality of staple foods consumed by poor people. Orange Fleshed Sweetpotato (OFSP) is one of biofortified staple crops that have recently attracted much interest following the success of the efficacy trials that showed that it can greatly contribute to reductions in vitamin A deficiency (VAD). The OFSP is high in beta carotene, a precursor for vitamin A. It is therefore one of the crops being heavily promoted as a remedy to the VAD in sub-Sahara Africa

Evidence from Uganda suggests that OFSP can provide significant amounts of vitamin A to malnourished children and women (Harvestplus, 2012). Van Jaarsveld et al., 2005 also found that regular consumption of modest amounts of boiled OFSP roots by children improved their vitamin A levels in the blood. A similar result was obtained by Lowet al., (2007). These studies indicate that one-quarter to one full cup of boiled and mashed OFSP is able to meet intake requirement of children under 5 fives, which is recommended to be 400 - 500 Retinol Activity Equivalents (RAE) (Jaarsveld et al., 2006; Institute of Medicine, 2001).

Sweetpotato is one of the most widely grown root crops in many African countries. According to FAO (2008), it covers approximately 2.9 million hectares with 12.6 million tons estimated production in 2007. Rwanda, Kenya, Uganda and Tanzania are among the countries where sweetpotato is a significant food crop, especially during periods of food shortage while Angola, Malawi, Madagascar and Mozambique are modest producers (Woolfe, 1992). According to Woolfe (1992), sweetpotato is superior to other staples, such as maize, in that it generates large amount of food per unit area, yields more even on poor soils and is drought tolerant (Ewell, 1990).Wheatley and Loechl (2008) argues that sweetpotato is different from other root crops in the role it plays in enhancing the diets/nutrition of rural and urban consumers and incomes of rural households, hence justifying the efforts to increase its production. They further found that, in addition to combating vitamin A deficiency, roots of orange-fleshed sweetpotato are important sources of vitamin C, B and E, while leaves are rich in micronutrients and proteins. Some varieties of sweetpotato are early maturing (i.e., takes with 3-4 months to mature) hence are suited for the drier agro-ecologies. Further, sweetpotato has unique starch properties (these include, among others, amylose content, granule structure, gelatinization and pasting behavior) which are already being exploited in Asia but not yet in SSA (Wheatley and Loechl, 2008).

Despite the current efforts to promote sweetpotato consumption, access to quality planting materials has remained a major factor hindering increase in sweetpotato production. Fuglie (2007), for example, found that seed quality and supply system were ranked the highest priority for future research and development (R&D) against all other sweetpotato technologies.

1.1. Statement of the problem

Malnutrition and hidden hunger continue to be major problems faced by Sub-Saharan Africa. HarvestPlus, a global alliance of research institutions and implementing agencies, has to date led global effort to combat malnutrition caused by the lack of essential vitamins and minerals such as vitamin A, zinc and iron in diets. HarvestPlus has specifically been leading efforts to breed and disseminate biofortified crops for better nutrition through promoting the growing and consumption of biofortified food crops. One of the biofortified crops being promoted in order to combat vitamin A deficiency in diets is OFSP. However, despite these, access to quality (that is, disease and pest-free) planting materials has been a major challenge, especially early in the season (Andrade et al., 2009; Fuglie, 2006; Sindi et al., 2012). At the same time, in some of the sweetpotato varieties, the virus load can becomes a big problem, resulting in a major decrease in yield (Kapinga et al., 1995; Mukibii, 1977; Gibson et al., 1998).

In response, the International Potato Center (CIP), jointly with government of Tanzania and other non-governmental organization partners, recently implemented, in the lake zone region of

Tanzania, a project that provided access to quality planting materials. The project also aimed at improving nutrition and food security for farmers who rely of sweetpotato as staple food and for income generation (Sindi et al., 2012). The project distributed sweetpotato planting materials that are free from virus and sweetpotato weevil infection to approximately 10,000 farmers. The sweetpotato vines included both biofortified (orange-fleshed) and non-biofortified (non-orange fleshed) varieties.

Recent studies have shown that farmers who are aware of the benefits of consuming OFSP are willing to pay more for OFSP roots than their counterparts (Meenakshi et al., 2010). Theoretically, this demand for roots is expected to translate into demand for OFSP vines. However, the same and other studies have also indicated that the changes in taste and dry matter content caused by biofortification negatively affect demand for OFSP roots (Nestel et al., 2006; Masumba et al., 2007; Tumwegamire et al., 2007; Naico and Lusk, 2010). Hence farmers face a dilemma over the choice of nutrition against taste and dry-matter content. Indeed, Combris et al., (2007) found that some attributes of a product (specifically taste) is more important to the consumer in product choice than nutritional quality. To date no known study has examined in the effect of root attributes (namely, taste and dry matter content) and the quality of planting materials on demand for sweetpotato planting materials. This study used a field experiment that controlled for quality of planting materials to compare farmer demand for biofortified (OFSP) and non-biofortified (NON-OFSP) varieties and the factors affecting the demand for these varieties.

1.2.0. Purpose of the study

The purpose of this study was to assess the farmers' willingness to pay (WTP) for quality biofortified and non-fortified sweetpotato planting materials (vines) and the factors affecting the willingness to pay for biofortified OFSP planting materials.

1.2.1. Specific objectives

The specific objectives of this study were:

1. To compare the farmers' willingness to pay for quality planting materials across different administrative regions, agro-ecological zones and varieties.
2. To compare the farmers' willingness to pay for quality planting materials of biofortified versus non-biofortified sweetpotato varieties.
3. To assess the factors influencing willingness to pay for biofortified and non-biofortified clean sweetpotato planting materials.

1.2.2. Hypotheses tested

This study tested the following hypotheses:

I. Mean willingness to pay for quality sweetpotato planting materials does not differ across administrative regions, agro-ecological zones and varieties.

II. The mean willingness to pay for quality non-biofortified sweetpotato planting material is higher than the mean willingness to pay for biofortified varieties.

III. The number of young children in the household does not influence willingness to pay for biofortified and non-biofortified quality sweetpotato planting materials.

1.3. Study background

Vegetatively propagated crops such as sweetpotato, cassava, yams and plantains are important for food security in sub-Saharan Africa. Their combined production exceeds that of cereals (FAO, 1998). However, yields per hectare are generally far below world averages. It is estimated that about three quarters of sweetpotato production in Africa is in East Africa, particularly in the Great Lakes region, with Uganda having the largest production in Africa and the second largest in the world. Tanzania has the second largest area under production of sweetpotato in Africa, after Uganda, but due to low yields, is only the sixth largest producer (FAO, 1998). According to Gibson et al., (2000), the underlying cause of low yields in sweetpotato in East Africa is sweetpotato virus disease (SPVD).

In Tanzania, sweetpotato is the second most important root crop after cassava, because it tends to do well even when the rains are insufficient (Kapinga et al., 1995). Sweetpotato is considered a reserve crop that families turn to during famine and drought. It is mainly grown for home consumption, except in areas with good climate, where it is grown as a cash crop. Recent spread of the cassava brown streak virus disease has made sweetpotato an important source of energy for many rural households (Sindi et al., 2012).

Currently, there is no significant production of sweetpotato planting material by the private and public sector. As a result, farmers recycle old planting material over long periods of time. This leads to deterioration in quality of such materials and the buildup of pest and diseases, and consequently to decreases in yield (Harvestplus, 2012). The Marando Bora project was designed to tackle some of these problems. It specifically aimed at addressing the problem of farmers' lack of access to quality planting material. The project used two strategies namely, decentralized vine multipliers (DVM) and mass distribution (MD) to improve farmer access to quality sweetpotato planting materials. Under the DVM model, 88 trained vine multipliers were provided with quality planting materials to bulk. The farmers were then linked to these multipliers through a voucher scheme that enabled them to purchase quality planting materials at subsidized rates. The MD model used community-based groups to distribute quality vines to farmers at no cost from central locations. Both models had a common component which included creating awareness among farmers, vine multipliers and extension agents on the importance of using quality planting materials and how to maintain the quality of such materials on the farm. This project also had promotional campaigns which were designed to create awareness of the benefits of using cleaner planting materials, benefits of consuming orange fleshed sweetpotato and sources of quality planting materials.

1.4. The organization of thesis

This thesis is organized into five chapters. Chapter 1 provides introduction, background of the study, problem statement, the purpose of the study, objectives and hypothesis. Chapter 2 summarizes the relevant literature while Chapter 3 discusses the study methodology and covers the analytical framework, data sources, sampling procedure, data collection method, empirical models and the study area. Chapter 4 presents the results and discusses the findings and Chapter 5 provides the summary, conclusions and recommendations.

2.0: LITERATURE REVIEW

2.1. Biofortification

Biofortification is a new approach to tackling hidden hunger by using stapled foods consumed by poor people as part of the regular diet. It was launched in 2003 with the formation of HarvestPlus, and since then, scientists have been developing new varieties of staple food crops with higher amounts of vitamin A, iron, and zinc. Hidden hunger is defined as a condition where people do not get enough of crucial vitamins and minerals such as vitamin A, zinc, and iron, even though they have enough food. It is hidden in the sense that its effects are usually not visible (Harvestplus, 2012). Biofortification has advantages over other nutrition interventions because it reaches the rural communities often missed by other nutrition interventions such as supplementation and industrial fortification, and it is sustainable since it uses staple foods that people already eat regularly.

The oldest biofortified crop in Africa is quality protein maize, which was bred for higher levels of lysine and tryptophan, the limiting amino acids in maize, which substantially increases the quality of the maize protein (Krivanek et al., 2007). The second crop to be biofortified was orange flesh sweetpotato. These varieties of sweetpotato were bred for high pro-vitamin A content (Low et al., 2007). Other examples of crops that have recently been biofortified are: maize varieties high in pro-vitamin A (released in 2011), beans with iron and zinc (2010), pearl millet with iron and zinc (2011), rice with zinc and iron (2012), wheat with zinc and iron (2013), and pro-vitamin A rich cassava (yet to be released) (Meenakshi, 2008).

2.2. Review of empirical methods

Following past studies, this study has used the seeming unrelated regression model to assess the factors that affect farmers' willingness to pay quality sweetpotato planting materials. Luchini et al., (2003) did a study that elicited several willingness to pay for three health programmes (including heart disease, breast cancer and a service of helicopter ambulance), in a single contingent valuation survey in health care. They compared the application of independent Ordinary Least Square Regressions (OLS) for each programme versus simultaneous estimations using Seemingly Unrelated Regressions (SUR). Their results showed that separate estimations could lead to model misspecification because they do not take into account the fact that joint evaluation exogenously provides a reference structure to the respondent, which affects the estimates of willingness to pay for each programme. They indicated that the use of SUR model improved efficiency of the willingness to pay estimates. Moreover, their study showed that willingness to pay equations for the three programmes were significantly correlated through their error terms, which gave additional evidence that some common factors, not explicitly observed in the survey, were jointly influencing respondents' willingness to pay for all three programmes.

Combris et al., (2007) investigated how information on quality attributes affects consumers' willingness to pay for pears in a study conducted in Portugal. The study objective was to compare the relative influences of attributes which are directly observable, like "appearance" of pears, experience attributes like "taste" and credence attributes like "food safety", which cannot be evaluated directly by consumers. The study found that consumers are willing to pay significantly more for fully ripened pears and for better quality assurances such as the absence of pesticides. It also found that the sensory intrinsic attributes related to taste finally beats the guarantee of food safety in driving the buying behavior and that even when consumers were well informed about safer products, they still chose the tasty alternative. This current study therefore compares willingness to pay for quality planting materials of both biofortified and non-biofortified crops that were similar in every aspect except that one is high in vitamin A (hence orange-fleshed) while the other is not (hence white-fleshed).

A study by Shibru (2006) assessed the value of conserving the wild coffee genetic resource for the local coffee producing farmers in terms of their willingness to pay for improvements in the coffee planting material and the production effects of improved coffee cultivars. The study found that farmers' willingness to pay for improved coffee planting material is affected by performance of the planting materials against yield-limiting factors such as coffee berry disease, coffee wilt disease, rust, and the vigorous growth nature of the coffee trees.

Hugo et al., (2010) assessed rural consumers' willingness to pay for orange, biofortified maize in Ghana using three elicitation methods namely, Becker-DeGroot-Marschak (BDM), choice experiments and group auctions. The survey was based on a sample of 696 respondents. Results indicated that color preferences are affected by regional factors and the information the consumer has about the biofortified maize. They argued that the color of biofortified maize should therefore not be seen as major impediment, and recommended that proper informational messages should differ by regions, and based on the context.

A study by Steur (2011) evaluated, ex-ante, the market potential of foliate biofortified rice (FBR) in China. They found relatively high acceptance of FBR (62.2 %) and that consumers were willing to pay 33.7% higher price than for regular rice.

Pillay et al., (2011) assessed consumer acceptance of yellow, pro-vitamin A-biofortified maize in KwaZulu-Natal, South Africa, using consumer sensory evaluation and the logit and ordinary least squares regressions. The study found that consumers would purchase yellow maize only if it was sold at a lower price than the predominant white maize. Interestingly, the study also found that preschool children preferred food products from yellow maize than from white maize. It concluded that pro-vitamin A- rich yellow maize has the potential to succeed as a new strategy of dealing with the serious problems of vitamin A deficiency among preschool-age children.

A study by Chowdhury et al., (2011) assessed the willingness to pay more for micronutrient-dense biofortified foods by consumers in Uganda. It used choice experiment to collect bids and the multinomial probit regression model to examine the drivers of willing to pay. The study found that consumers who received nutritional information about the benefits of OFSP were willing to pay premium prices for the biofortified sweetpotato.

While most of these studies focused on willingness to pay by consumers for final product and shows there is, indeed, demand for biofortified food, none examined the willingness to pay for planting material of biofortified crops such the orange-fleshed sweetpotato. The only study in the literature that has assessed willingness to pay for quality planting materials of biofortified sweetpotato is Larbata (2009). The current study differs from his by controlling for correlation or interdependence in the willingness to pay for quality planting materials of biofortified and non-biofortified crops when both options co-exist during the collection of bids. Thus unlike Labarta (ibid) who assessed the willingness to pay for the OFSP planting materials only, this study jointly assesses the willingness to pay for both the biofortified and non-biofortified varieties of sweetpotato. It uses seemingly unrelated regression which controls for the correlations in willingness to pay bids for the quality planting materials of biofortified and non-biofortified sweetpotato varieties.

3.0: METHODOLOGY

3.1. Theoretical framework

A number of theoretical approaches for estimating willingness to pay have been developed in the demand theory literature. One approach to analyzing willingness to pay is based on Lancaster's theory of demand (Hammit, 1986). This theory posits that consumers demand the attributes/characteristics of a good rather than the good per se, and explains product quality as a bundle of attributes that determine the product's performance relative to its price (Caswell and Mojduszka, 1996). According to Hooker and Caswell (1996), there is no precise list of food attributes and hence, the important characteristics will vary across circumstances and among individuals. Quality attributes of a product may include food safety (e.g., absence of heavy metals, pesticide residues), nutritional value (e.g., vitamins and proteins), value attributes (i.e., taste and appearance) and package attributes (e.g., labeling and package material(s) (Hooker and Caswell, 1996). The demand for quality is determined by consumers' willingness to pay for additional quality attributes such as nutrition, and reflects the value placed upon the benefits that they derive from that attribute. In this study, WTP is an indicator of demand for quality sweetpotato planting materials, (that is, planting materials (i.e., vines) that are free from pest and diseases). Vine producers will supply quality planting materials if it is profitable for them to do so. According to Spence (1975, 1976) producer's incentive to provide quality is related to the marginal willingness to pay for quality. The Lancasterian framework was used in this study to estimate willingness to pay for quality planting materials since freedom from pests and diseases is a characteristic of a sweetpotato that is generally known to sweetpotato growers.

3.2.0. Empirical methods used in this study

Willingness to pay usually refers to the maximum amount of money a consumer is willing to commit towards a purchase of a product or service, and is therefore a reflection of consumers demand for the product/service (Kalish and Nelson, 1991). Two methods are often used to estimate consumer willingness to pay for new food products namely, the real willingness to pay and hypothetical willingness to pay. These methods differ in that the former requires real economic engagement (hence the word real) while the latter does not (hence the word hypothetical). Real willingness to pay involves actual purchases with payment of the elicited reservation price, while hypothetical willingness to pay does not have any financial obligations on respondents. Methods that elicit real willingness to pay require consumers to pay the stated price of the chosen product. Examples for such methods include: experimental auctions (Lusk et al., 2007), lotteries such as the Becker, DeGroot, and Marschak method (Becker, DeGroot, and Marschak, 1964) and the Vickrey auctions (Vickrey, 1961). The most frequently used method for measuring hypothetical willingness to pay is the contingent valuation (CV). This is due to its flexibility and the relatively low cost of implementing it compared to other methods (Misra et al., 1991, Mitchell and Carson, 1989, Hammit, 1986).

In the CV method, a sample of representative individuals is asked to state how much they are willing to pay for a product directly (Kalish and Nelson, 1991). The method uses survey questions to elicit respondents' preference for goods by finding out what they would be willing to pay for specified improvement incorporated in them. The method therefore presents a consumer with a hypothetical market that gives them the chance to buy the good in question. Since the elicited willingness to pay values are contingent upon a particular hypothetical market described to the respondent, the approach was known as contingent valuation method (Brookshire and Eubanks, 1978). The respondent is usually presented with a question consisting of three parts; i) a description of the good being valued and hypothetical situation under which it is made available, ii) question that elicit the respondent willingness to pay bid(s) for the good being valued and, iii) questions about respondents' characteristics e.g. age, income, and preference for the good being valued.

However, despite the popularity of CV method, it has been criticized for overestimating or under-estimating the true individuals' willingness to pay since most of the analyses are based on hypothetical situations that the consumer may take less seriously than a real one. This leads to bias on the true mean willingness to pay value for a product (Hanemann, 1991).

Currently, there is a debate on the accuracy of the CV method, that is, whether or not it can measure the maximum willingness to pay of an individual accurately. This has recently contributed to the development of an alternative method of estimating willingness to pay namely, the choice experiment (CE). The CE can be either about revealed preferences, if they are hypothetical, or stated, if they are binding. However, choice experiment also has a number of drawbacks as a method. These are: i) preferences may be unstable throughout the experiment, ii) the designing of experiments is a difficult task, iii) they are much more demanding for respondents to answer and, iv) the incentive properties are unclear (Carson et al., 2001; Mogas et al., 2006; Meyerhoff et al., 2007). Furthermore, some studies have shown that there is no difference between the two methods. For example, a study by Carson et al., (2001) showed that there is no difference in preferences between a hypothetical and an actual choice experiment. In addition, Voelckner (2006) has argued that the question about which method should be used in measuring willingness to pay has no simple answer because of the fact that consumers' true WTP is an unobservable construct and each method for measuring willingness to pay only represents an attempt to come as close as possible to the truth. Therefore, the choice of the method to use depends on the study context and on the trade-off between the advantages and disadvantages of the two methods. Based on this background and the simplicity in administering CV, this study used CV to elicit willingness to pay.

One additional advantage of the CV method that makes it more appropriate in our case is the fact that it allows, with some modifications, the valuation of many goods to be done jointly. This modified CV approach has an advantage over a single good CV method, which considers only one product, in that it reduces the cost of doing the survey (Boyle, 1991). In addition, asking for the willingness to pay (WTP) for several products within one survey reminds the respondent of the other potential substitutes for their payment thus eliciting 'truer' WTP values (Arrow, 1993). This modified CV approach is based on the assumption that joint evaluation will provide a respondent with a well-defined consumption set over which preference can be easily expressed/elicited (Luchini et al., 2003).

Furthermore, the standard approach of estimating willingness to pay functions independently for each scenario in a joint valuation survey may result in biased estimates of mean willingness to pay values. This is due to the fact that the model fails to capture individually the specific factors that have common effect on responses across goods. This arises mostly when the error terms includes systematic components, immeasurable or omitted variables that represent factors that are likely to cause correlation of errors in all the equations (Hsiao, 1986). This is referred to as informational effect which is caused by more information provided by the existence of description of different options. Luchini (2003), for example, finds evidence of this informational effect in the valuation of willingness to pay for three interrelated health programmes.

The direction of correlation is determined by the observed likeness of the goods under valuation: closely related goods are likely to have positive correlation in error terms, while goods with different characteristic may show positive or negative or independence of the alternative sets of characteristics (Gregory et al., 1997). Therefore, although the joint valuation method reduces cost, correlations between responses (across errors) may complicate comparison of expected benefits across scenarios (Carson and Mitchel, 1995).

To take into account such potential correlation, Zellner (1962) proposed the seemingly unrelated regression (SUR) which can control for possible correlation in the error terms that affects the efficiency of the willingness to pay estimates. SUR assumes that some factors that are not observed but cause correlation in the error terms may exist, without an a priori specification of those factors structurally.

In this study willingness to pay for the five varieties were elicited jointly, therefore information effect was expected. In describing a variety of sweetpotato, the information given may have an effect on other varieties leading to correlation in error terms that can affect the efficiency of willingness to pay estimates. Moreover, willingness to pay estimates for the five varieties may be interrelated through some common factors that may not have been observed during the survey. SUR model therefore became appropriate method for estimating the willingness to pay for this study.

3.2.1. Seemingly Unrelated Regression (SUR) model

The SUR model is a system of linear equations containing only exogenous regressors and has error terms that are correlated across equations for a given individual, but are uncorrelated across individuals. SUR regression specification has at least two equations ($N \geq 2$) corresponding to the dependent variables (Y_1, Y_2, . . . , Y_N). Basically, the SUR model assumes that, for each individual observation i, there are N dependent variables (Y_{ij}, j = 1,…, N) each with its own regression equation. That is, the model consists of j=1…N linear regression equations for i=1…N individuals.

The jth equation for individual i is

$$Y_{ij} = X_{ij}\beta_j + \mu_{ij} \qquad \text{For } i = 1, \ldots, M \text{ and } j = 1, \ldots, N \qquad 1$$

N equations can be stacked into a SUR model

$$\begin{bmatrix} Y_1 \\ . \\ . \\ . \\ Y_N \end{bmatrix} = \begin{bmatrix} X_1 & 0 \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & X_N \end{bmatrix} \begin{bmatrix} \beta_1 \\ . \\ . \\ . \\ \beta_N \end{bmatrix} + \begin{bmatrix} \mu_1 \\ . \\ . \\ . \\ \mu_N \end{bmatrix} \qquad 2$$

Where, X_{ij} is a k-vector of explanatory variables, β_j are the coefficients of the explanatory variables, within each j equation, the stochastic component (error terms) is assumed to have zero mean, and to be identically and independently distributed for i = 1, . . . ,M,

$$\mu_{ij} \sim N(0, \sigma_{ij}) \text{ for } i = 1, \ldots, M \qquad 3$$

Hence variance and covariance will be:

Var (μ_{ij}) = σ_j and Cov (μ_{ij} ,$\mu_{i^{\prime}j}$)=0, respectively for i ≠ i', and j = 1, . . . ,N 4

(Katchova, 2013; Henningsen and Hamann, 2007):

However, the error terms for the ith observation can be correlated across equations, therefore,

Cov (μ_{ij}, $\mu_{ij^{\prime}}$) ≠ 0, for j ≠ j', and i= 1, . . . ,M 5

μ_{ij} = E(Y_{ij}) = X_{ij} βj , for i = 1, . . . ,M, and j = 1, . . . ,N 6

SUR employs a three stage least squares (3SLS) technique which uses asymptotically efficient, feasible, generalized least-squares (FGLS) algorithm (Greene, 2012). The estimator generated by SUR is asymptotically equivalent to the generalized least squares (GLS) estimator which is unbiased and efficient among the set of maximum likelihood estimators.

3.2.2. Estimation of the SUR model

The general model estimated in this study is specified as:

$$WTP = X\beta + \mu \quad 7$$

Where;

$$WTP = [WTP_1 \ldots WTP_N] \quad 8$$

$$X\beta = [X_1\beta_1 \ldots X_M\beta_M] \quad 9$$

$$\mu = [\mu_1 \ldots \mu_K] \quad 10$$

WTP_1 to WTP_N are the equations estimated representing the number of varieties of sweetpotato; X_1 to X_M are explanatory variables; β_1 to β_M are coefficients to be estimated; and μ_1 to μ_K are the error terms.

The five equations estimated for each of the varieties of quality sweetpotato planting under the third objective are:

$$WTP_1 = X_K\beta_K + \mu_1 \quad 11$$

$$WTP_2 = X_K\beta_K + \mu_2 \quad 12$$

$$WTP_3 = X_K\beta_K + \mu_3 \quad 13$$

$$WTP_4 = X_K\beta_{K+}\mu_4 \quad 14$$

$$WTP_5 = X_K\beta_K + \mu_5 \quad 15$$

Where 1, 2...,5, represent Kabode, Jewel, Ejumula, New Polista and New Ukerewe sweetpotato varieties.

3.2.3. Description of variables in the econometric model

The implicit functional relationship for each of the SUR models can be expressed as:

$$WTP_i = f(Gend, Edu, Chld, lnAge, Ass - i, lnCpi, Lndm, Lndvi, Favrt, Yld, Tast) + \mu \quad 16$$

Where,

Dependent variables are:

1. Willingness to pay for Kabode sweetpotato variety in Tanzanian shillings (Tsh.).
2. Willingness to pay for Jewel sweetpotato variety in Tanzanian shillings (Tsh.).

3. Willingness to pay for Ejumula sweetpotato variety in Tanzanian shillings (Tsh.).

4. Willingness to pay for New Polista sweetpotato variety in Tanzanian shillings (Tsh.).

5. Willingness to pay for New Ukerewe sweetpotato variety in Tanzanian shillings (Tsh.).

Independent variables

Chld is the number of children under 5 years of age. This variable was included since, in the previous studies, the number of children under five years of age in the household has been found to influence willingness to pay significantly. Loureiro and Hine (2001) found that presence of children had a negative effect on purchase decisions. Govindasamy and Italia (1998) also found that households with more members may not be willing to pay more for a good due to the amount of money spent per person on food. However, for this study it was hypothesized that as the number of children less than 5 years of age in the household increases, the demand (willingness to pay) for OFSP will increase. This is because it is the age group that is most affected by problems associated with Vitamin A deficiency.

Age is the age of respondent in years and is also likely to affect willing to pay for quality planting materials. According to Rimal and Fletcher (2002), age increases the willingness to pay for products. However, some studies have found the opposite effect on willingness to pay. For instance, Loureiro and Hine (2001) found that age was negatively correlated with the willingness to pay for the organic potatoes. Hence this study had no a priori expectation on the effect of age on willingness to pay for quality planting materials.

Cpi is the income received by a household from sale of all crops, in Tanzanian shillings. This variable was included since income is likely to influence willingness to pay (Govindasamy and

Italia, 1998). Jekanowski et al., (2000) also found that household income was positively related to the probability of purchasing locally produced goods. It was hypothesized that respondents who earn more income from sale of crops will be willing to pay more for quality planting material.

Edu is the years of schooling of the respondent. Education has also been found to significantly influence product purchase decisions. Dasgupta et al., (2000), for example, found that education affected trout-steak purchasing decisions. In addition, past studies indicate that more educated consumers are willing to pay for food safety and nutrition (Bett et al, 2013; Largerkvist et al, 2014). It was expected in this study that education of the respondent would increase willingness to pay for quality planting materials of OFSP.

A number of dummy variables were also included in the SUR model to account for respondents' attitudes and perceptions towards sweetpotato. Demand theory posits that changes in consumers' tastes and preferences affect demand for a product. The dummies included in the model to capture taste and preferences were: i) *Favrt* which is equal1 if a specific sweetpotato variety was mentioned as the respondent's favorite sweetpotato, zero otherwise. If a respondent believed that a specific sweetpotato variety is his /her favorite, it was expected they would be willing to pay more for it; ii) *Gend* is the gender of respondent, (0 = Female, 1= Male). This variable has also been found to significantly influence willingness to pay (Jekanowski et al., 2000; Loureiro and Umberger, 2002). In this study it was hypothesized that female respondent would be more willing to pay for quality sweetpotato planting materials than their male counterparts since sweetpotato is perceived as a women's crop (low et al., 2009); *iii) Tast1* is equal 1 if a respondent agreed or strongly agreed that sweetpotato that have orange flesh taste better than those that have white flesh. It was expected to have a positive influence on willingness to pay for the orange fleshed varieties; iv) *Tast2* is equal to 1 if a respondent agreed or strongly agreed that sweetpotato that have non-orange flesh taste better than those that are Orange inside. The coefficient of this variable was expected to be positive. *Yld1*is equal 1if a respondent agreed or strongly agreed that sweetpotato that have non-orange flesh yield more than those that have orange flesh. This was expected to have a positive influence on willingness to pay for the non-orange fleshed varieties; vi) *Yld2* is equal 1if a respondent strongly agreed or agreed that sweetpotato that have orange flesh yield more than those that have non-orange flesh. This was also expected have a positive effect on willingness to pay for the orange-fleshed varieties.

Lndm is the natural log of distance to the output market. It was included as proxy for transaction cost the farmers incur in accessing the output market. This variable was expected to have a negative effect on willingness to pay. The study also included a transaction cost variables related to farmer access to sweetpotato planting materials (i.e., vines) in general namely, *Lndvi* which is measured as the natural log to distance to source of the vines used by the farmer. It was also expected to be inversely correlated with willingness to pay for quality sweetpotato planting materials.

Asset index was constructed as a proxy for wealth, in order to compare households based on their wealth status. The method used was adopted from McCulloch et al., (2002). This method gives a score to a household for every asset that it possesses. If the asset was very common among the households, the possession of that asset added a small score to the household asset index. On the other hand, if very few households own a certain asset, the asset index receives a large score. This method has been used by Bradshow et al., (2000) to rank wellbeing in developed countries in order to account for different durable goods based on their quality and value. This index was constructed as follows;

$$D_x = \sum d_{ix}(1 - P_i)\, P_i = n_i/n \qquad 17$$

Where d_{ix} =1 if household x possesses asset i; P_i is the probability of having asset i;

n_i = number of household which have asset i and, n=total number of households.

3.2.5. Comparison of willingness to pay for biofortified and non-biofortified sweetpotato varieties: the analysis of variance (ANOVA)

The first and second objectives of this study, namely the comparison the producers' mean willingness to pay for non-biofortified and biofortified varieties, were analyzed using the analysis of variance (ANOVA) technique. The ANOVA is a statistical technique invented by Fisher, and is therefore sometimes called Fisher's analysis of variance. It is a collection of statistical models used to analyze the differences between group or sample means and can also analyze variations between and among groups. ANOVA is used to test whether or not the means of several groups are equal by generating the t-test for groups. This method is considered useful especially when analyzing several groups since doing multiple two-sample t-tests would result in an increased chance of committing a type I error. For this reason, ANOVAs became useful in comparing means for statistical significance and was performed using SPSS software.

The hypothesis tested using the ANOVA method was:

$H_0: \mu_B = \mu_{NB}$ 18

$H_1: H_0$ is false 19

One-way between group analysis of variance (ANOVA) was conducted to compare mean willingness to pay for the biofortified orange fleshed sweetpotato (Jewel, Ejumula and Kabode) and mean willingness to pay for non-biofortified sweetpotato varieties (New Polista and New Ukerewe). In addition, ANOVA was used to compare mean willingness to pay for quality planting materials for the five varieties jointly.

The model of one-way ANOVA is given by;

$$yij = \mu + \alpha i + \varepsilon_{ij} \qquad 20$$

For levels i = 1,…, k, and observations j = 1,…, n_i.

Define $\bar{y}_i$ as the weighted mean of y_{ij} over j and $\bar{y}$ as the overall (weighted) mean of y_{ij}. w_{ij} is the weight associated with y_{ij} , which is equal to1 if the data is unweighted. w_{ij} is normalized to sum to $n = \sum_i ni$ if weights are used and not normalized if otherwise. w_i refers to $\sum_j w_{ij}$, and w refers to$\sum_i w_i$

Total sum of squares (TSS) is given by

$$S = \sum_i \sum_j w_{ij}\left(y_{ij} - \bar{y}\right)^2 \qquad 21$$

Following Snedecor and Cochran (1989, the between- group sum of squares is given by;

$$S_1 = \sum_i w_i(\bar{y}_i - \bar{y})^2 \qquad 22$$

The within-group sum of squares is given by $S_e = S - S_1$; the between-group mean square is $s_1^2 = S_1/(k-1)$ and the within-group mean square is $s_e^2 = S_e/(w-k)$ thus the test statistic is $F = s_1^2/s_e^2$.

3.3. The area of study

This study was conducted in Southern highlands of Tanzania. Tanzania has a total land area of 945,087 km^2 including 61,000 km^2 of inland water and a population of 45 million (2012, census). More than 80 percent of this population is in rural areas (PHC, 2013). Figure 1 shows the regions where the data was collected for this study. Specifically, the data was collected from four regions namely Kagera, Mwanza, Shinyanga, Mara.

Figure 1: A map displaying the area of study

Source: http://www.mapsofworld.com/tanzania/tanzania-political-map.htm

3.4. Data and sampling procedures

The study used secondary data collected by Marando Bora project which was a project of the Sweetpotato Action for Security and Health in Africa (SASHA) implemented in Tanzania by International Potato Center and its partners. The study focused on areas where the project had created awareness of the importance of using clean sweetpotato planting materials and also facilitated farmer linkage to sources of clean planting materials. A multi-stage sampling procedure was used. Sixteen districts were chosen, corresponding to areas of intervention. Then wards were randomly sampled from the districts, focusing on sweetpotato growing areas. From each ward, all villages were listed and a random sample of villages drawn. In each of the sampled village, separate lists were drawn for households with children under the age of five years, female headed and vulnerable (i.e., households affected by HIV-Aids). Then a random sample was drawn from each list proportional to size of the list. Each farm household was then interviewed using pretested questionnaires. In total 481 project participants and 251 non-project participants were interviewed. However, out of the 481 participants' questionnaires, 31 did not have complete information needed for the current study and were, therefore, not included in the analysis. This resulted to a total of 450 observations being used in this study.

3.5. Elicitation of willingness to pay scenario

In collecting the willingness to pay data, the respondents were asked a series of questions related to effects of sweetpotato pest (weevil) and diseases (virus). Some of the questions exposed the respondents to the symptoms of major sweetpotato pests and diseases including the weevil and sweetpotato virus, respectively. The respondent was then shown samples and pictures of a virus-infected sweetpotato plant and asked whether he/she had experienced such symptoms in his/her plot(s). The cause of such symptoms were discussed and explained. Next, the respondent was informed that the project vines were of higher quality because they had been cleaned of weevil and virus. Then, the respondent was shown a picture of cleaned vines that are of better quality and also informed that such clean vines (that is, *marando bora* in the local Kiswahili language) had higher yield than those locally available from farmers in the area.

Next, the respondent was informed that some of the cleaned vines had ability to provide vitamin A (that is, are biofortified) and had orange flesh while others, which had white flesh, did not. The varieties that could provide vitamin A were Kabode, Jewel, and Ejumula, while those that could not were New Polista and New Ukerewe. Additional information on sweetpotato pests and diseases and the orange-fleshed sweetpotato (including the benefits) was provided through radio broadcasts and market information boards located in the local markets in the study region. Information provided through these two channels targeted both project and non-project participants (i.e. all the respondents) alike. Additional information on sweetpotato production was provided specifically to project participants through the decentralized vine multipliers and hence is expected to have reached farmers that had contact with (or received/purchased quality vines from) these multipliers. Prior to this study, project participants had been offered free clean/quality vines of biofortified and non-biofortified varieties to plant and utilize (eat and/or sell) the roots. The farmers planted the better quality vines for two seasons. This last procedure (i.e., planting and utilizing sweetpotato) was intended to enable the project participants to "assess/experience the product" in order for them to learn about the taste, dry matter content, and performance against the sweetpotato weevil and virus. In order to collect the bid, the respondent was asked how much Tanzania shillings (Tshs) she/he would be willing to pay for a bundle of 100 vines of 30cm each, for each of the biofortified and non-biofortified sweetpotato varieties. Bid values mentioned by the farmers were recorded in Tanzanian shillings, and if the farmer was not willing to buy, a zero value was recorded.

The survey protocol also included a series of questions on respondents' attitudes and perceptions towards sweetpotato and also, demographic characteristics including, household income received from sale of crops, education, food consumption frequency, gender, age.

3.6. Data analysis

To assess the factors influencing willingness to pay for quality planting material, SUR model was estimated using STATA software. In order to compare willingness to pay among varieties, Analyses Of Variance (ANOVA) was run on Statistical Package for Social Sciences (SPSS) version 20. In addition, SPSS was used to compare willingness to pay across regions and agro-ecological zones. Descriptive statistics involved computation of means, standard deviation and frequencies, in order to describe the respondents' socio-demographic attributes in the four regions of the study. The results were presented using figures and tables.

Some observations of the dependent variables contained zero values which could not be transformed into natural logarithm. Specifically, the number of respondents who expressed a null (zero) willingness to pay for Kabode, Jewel, Ejumula, New Polista and New Ukerewe was 54 (12%), 93(20.67%), 90(20%), 36 (8%) and 77 (17.11%), respectively. For these cases, the Battese (1997) dummy variable transformation method was used in order to identify zero-valued observations without bias to the analysis.

4.0: RESULTS AND DISCUSSION

4.1. Overall sample socio-economic characteristics

Table 1 presents the results of the analysis of the socioeconomic characteristics for the entire sample. The average age of respondents in the whole sample is 45 years, indicating that most of sweetpotato growers in Tanzania are of middle age and, as expected, most of the respondents (71%) were female. On average, households had seven members with an average of one child who is five years old or below. The table also shows that a large majority of project participants (96%) stated that farming is their main livelihood activity and, earned, on average, TShs. 226, 289 from crops in 2012. The results also show that the average farm size was 4.6 acres, of which on average 3.5 acres were under use.

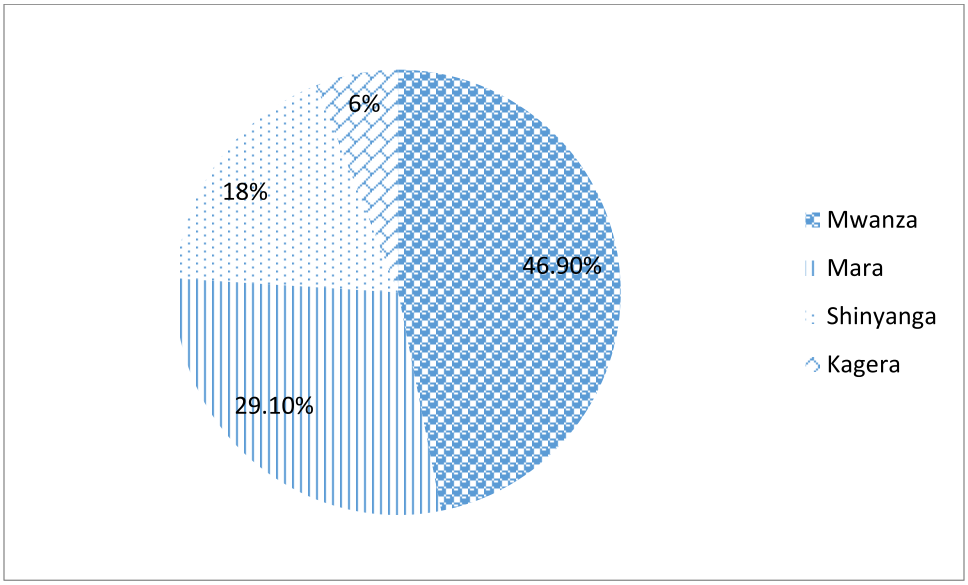
Table 1: Summary statistics of variables used in empirical estimations of the SURE model (n=450)

Variables	Description	Mean	Stard.dev
Dependent	***Variables***		
Ln WTPK	Natural logarithm of willingness to pay for Kabode variety	5.85	2.41
Ln WTPJ	Natural logarithm of willingness to pay for Jewel variety	5.23	2.85
Ln WTPE	Natural logarithm of willingness to pay for Ejumula variety	5.31	2.83
Ln WTNP	Natural logarithm of willingness to pay for New Polista variety	6.19	2.10
Ln WTPU	Natural logarithm of willingness to pay for New Ukerewe variety	5.54	2.71
Independent variables			
Household characteristics			
Gend	Dummy variable 1=male, 0 female	0.29	0.45
Edu	Years of schooling of the respondent 0=pre school/ no formal education,1-7=standard 1-7 8-13=form1-6, 14=college 1, 15=college 2, 16=college / Graduate, 18=post graduate	5.66	3.10
Chld	Number of children 5years of age and below	1.21	1.13
Lnage	Natural logarithm of age of respondent in years	3.83	0.37
Ass-i	Asset index	3.61	2.16
Lncpi	Natural logarithm of crop income	6.66	8.68
Farm characteristics			
Lndm	Natural logarithm of distance to output market in minutes	1.27	1.63
Lndvi	Natural logarithm distance to vine source	3.19	0.81
Preference & perception characteristics			
Favrt-K	Dummy variable=1 if Kabode is the most preferred variety, 0 otherwise	0.21	0.41
Favrt-J	Dummy variable=1 if Jewel is the most preferred variety, 0 otherwise	0.06	0.23
Favrt-E	Dummy variable=1 if Ejumula is the most preferred variety, 0 otherwise	0.04	0.19
Favrt-NP	Dummy variable=1 if New Polista is the most preferred variety, 0 otherwise	0.36	0.48
Favrt-NU	Dummy variable=1 if New Ukerewe is the most preferred variety, 0 otherwise	0.18	0.38
Yld2	Dummy variable = 1 if respondent agrees or strongly agrees that sweetpotato that have orange flesh yield more than those that have white flesh, 0 otherwise	0.58	0.49
Yld1	Dummy variable = 1 if respondent agrees or strongly agrees that sweetpotato that have white flesh produce more than those that have orange flesh, 0 otherwise	0.42	0 .49
Tast1	dummy variable =1 if respondent agrees or strongly agrees that sweetpotato that have orange flesh taste better than those are white inside, 0 otherwise.	0 .73	0.45
Tast2	dummy variable =1 if respondent agrees or strongly agrees that sweetpotato that have white flesh taste better than those that have orange flesh, 0 otherwise	0.27	0.45

Source: Survey results (2014)

The distribution of respondents by region is shown in Figure 2. It shows that 211(46.9%) sweetpotato growers were interviewed in Mwanza, Mara region had 131(29.1%), Shinyanga 81(18%) and Kagera 27(6%) respondents. Hence the highest percentage of the respondents came from Mwanza.

Figure 2: Distribution of respondents by region



Source: Survey results (2014)

4.2. Characteristics of study respondents by region

Table 2 shows the socio-economic characteristics of sweetpotato growers in the 4 study regions. In Mara region, the average age of the respondents was 44 years, with the oldest being 77 years and youngest being 19 years old. On average, respondents had 6 years of formal education, with the most educated farmer having some college education (16 years). There were also some respondents with no formal education at all. Out of the sampled farmers from Mara region, only 36% were male. Results also show that most of the interviewed households had at least one child aged five years or below, while majority of the respondent being married (73%). On average, 44% of the respondents had been trained on sweetpotato production and management.

In Mara region, 41% of sweetpotato growers produced sweetpotato for commercial purposes. The average income earned in the 2011/2012 cropping seasons from sale of sweetpotato was Tsh.127760 with total income from sale of all crops averaging to Tsh. 216463. This indicates that approximately 59% of crop income was from sale of sweetpotato. The mean household size among respondents was 7 members with a range of 2 - 17 residents. Most sweetpotato growers (95%) reported that farming was their principal activity. On average sweetpotato growers owned 4.6 acres of land during 2011/2012 cropping seasons.

Table 2: Summary of socio-economic characteristics of sweetpotato growers in the study regions

	Mara(n=131)		Mwanza(n=211)		Shinyanga(n=81)		Kagera(n=27)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Age	44.53	12.16	45.82	12.23	45.93	12.73	42.74	11.24
Gender	0.36	0.48	0.27	0.45	0.21	0.41	0.30	0.47
Years of schooling	6.27	2.98	5.50	3.05	4.86	3.43	6.30	2.32
Number of children 5yrs and below	1.29	1.15	1.32	1.16	1.01	1.03	0.56	0.70
dummy variable=1 If the respondent had training in the last 3 years,0 otherwise	0.44	0.50	0.49	0.50	0.35	0.48	0.48	0.51
dummy variable=1 if Sweetpotato is grown for sale, zero otherwise	0.41	0.49	0.32	0.47	0.32	0.47	0.48	0.51
income from sale of sweetpotato	127760	330572	33414	86374	30158	86603	128129	518086
dummy variable=1 if married, 0 otherwise	0.73	0.45	0.74	0.44	0.79	0.41	0.81	0.40
Number of resident people	7.25	3.11	8.10	3.24	7.04	3.22	7.26	2.18
Total crop income	216462	277877	181065	260710	356658	308619	236277	282820
Asset index	4.15	2.53	3.50	1.92	3.15	1.89	3.19	2.43
dummy variable=1 if farming is the principal activity, zero otherwise	0.95	0.21	0.97	0.18	0.98	0.16	0.93	0.27
land owned in the 2011/2012 cropping seasons	4.56	2.52	4.39	2.73	4.91	2.37	5.19	3.11

Source: Survey results (2014)

Demographic characteristics of the rest of the study regions namely, Mwanza, Shinyanga and Kagera are also shown in Table 2. The results show similarities and well as marked differences in the characteristics across the regions. For instance, while the average household size in Mara was 7, households in Shinyanga and Kagera had, on average, only 3 and 2 members, respectively. The number of children less than 5 years of age is, on average, about one across the four regions.

4.3. Comparison of farmers' willingness to pay for quality planting materials across different administrative regions, agro-ecological zones and varieties

4.3.1 Comparison of mean willingness to pay for quality planting materials by region.

It was hypothesized that there is no difference in the mean willingness to pay for quality sweetpotato planting materials across the different study regions. The results of test of differences in means presented in Table 3 however indicate that the hypothesis of equal willingness to pay for quality sweetpotato planting materials across the study regions is rejected. Farmers in Mara are willing to pay significantly more for Kabode vines than those in Mwanza (p= 0.039) and Shinyanga (p=0.012). Specifically, farmers in Mara are willing to pay Tsh. 350 more than Mwanza and Tsh. 510 more than Shinyanga. Results also show that Mara farmers are also willing to pay significantly higher (that is, Tsh.456.) for Jewel vines than those in Shinyanga (p=0.017). Results however indicate that there is no statistically significant difference in willingness to pay for Ejumula vines across the study regions. In the case of New Polista, the results indicate that there is statistically significant difference in willingness to pay in the four regions. Specifically, sweetpotato growers in Mara are willing to pay, on average, Tsh.520, Tsh. 492 and Tsh. 902 extra for New Polista vines than those in Mwanza, Shinyanga and Kagera, respectively.

Table 3: Comparison of mean willingness to pay (Tanzanian shillings – Tshs.) for a bundle of 100 vines of 30cm each of quality planting materials, by region (n=450): Results of analysis of variance (ANOVA)

Dependent Variable			Mean Difference (I-J)	Std. Error	P-value
WTP for Kabode	Mara	Mwanza	349.97*	128.04	.039
		Shinyanga	510.34*	163.77	.012
		Kagera	555.42	247.59	.152
	Mwanza	Mara	-349.97*	128.04	.039
		Shinyanga	160.36	150.93	1.000
		Kagera	205.45	239.29	1.000
	Shinyanga	Mara	-510.34*	163.77	.012
		Mwanza	-160.36	150.93	1.000
		Kagera	45.09	260.17	1.000
WTP for Jewel	Mara	Mwanza	284.73	118.08	.098
		Shinyanga	456.45*	151.62	.017
		Kagera	590.04	228.33	.060
	Mwanza	Mara	-284.73	118.08	.098
		Shinyanga	171.72	139.83	1.000
		Kagera	305.31	220.68	1.000
	Shinyanga	Mara	-456.45*	151.62	.017
		Mwanza	-171.72	139.83	1.000
		Kagera	133.59	240.31	1.000
WTP for Ejumula	Mara	Mwanza	185.69	118.35	.704
		Shinyanga	332.45	151.24	.171
		Kagera	507.00	225.09	.149
	Mwanza	Mara	-185.69	118.35	.704
		Shinyanga	146.76	139.47	1.000
		Kagera	321.31	217.36	.840
	Shinyanga	Mara	-332.45	151.24	.171
		Mwanza	-146.76	139.47	1.000
		Kagera	174.55	236.88	1.
WTP for New polista	Mara	Mwanza	520.12*	134.60	.001
		Shinyanga	491.86*	171.19	.026
		Kagera	902.37*	255.56	.003
	Mwanza	Mara	-520.12*	134.60	.001
		Shinyanga	-28.26	157.53	1.000
		Kagera	382.25	246.62	.731
	Shinyanga	Mara	-491.86*	171.19	.026
		Mwanza	28.26	157.53	1.000
		Kagera	410.51	268.35	.761
WTP for New Ukerewe	Mara	Mwanza	388.09*	133.83	.023
		Shinyanga	617.54*	171.02	.002
		Kagera	766.55*	254.53	.016
	Mwanza	Mara	-388.09*	133.83	.023
		Shinyanga	229.44	157.71	.879
		Kagera	378.46	245.79	.746
	Shinyanga	Mara	-617.54*	171.02	.002
		Mwanza	-229.44	157.71	.879
		Kagera	149.02	267.86	1.000

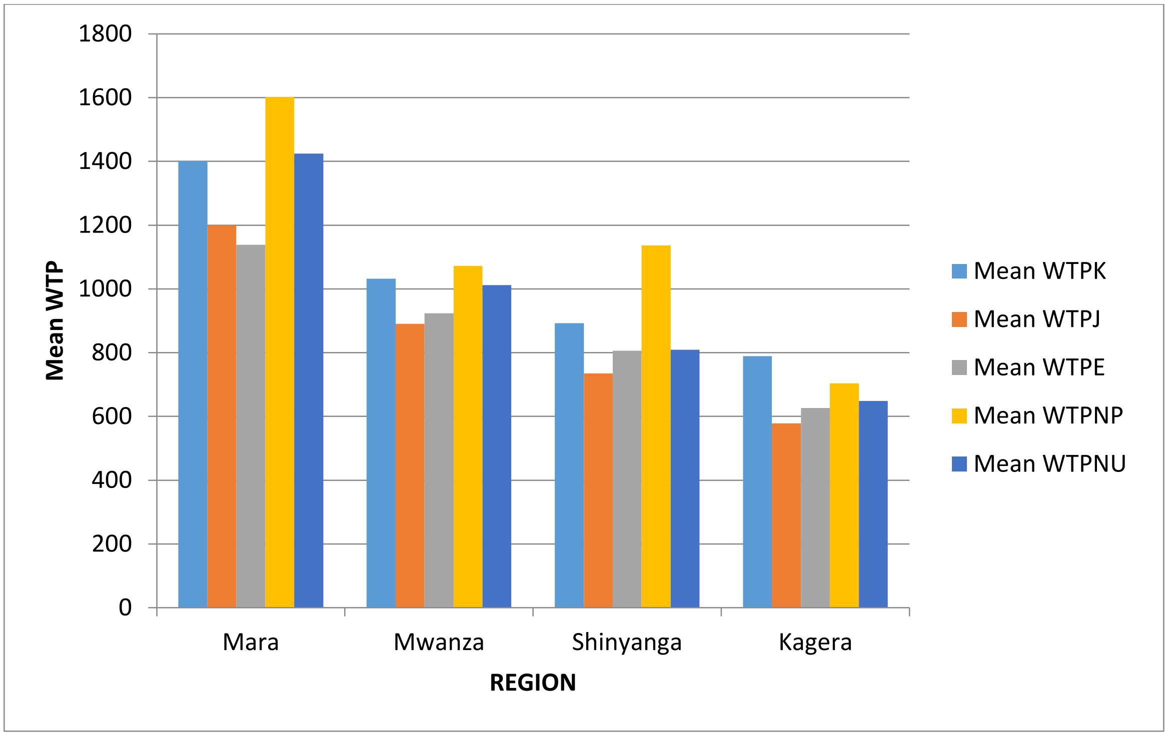
Source: Survey result (2014)* Indicates significance at 5% level

Results further show that farmers in Mara region are willing to pay statistically significantly higher amount of money for New Ukerewe vines than those in the other three regions. Specifically, the sweetpotato growers in Mara region are willing to pay an extra Tsh.388 for New Ukerewe vines than those in Mwanza, Tsh. 617 more than in those in Shinyanga and Tsh.767 more than farmers in Kagera.

Figure 3 presents the overall ordering of the willingness to pay for the five sweetpotato varieties across regions. Generally, sweetpotato growers in Mara region have the highest willingness to pay for sweetpotato vines as compared to other regions. This is followed by Mwanza and then Shinyanga, while Kagera has the lowest willingness to pay. Specifically, sweetpotato growers in Mara region are willing to pay the highest amount for New Polista vines, followed by New Ukerewe vines. The willingness to pay for New Polista vines is also highest in Mwanza and Shinyanga regions, but second to Kabode vines in Kagera region. These findings further indicate that there is no evidence to support the hypothesis that there is no difference in willingness to pay for quality sweetpotato planting materials across the four study regions.

This above analysis of willingness to pay quality planting materials by region shows that quality planting materials of New Polista are the most preferred variety by sweetpotato growers in the study regions. This could be due to its high dry matter content and the good taste of New Polista compared to the other varieties. According to the Catalogue of Orange-fleshed Sweetpotato for Africa (2014), New Polista and New Ukerewe have the highest dry matter content (35%), as compared to Kabode with 30.5%, Ejumula 33% and Jewel 28%. However, the results in Figure show that New Ukerewe is not as a popular as the Kabode, which has a lower dry matter content.

Figure 3: Mean willingness to pay in Tanzanian shillings for a bundle of 100 vines of 30cm each of quality planting materials among Tanzanian sweetpotato growers, by region (n=450)



Source: Survey results (2014)

4.3.2 Comparison of willingness to pay for quality planting materials of sweetpotato varieties by agro ecological zones

Table 4 presents the difference in mean willingness to pay for the five sweetpotato varieties across the agro-ecological zones. Sweetpotato growers living lower altitudes, i.e., 1000 to 12000 meters above sea level, and receiving 600 to 1200 millimeters of rainfall are willing to pay the highest amounts for New Polista, followed by Kabode, then New Ukerewe, Jewel and lowest Ejumula. In altitude of 1200 to1300m above sea level with 600 to1000 millimeters of rainfall, sweetpotato growers are willing to pay highest for New Polista, then Kabode, followed by Ejumula, then New Ukerewe and least for Jewel. Results also show that New Polista had the highest willingness to pay among farmers in the 1500 to 1800 meters above sea level receiving rainfall amount of 1400 to 1600 millimeters zone as well as in the zone 1100 to 1300 meters above sea level and receiving 600 to 1000 millimeters of rainfall. The only agro-ecological zone where New Polista did not lead in willingness to pay is that with1200 to 1600 with 600 to 800 millimeters of rainfall. In this zone, Kabode had the highest willingness to pay followed by New Polista, then New Ukerewe, while Jewel had the lowest willingness to pay. These results indicate that there are differences in willingness to pay for quality sweetpotato planting materials across the various agro ecological zones. They also indicate that there is no evidence to suggest that willingness to pay for quality sweetpotato planting materials is the same across the various agroecological zones as hypothesized.

Table 4. Comparison of mean willingness to pay (in Tanzanian shillings) for a bundle of 100 vine cuttings of 30cm each of quality planting materials, by agro ecological zones

Agro-ecological zone	n	WTP Kabode	WTP Jewel	WTP Ejumula	WTP New Polista	WTP New Ukerewe
Attitude1000-1200		1309.80	1068.75	964.14	1373.03	1258.22
rainfall 600-1200	152	(1251.05)	(1081.05)	(1048.45)	(1254.3)	(1302.11)
Attitude 1200-1300		1009.76	902.68	971.36	1133.74	963.35
rainfall 600 -1000	206	(1067.07)	(1063.49)	(1053.92)	(1166.5)	(1070.2)
Attitude 1500-1800		1342	1158	1158	1577.55	1498
rainfall 1400-1600	50	(1435.71)	(1279.84)	(1267.83)	(1622.79)	(1697)
Attitude 1100-1300		522.92	516.67	745.83	904.04	625.04
rainfall 600-1000	24	(526.26)	(601.93)	(1088.67)	(697.85)	(583.24)
Attitude 1200 -1600		1047.84	732.05	805.74	878.95	805.26
rainfall 600-800	19	(895.94)	(838.25)	(819.72)	(833.05)	(804.48)

Source: Survey results (2014); Numbers in parentheses are the Standard Deviations.

4.3.3 Comparison of mean willingness to pay for a bundle of 100 vines of 30cm each across varieties analysis of variance (ANOVA)

Table 5 presents the results of the Analysis of Variance (ANOVA) among sweetpotato vines of the five varieties. The between-group sum of squares for the model is 24.57 with 4 degrees of freedom, resulting in a mean square of 6.14. The F-statistic is 4.68 and is significant at less than 1 % level (p-value=0.0009).These results indicate that the means of the five varieties are significantly different at less than 1% level which implies that the mean willingness to pay for the five varieties is significantly different from each other. Results also show that the within-group sum of squares (residual variation) is 2945 with 2245 degrees of freedom and a mean squared error of 1.31 while the total sum of squares (TSS) is 2970 with 2249 total degrees of freedom.

Table 5: Analysis of Variance (ANOVA) of five sweetpotato varieties (n=450)

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	24.57	4	6.14	4.68	0.0009
Within Groups	2945.99	2245	1.31		
Total	2970.56	2249	1.32		

Source: Survey results (2014)

Note: Figures are in thousand Tanzanian shillings.

Overall, the results in Table 5 show that the mean willingness to pay for the clean planting materials is not equal across all the five sweetpotato varieties. However, the ANOVA results do not reveal where the differences in willingness to pay are. Hence this study used Bonferroni multiple comparisons tests to identify these differences. These tests examine the differences between each pair of means, taking each variety as a reference point and comparing it with the rest.

The results of the tests are presented in Table 6. As shown, with Kabode as the reference, the results indicate that the mean willingness to pay for Kabode vines is higher than mean willingness to pay for Jewel, Ejumula and New Ukerewe, but lower than the mean willingness to pay for New Polista. However, none of these mean differences in willingness to pay is statistically significant. Comparison of mean willingness to pay for Jewel vines with those of the other varieties shows that it has lower mean willingness to pay than Kabode, Ejumula, New Polista and New Ukerewe vines. However, the only difference in willingness to pay that is statistically significantly is that with New Polista (p-value =0.002). These findings indicate that Jewel vines have the lowest willingness to pay among the sweetpotato varieties considered in this study.

Similarly, results indicate that the mean willingness to pay for Ejumula vines is higher than that of Jewel vines, but lower than those of the vines of the other varieties. At the same time the table shows that only the difference with New Polista is statistically significant (p-value =0.004). Therefore, based on the findings of ANOVA and Bonferroni tests, this study rejects the hypothesis that willingness to pay for quality planting materials of the five sweetpotato varieties is equal across the varieties.

Table 6: Multiple comparisons (Bonferroni) of Mean willingness to pay for Kabode, Jewel, Ejumula, New Polista and New Ukerewe sweetpotato vines (n=450)

(I) Variety	(J) Variety	Mean Difference (I-J)	Std. Error	P-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Kabode	Jewel	166.11	76.37	0.297	-48.47	380.69
	Ejumula	152.44	76.37	0.460	-62.14	367.03
	New Polista	-116.22	76.37	1.000	-330.80	98.36
	New Ukerewe	25.89	76.37	1.000	-188.69	240.47
Jewel	Kabode	-166.11	76.37	0.297	-380.69	48.47
	Ejumula	-13.67	76.37	1.000	-228.25	200.92
	New Polista	-282.33*	76.37	0.002	-496.92	-67.75
	New Ukerewe	-140.22	76.37	0.665	-354.80	74.36
Ejumula	Kabode	-152.44	76.37	0.460	-367.03	62.14
	Jewel	13.67	76.37	1.000	-200.92	228.25
	New Polista	-268.67*	76.37	0.004	-483.25	-54.08
	New Ukerewe	-126.56	76.37	0.976	-341.14	88.03
New Polista	Kabode	116.22	76.37	1	-98.36	330.80
	Jewel	282.33*	76.37	0.002	67.75	496.92
	Ejumula	268.67*	76.37	0.004	54.08	483.25
	New ukerewe	142.11	76.37	0.629	-72.47	356.69
New Ukerewe	Kabode	-25.89	76.37	1	-240.47	188.69
	Jewel	140.22	76.37	0.665	-74.36	354.8
	Ejumula	126.56	76.37	0.976	-88.03	341.14
	New Polista	-142.11	76.37	0.629	-356.69	72.47

Source: Survey results (2014)

* The mean difference is significant at the 5% level.

4.4 Comparison of farmers' willingness to pay for quality planting materials of biofortified and non-biofortified sweetpotato varieties

4.4.1: Analysis of variance (ANOVA) for willingness to pay for biofortified (OFSP combined) and non-biofortified (NON-OFSP combined) sweetpotato varieties

Table 7 displays the mean amounts of money in Tanzanian Shillings (Tshs.) the study respondents were willing to pay for the two different sweetpotato vines based on the flesh color, that is, for the biofortified (OFSP) and non-biofortified (NONOFSP) sweetpotato varieties. The mean willingness to pay for the clean planting materials of the OFSP varieties combined is Tshs. 993 while the mean willingness to pay for the vines of non-orange fleshed sweetpotato varieties combined (NON-OFSP) is Tshs. 1145.The results therefore show that sweetpotato growers are willing to pay Tshs.151 more for quality planting materials of the NON-OFSP than OFSP varieties.

Table 7: Summary statistics of willingness to pay of OFSP vines and NON-OFSP vines (n=450)

Variety Type	Mean	Std. Dev.	Freq.
OFSP	993.26	1094.34	1350
NONOFSP	1144.61	1222.09	900
Total	1053.8	1149.28	2250

Source: Survey results (2014)
Note: Figures are in thousand Tanzanian shillings.

Table 8 presents the findings of Analysis of Variance (ANOVA) between OFSP and NONOFSP varieties. The between-group sum of squares for the model is 12with 1 degree of freedom with a mean square error of 12 (i.e., 12.37/1).The within-group sum of squares is 2958 with a mean squared error of 1.32. As shown, the total sum of squares (TSS) is 2971. The corresponding F-statistic is 9.4, with a p-value of 0.002. These findings indicate that the mean willingness to pay for quality planting materials of non-biofortified (non-OFSP) is statistically significantly different from that of the biofortified (i.e., OFSP) vines at the 1% level. Therefore the hypothesis that there is no difference in willingness to pay between quality planting materials of the biofortified OFSP and the non-biofortified (non-OFSP) vines is rejected at 1% level of significance.

Table 8: Analysis of Variance (ANOVA) between OFSP and NONOFSP (n=450)

	Sum of Squares	df	Mean Square	F	P-value
Between Groups	12.37	1	12.37	9.40	0.002
Within Groups	2958.19	2248	1.32		
Total	2970.56	2249	1.32		

Source: Survey results (2014)
Note: Figures are in thousand Tanzanian shillings.

Further, the above results show the willingness to pay for quality planting materials of NON-OFSP varieties is larger and statistically significantly different from that of OFSP varieties. These results therefore corroborate the earlier finding that demand for clean planting materials of the local varieties is higher. They also corroborate past findings (Combris et al., 2007) which suggested that consumers value taste and other related varietal attributes more that nutritional quality of a product. They specifically support argument that "taste beats quality”.

4.5. Factors affecting willingness to pay for quality planting materials: Results of the SUR regression analysis

Table 9 presents results of the SUR regression model estimated to identify the drivers of willingness to pay for quality planting materials of biofortified and non-biofortified sweetpotato varieties. Starting with Kabode variety, results show that the null hypothesis that the number of children under five years of age has no effect on willingness to pay for Kabode planting materials is rejected at 5% level. Thus, as expected, households with children under 5 years have a positive and statistically significant willingness to pay for Kabode. Results also show that the age of the respondents (Lnage) has a positive and statistically significant effect on willingness to pay for Kabode variety. Specifically, as the natural log of respondent's age increases by one, the willing to pay increases by 0.76%, other things constant.

Ass-i variable, which is a proxy for household wealth status, also has positive and statistically significant relationship with willingness to pay for clean Kabode planting materials. In particular, this implies that a unit increase in asset index increases the respondents' willingness to pay for planting materials of the Kabode variety by 0.12, other things being constant. Contrary to our expectations, the variable lncpi which captures the effect of income earned from total sale of crops negatively influences willingness to pay. This negative effect likely suggests that farmers treat sweetpotato as an inferior good. Indeed, this finding is consistent with that of Mukras et al., (2013) whose analysis of demand for sweetpotato at the farm found that 1% change in the incomes of consumers resulted in a decrease in demand for sweetpotato by 0.309%. In addition, Sindi et al., (2012) also found that income is inversely related to consumption of sweetpotato.

Table 9: Determinants of willingness to pay for quality planting materials among Tanzanian sweetpotato growers: results of SURE regression model (n=450)

	Kabode		Jewel		Ejumula		New Polista		New Ukerewe	
Variables	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value
-cons	0.99	0.442	-1.98	0.193	-0.36	0.809	1.99	0.080	1.08	0.453
Gend	0.12	0.62	0.16	0.572	-0.02	0.94	-0.19	0.395	0.30	0.284
Edu	0.01	0.85	0.01	0.75	0.02	0.598	0.04	0.255	0.03	0.404
Chld	0.21	0.031**	0.34	0.004***	0.36	0.002***	0.14	0.108	0.27	0.016 **
Lnage	0.76	0.010***	1.14	0.001***	0.83	0.017**	0.70	0.008***	0.74	0.027**
Ass-i	0.12	0.019**	0.12	0.049**	0.09	0.112	-0.01	0.841	0.00	0.988
Lncpi	-0.03	0.074 *	-0.02	0.326	-0.04	0.029 **	-0.02	0.064*	-0.03	0.040**
Lndm	0.21	0.007***	0.16	0.082*	0.19	0.038 **	0.17	0.011**	0.27	0.002***
Lndvi	0.10	0.443	0.29	0.066*	0.09	0.551	0.17	0.151	0.09	0.53
Favrt	1.05	0.000***	0.77	0.022**	1.65	0.000***	0.74	0.000***	0.06	0.778
Yld	0.79	0.000***	1.00	0.000***	1.31	0.000***	-0.44	0.025**	1.16	0.000***
Tast	0.16	0.512	0.35	0.218	0.64	0.024**	0.36	0.096*	-0.35	0.20
R-sq	0.3205									
P	0.0000									
n	450									

Source: Survey result (2014)

Notes: *** Indicates 0.01 level of significance,** 0.05 level, and * 0.10 level.

Demand theory posits that changes in consumers' tastes and preferences may also affect demand. In line with the theory, *Favrt* dummy variable that captures whether a particular variety is the most preferred or not, has a positive and significant effect on willingness to pay for Kabode planting materials. *Yld*, a proxy for yield, as expected, also has a positive and significant influence on willingness to pay for Kabode planting materials indicating that sweetpotato growers who are concerned about the yield potential of the variety are willing to pay more for Kadode vines. The results also show that distance to the output market (*Lndm*), a proxy for transaction cost affects the willingness to pay for Kabode vines. Contrary to expectations, farmers who are located far from the output market would be willing to pay less for Kabode vines and vice versa, other things constant. This finding may reflect the fact that purchase decisions of such respondents are not driven by market incentives since they are unlikely to participate in the market as sellers.

The results of the model fitted to assess factors affecting willingness to pay for Jewel vines are presented columns 4 and 5 of Table 3. Results show that willing to pay for Jewel vines is affected by the similar factors as Kabode. As in the case of the Kabode model, the variables *chld*, *Lnage, Ass-I, Lndm*, *Favrt*, and *Yld* have positive and significant relationship with willingness to pay for Jewel vines. In addition, however, the results show that distance to source of vines (*Lndvi*) also affects the respondents' willingness to pay for Jewel vines. The results specifically show that an increase in distance to source of vines by 1 unit increases the willingness to pay for Jewel vines by 29%, other things being constant.

The results of the fitted model for Ejumula vines are in column 6 and 7 of Table 3. They also show that willingness to pay for Ejumula is driven by the same factors as those that influence willingness to pay for clean planting materials of Kabode and Jewel varieties. Presence of children under 5 years of age, age of the respondent, total income earned from crops, distance to the output market, and perceptions about taste and yield all have a positive and statistically significant effect on willingness to pay for Ejumula vines. The only additional driver of WTP for the vines of this variety is the respondents' perception of the taste (*Taste1*) which, as expected, has a positive and statistically significant effect on willingness to pay for Ejumula.

The next two columns of Table 3, that is, columns 8 and 9, present the results of the model fitted for WTP for the vines of New Polista, one of the two non-biofortified sweetpotato varieties used in this study. They show, as in the earlier case that age, distance to market, taste and varietal preference all have a positive and statistically significant effect on willingness to pay for New Polista. Results, however, show that crop income and yield negatively influence willingness to pay for New Polista.

The results of the demand for planting materials of the second non-biofortified variety, i.e., the New Ukerewe, are presented in the last two columns of Table 3. They show that the number of children under five years of age, age of the respondent, distance to market, and farmers' perception of yield performance of the variety have positive and significant effect on the willingness to pay for the New Ukerewe vines. However, as in the case of Kabode, crop income has an inverse relationship with willingness to pay for New Ukerewe vines.

4.6. Results of the diagnostic tests of independence of error terms and multicollinearity

Table 10 displays the correlation matrix of the residuals between equations and performs a Breusch–Pagan test for independence of error terms (that is, that the disturbance covariance matrix is diagonal) (Breusch and Pagan, 1980). The results reveal presence of substantial correlation in residuals across the equations. The correlation coefficient of the residuals for the five equations is 0.38 and above, with some as high 0.75. The results also indicate that the 10 correlation coefficients are jointly significant at the 0.01 level ($\chi^2_{v=10} = 1444.989$). Thus there is evidence that willingness to pay for quality planting materials of the different sweetpotato varieties are correlated, just as it was suspected.

The correlation in the willingness to pay for quality planting materials of the different sweetpotato varieties implies that the use conventional regression approach, especially the Ordinary Least Square (OLS), would yield inefficient parameters, since OLS ignores the correlation in error terms across equations (Greene, 2011). This finding justifies the use of SUR regression model which caters for such correlation, hence yields efficient parameter estimates.

Table 10: Correlation matrix of residuals

	LnWTPK	LnWTPJ	LnWTPE	LnWTPNP	LnWTPNU
LnWTPK	1.00				
LnWTPJ	0.64	1.00			
LnWTPE	0.59	0.75	1.00		
LnWTPNP	0.38	0.44	0.43	1.00	
LnWTPNU	0.52	0.66	0.68	0.46	1.00

Source: Survey result (2014)
Breusch-Pagan test of independence: chi2 (10) = 1444.989, Pr = 0.0000

The results of the test for the existence of multicollinearity using variance inflation factor (VIF) test (Gujarati, 2008) are presented in Table 11. The results show that all variables in the SUR model had a mean VIF less than 2 which is below the threshold level of 10 recommended by Kleinbaum et al., (1988). The results of the VIF test therefore find no evidence of multicollinearity among the regressors in the SUR model.

Table 11: Results for VIF test for SUR model

	KABODE		JEWEL		EJUMULA		N-POLISTA		N-UKEREWE	
variable	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
Lndm	1.35	0.74	1.36	0.73	1.37	0.73	1.35	0.74	1.36	0.74
Lncpi	1.34	0.75	1.34	0.75	1.34	0.74	1.34	0.74	1.34	0.74
Gend	1.08	0.92	1.08	0.93	1.08	0.92	1.08	0.92	1.08	0.93
Edu	1.08	0.93	1.08	0.93	1.08	0.92	1.08	0.93	1.08	0.93
Lnage	1.06	0.94	1.07	0.94	1.06	0.94	1.07	0.94	1.06	0.94
Chld	1.05	0.95	1.06	0.95	1.05	0.95	1.06	0.95	1.05	0.95
yld2	1.04	0.97	1.04	0.96	1.04	0.96	1.03	0.97	1.03	0.97
Favrt	1.03	0.97	1.03	0.97	1.03	0.97	1.02	0.98	1.03	0.98
ass-in	1.03	0.97	1.03	0.97	1.03	0.97	1.02	0.98	1.02	0.98
Lndvi	1.02	0.98	1.02	0.98	1.02	0.98	1.02	0.98	1.02	0.98
tst1	1.01	0.99	1.01	0.99	1.01	0.99	1.01	0.99	1.01	0.99
Mean VIF	1.1		1.1		1.1		1.1		1.1	

Source: survey results (2014)

5.0: SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Summary

This study assessed the farmers' willingness to pay for quality planting materials (vines) of biofortified and non-fortified sweetpotato and the factors affecting willingness to pay. It specifically compared the farmers' willingness to pay for quality planting materials across different administrative regions, agro-ecological zones and varieties; farmers' willingness to pay for quality planting materials of biofortified and non-biofortified sweetpotato varieties; and the factors influencing willingness to pay for biofortified and non-biofortified quality sweetpotato planting materials. It used data collected from 450farm households in January and February 2013 in Mara, Mwanza, Shinyanga, and Kagera regions of Tanzania using multi-stage sampling procedure. The four regions were selected because it was covered by a project that created awareness of the importance of using clean planting materials and also facilitated farmer linkage to sources of clean planting materials.

Descriptive statistics were used to compare willingness to pay for clean sweetpotato planting materials by variety, region and agro-ecological zones. In addition, analysis of variance (ANOVA) was used to compare willingness to pay for biofortified and non-biofortified clean sweetpotato planting materials. The SUR model was used to analyze factors influencing willingness to pay for biofortified and non-biofortified clean sweetpotato planting materials.

The study found that the majority of sweetpotato growers were female (71%). Sweetpotato farming was mainly done by middle-aged farmers with overall mean age of 45 years. On average, households had seven members with an average of one child five years old or below.

Most respondents were married (75%) and most sweetpotato growers had primary education. The large majority (96%) of the project participating households was engaged in farming as their main activity and on average earned Tsh.226, 289 from crops in year 2012. Sweetpotato growers had an average 4.6 acres of land, of which on average 3.5 acres was under use.

The study also revealed that New Polista vines have the highest willingness to pay followed by those of Kabode, New Ukerewe and Ejumula, while Jewel vines have the lowest willingness to pay. Results from SUR regression further revealed that farmers' willingness to pay for New Polista is affected by location variables such as distance to market and input source, crop income and varietal attributes such as taste. In addition, the results showed that willingness to pay for Kabode is affected by, among others, number of children under five years of age, age, wealth, distance to market and a number of varietal attributes including yield. The willingness to pay for quality planting materials of the other OFSP varieties, namely Ejumula and Jewel, is also affected by similar factors.

5.2. Conclusions

This study concludes that willingness to pay for quality planting materials of biofortified OFSP and non-OFSP differs by region, agroecological zones and varieties. It also concludes that farmers are willing to pay more for quality planting materials of non-biofortified varieties, especially New Polista, than for the biofortified OFSP varieties. The findings corroborate those of other studies which found that taste is preferred to quality. Further, the study concludes that willingness to pay for quality sweetpotato planting materials is affected by farmer-specific factors (e.g., age and education), location factors (e.g., distance to markets), asset endowments factors (e.g., wealth and income), and number of varietal attributes (e.g., taste and yield), but the effect is variety specific.

5.3. Policy recommendations and areas for future research

One major implication of the findings of this study is that farmers' demand for non-OFSP is still stronger than for OFSP. Therefore projects and programs that promote OFSP should provide the farmers with opportunity to access quality planting materials of their favorite local varieties, such as New Polista in this case. This is because sweetpotato is often used as bridge the hunger gap and hence is a food security crop. The finding that distance to source of quality planting materials reduces demand for such materials supports the need to decentralize multiplication and make it available locally and closer to the farmers. In addition, the finding that a number of varietal attributes affect the demand for quality planting materials implies the need to focus breeding on varietal attributes in addition to the agronomic attributes.

While the study focused on willingness to pay for vines of a number of biofortified and non-biofortified varieties, it was only conducted in one country thus making the results context specific. Similar studies therefore need to be done in other countries and contexts to test the validity of this study's findings.

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7.0: APPENDICES

Appendix I: correlation results of the variables used for SUR model estimation

	lnwtp K	lnwtp J	lnwtp E	lnwtp NP	lnwtp NU	Gend	Edu	Chld	YLD1	YLD2	Favrt 2	Favrt 3	Favrt 5	Favrt 6	Favrt 8	lndm	lndvi	lncpi	ass_i	Lnage	Tast1	Tast2
lnWTPK	1.00																					
lnWTPJ	0.65	1.00																				
lnWTPE	0.60	0.76	1.00																			
lnWTNP	0.37	0.44	0.43	1.00																		
LNWTNU	0.55	0.68	0.70	0.48	1.00																	
Gend	0.05	0.04	-0.01	-0.01	0.05	1.00																
Edu	-0.02	-0.01	0.00	0.02	0.01	0.18	1.00															
Chld	0.09	0.11	0.11	0.05	0.09	0.04	-0.07	1.00														
YLD1	-0.18	-0.18	-0.21	-0.09	-0.20	0.09	-0.02	0.07	1.00													
YLD2	0.18	0.18	0.21	0.09	0.20	-0.09	0.02	-0.07	-1.00	1.00												
Favrt2	0.10	0.11	0.07	0.03	0.10	-0.03	-0.01	-0.01	-0.08	0.08	1.00											
Favrt3	0.07	0.14	0.08	0.01	0.03	-0.03	0.04	0.05	-0.09	0.09	-0.11	1.00										
Favrt5	-0.16	-0.11	-0.09	0.13	-0.02	0.05	0.00	-0.06	0.08	-0.08	-0.34	-0.18	1.00									
Favrt6	-0.15	-0.11	0.02	-0.10	-0.06	-0.05	0.05	-0.03	0.09	-0.09	-0.09	-0.05	-0.15	1.00								
Favrt8	0.15	-0.06	-0.04	-0.11	-0.08	0.05	-0.01	0.04	-0.10	0.10	-0.24	-0.12	-0.38	-0.10	1.00							
lndm	0.11	0.06	0.04	0.09	0.12	0.04	-0.09	0.02	0.00	0.00	0.06	-0.09	0.03	-0.11	0.07	1.00						
lndvi	0.05	0.10	0.05	0.07	0.05	0.03	-0.04	0.05	-0.01	0.01	0.06	-0.01	-0.01	0.02	0.00	0.08	1.00					
lncpi	-0.01	0.00	-0.06	-0.01	-0.02	0.02	0.01	-0.07	-0.01	0.01	-0.03	-0.01	0.08	0.00	0.05	0.49	0.06	1.00				
ass_i	0.13	0.11	0.07	-0.01	0.01	0.07	0.03	-0.01	-0.07	0.07	-0.07	0.12	-0.02	-0.10	0.09	-0.05	-0.02	-0.01	1.00			
Lnage	0.11	0.14	0.09	0.10	0.09	0.10	-0.10	-0.16	-0.04	0.04	-0.03	0.03	-0.03	0.00	-0.02	0.00	0.03	0.05	0.05	1.00		
Tast1	0.03	0.05	0.09	-0.07	0.05	-0.04	-0.06	-0.01	0.03	-0.03	-0.01	0.00	-0.01	-0.01	0.04	0.04	0.04	0.00	-0.05	0.01	1.00	
Tast2	-0.03	-0.05	-0.09	0.07	-0.05	0.04	0.06	0.01	-0.03	0.03	0.01	0.00	0.01	0.01	-0.04	-0.04	-0.04	0.00	0.05	-0.01	-1.00	1.00