# Are Farmers Willing to Pay for Quality Planting Materials of Clonally Propagated Biofortified Crops? The Case of Orange-Fleshed Sweetpotato in Tanzania

Florine K. Mwiti[1*], Julius J. Okello[2] and Kimpei Munei[1]

[1]University of Nairobi, Department of Agricultural Economics, P.O. Box 29053, Nairobi, Kenya

[2] International Potato Center, P.O. Box 22274, Kampala, Uganda; Email: j.okello@cgiar.org

*Corresponding author, e-mail: florkarm@yahoo.com.

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## Abstract

Hidden hunger, resulting from micronutrient deficiency, is a major problem in developing countries. Vitamin A is one of the micronutrients that are widely deficient in diets of many rural households. Biofortified staples that are rich in beta carotene, a precursor for vitamin A, such as Orange Fleshed Sweetpotato (OFSP) can contribute to solving this problem. Recent efforts have therefore focused on sensitizing farmers about the benefits of OSFP while at the same time supplying highly subsidized quality (i.e., pest and diseases free) OFSP planting materials (i.e., vines), usually fee or at heavily subsidized prices. This study uses seemingly unrelated regression technique and data from 481 farmers to assess the demand for quality OFSP vines and the factors affecting the demand for such vines. It finds high willingness to pay for quality OFSP vines shown by the high willingness to pay. Demand for quality vines is affected by number of children, age, tastes, preferences, yield and Income. The study concludes that demand for quality OFSP vines is high, but still lower than for white-fleshed varieties. It discusses implications of the findings.



**Key words:** Biofortified crops, quality planting materials, smallholder farmers, willingness to pay, Tanzania.

JEL: O30, O33, Q12

## 1. Introduction

Micronutrient malnutrition and hunger are major problems affecting developing countries, especially in Sub-Saharan Africa (FAO, 2012). A leading micronutrient deficiency facing these countries is vitamin A (West and Darnton-Hill, 2001). The effect of vitamin A deficiency (VAD) is especially intense among the poorer populations who can't afford the artificial food supplements and whose options for food diversification are limited (Bouis, 1999). Biofortification, a food-based approach that seeks to combat VAD improving the nutritional quality of staple food crops consumed by poor households has thus attracted a lot of interest among the development community (Bouis et al., 2011). Its attraction emanates from the fact that it can supply the needed micronutrient to combat VAD among the vulnerable groups at low or no cost. One of vitamin A biofortified staple that can greatly contribute to the fight against VAD is the orange-fleshed sweetpotato (OFSP).The OFSP is rich in beta carotene, a precursor for vitamin A (Nestel et al., 2006). Proof of concept studies in Uganda, Mozambique, Kenya and Rwanda find strong evidence that OFSP can provide significant quantities of vitamin A needed to overcome VAD among vulnerable groups, namely children under five years and pregnant and lactating women (Harvestplus, 2012). In addition, Van Jaarsveld et al., (2005) have found that consumption of moderate amounts of boiled OFSP regularly by children in significantly improved their vitamin A levels in the blood.

One of the major constraints to farmers' adoption of OFSP, and hence the campaign to tackle VAD using OFSP, has been the lack of access to quality planting materials (or vines[1]). Majority of the farmers still depend on own sweetpotato vines of those borrowed from close social networks (Okello et al, 2015). The resulting widespread practice of recycling planting materials of this clonally propagated crop usually lead to accumulation of pests and diseases resulting which reduces its performance, and especially yields (Kapinga et al., 1995; Mukibii, 1977; Gibson et al., 1998). For OFSP, the poor access to quality planting materials is exacerbated by unavailability of the certified disease-free materials and the challenges of conserving planting materials during the dry periods (Andrade et al., 2009; Fuglie, 2007; Sindi et al., 2012).

1 Through this document, the term vines is used interchangeably with sweetpotato planting materials.

In response to this bottleneck of availability of quality sweetpotato planting material, the International Potato Center (CIP), jointly with the public and private sector partners, has spearheaded efforts to promote farmer access to quality sweetpotato planting materials, often free or at heavily subsidized prices. One such case was the joint partnership involving CIP, the government of Tanzania and some non-governmental organizations. The partnership aimed at promoting farmers' access to quality planting materials at 50-100% subsidy. The materials promoted included both the OFSP and white fleshed sweetpotato (WFSP) varieties. The white varieties promoted by the project were disease and pest free unlike the dominant traditional varieties, but contained no beta-carotene (Stathers et al.,2005). The project also sensitized farmers on the nutritional value of consuming OFSP (Sindi et al., 2012) and the need to use quality planting materials. It is estimated that more than 10,000 farmers benefited from this intervention (Okello et al, 2015).

The need to scale up the production and consumption of OFSP among the vulnerable populations has led to questions regarding whether farmers would be willing to pay for quality planting materials (that is, vines that are free from diseases and pests) if the current subsidies were removed and how much they would be willing to pay. To date, studies that have assessed the willingness to pay for OFSP (Nestel et al., 2006; Masumba et al., 2007; Tumwegamire et al., 2007; Meenakshi et al., 2010; Naico and Lusk, 2010) have mainly focused on fresh roots. The only exception is Labarta's (2009) who examined the willingness to pay for OFSP planting materials in Mozambique using an auction. Our study however differs from his by utilizing a field experiment that enabled farmers to plant quality vines of both the biofortified OFSP and non-biofortified white fleshed varieties of similar quality, thus enabling the respondents to have real rather than hypothetical experience of the varieties prior to bidding for their prices.

This study uses data from a carefully designed field study that controlled for quality of planting materials to examine farmers' willingness to pay for quality vines. The data used was collected from among sweetpotato farmers who participated in a project that first sensitized them about the nutritional benefits of OFSP. The farmers were then provided with clean materials of both OFSP and WFSP to plant for two seasons prior to the study. The study uses seemingly unrelated regression technique to assess the factors that influence farmers' willingness to pay for quality planting materials. The rest of this paper is organized as follows. Section 2 discusses the study methods and also presents the analytical framework. Section 3 discusses the empirical methods. Section 4 presents and discusses the results while Section 6 concludes and draws some policy implications.

## 2. Study methods

This study is based on the Lanchaster's consumer theory which is a refinement of the traditional approach to the theory of consumer behavior. The Lancaster theory is based on the proposition that consumers value goods due to their attributes rather than the good per se (Lanchaster, 1966). Specifically, the Lancasterian demand theory posits that consumers derive utility from the characteristics or properties of a good rather than the good being the direct object of utility. This implies that a good by itself does not give utility to the consumer; rather, its attributes in terms of characteristics and features do. In general, a good will possess more than one attribute, and attributes may be shared by more than one good.

Two methods are normally applied in the study of consumer evaluation of new food products namely, the sensory evaluation and direct elicitation of consumers' willingness to pay. These methods can be categorized into revealed preference and stated preference methods, respectively. The most commonly used stated preference method is the contingent valuation (CV). Its popularity stems from flexibility and ease of application compared to other methods (Carson et al., 2001). It uses survey questions to assess respondents' preference for goods by directly asking how much the respondents would be willing to pay for specified attributes incorporated in them. The method is based on hypothetical market and is applied in a series of steps. First, a description of the good being valued, and the condition under which it is made available, are carefully described. Second, a payment vehicle is selected. Third, a question that derives the respondent willingness to pay for good being valued is posed. Fourth, information about the respondent's characteristics e.g. socio-economic characteristics is collected.

Despite its ease of application the CV method is usually criticized for over-or under estimating the true individual willingness (Hanemann, 1991; Okello et al, forthcoming)). One of the recommended methods for overcoming the inadequacies of CV is the use of choice experiment (CE). The CE method can be categorized into stated preference, if hypothetical, or revealed preference if binding. However, choice experiment also has a number of drawbacks namely: preferences may be unstable throughout the experiment, it is often very difficult to design the experiments, CE is much more demanding on respondents, and the incentive properties are unclear (Carson et al., 2001; Mogas et al., 2006; Meyerhoff et al., 2008). The literature is divided about the superiority of one of these approaches over the other. Indeed, Carson et al., (2001) suggested that there is no difference between the two methods. Consequently, the choice of the method to use in a survey really depends on the study context and on the trade-off between the advantages and disadvantages of the two methods.

*Scenario description and the elicitation of the willing to pay*

In collecting the WTP data for this study, the respondent was asked a series of questions related to effects of sweetpotato pest (weevil) and diseases (virus). The questions exposed the respondent to the symptoms of major sweetpotato pests and diseases, especially the sweetpotato weevil and sweetpotato viral diseases, respectively. The respondent was then shown samples and pictures of a virus-infected sweetpotato plant and asked whether he/she had experienced similar symptoms in his/her plot(s). The cause of such symptoms were discussed and explained. Next, the respondent was informed that the project vines used in this study, and which comprised both OFSP and WFSP varieties, were of higher quality because they had been cleaned of the virus diseases. Then, the respondent was shown a picture of cleaned vines of better quality and also informed that such quality vines had higher yield than those found locally among the sweetpotato farmers in the same 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 color while others, which had white flesh color, did not. The varieties that could provide vitamin A were introduced and marked as Kabode, Jewel, and Ejumula, while those that could not were introduced and marked as 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 radio broadcast and market information boards 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 clean/quality vines from) these multipliers.

Prior to the study, the project participants were offered free clean/quality vines of OFSP and WFSP varieties and asked to plant and utilize (eat and/or market) the roots. The farmers planted the better quality vines for two seasons. The planting and utilization sweetpotato enabled the project participants to "evaluate/experience" the performance of quality OFSP vines in terms of taste, dry matter, and resistance to the sweetpotato weevil and virus diseases relative to the cleaned WFSP.

In order to collect the willingness to pay bids, each respondent was first asked to remember the information he/she has been given and consider his/her experience of planting and utilizing the sweetpotato vines from the project. Ultimately, the respondent was asked how much money she/he would be willing to pay for a bundle of 100 vines each measuring 30cm of both the OFSP and WFSP varieties. Bid values were recorded in Tanzania shillings (Tshs). Some farmers were not willing to pay anything for quality OFSP and WFSP vines and were assigned a willingness to pay value of zero.

Additional information was collected using a pre-designed and pre-tested questionnaire. The Information collected included farmer attitudes and perceptions towards sweetpotato, demographic characteristics (including gender, education and age), household income, and food consumption frequency.

*Assessment of factors influencing WTP for quality sweetpotato vines*

The factors influencing willingness to pay for the five varieties was assessed using Seemingly Unrelated Regression (SURE) model to cater for any possible correlation in the WTP between and among the different varieties. The SURE 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. The 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 represented as:

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

The N equations can be stacked into SURE model given by:

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

Where $X_{ij}$ is a k-vector of explanatory variables and $\beta_j$ is the vector of coefficients of the explanatory variables. Within each of the j equation, the error terms are assumed to have zero mean and to be identically and independently distributed for i = 1, . . . , M. That is:

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

The variance and covariance matrix is therefore given by:

$$Var(\mu_{ij}) = \sigma_j \text{ and } Cov(\mu_{ij}, \mu_{i'j}) = 0, \text{ respectively for } i \neq i', \text{ and } j = 1, \ldots, N \quad (4)$$

However, the error terms for the ith observation can be correlated across equations, so that the covariance matrix is expressed following Katchova (2013) and Henningsen and Hamann (2007) as:

$$Cov(\mu_{ij}, \mu_{ij'}) \neq 0, \text{ for } j \neq j', \text{ and } i = 1, \ldots, M. \quad (5)$$

and,

$$\mu_{ij} = E(Y_{ij}) = X_{ij}\, \beta j, \text{ for } i = 1, \ldots, M, \text{ and } j = 1, \ldots, N \quad (6)$$

SURE uses a three stage least squares (3SLS) technique which, in turn, uses asymptotically efficient and feasible generalized least-squares (FGLS) algorithm (Greene, 2012). Therefore, the estimator generated by SURE is asymptotically equivalent to the generalized least squares (GLS) estimator which is unbiased and efficient.

The general empirical model estimated was specified as;

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

Where;

$$WTP = [WTP_1, WTP_2, \ldots, WTP_5] \quad (8)$$

$$X\beta = [X_1\beta_1, X_2\beta_2, \ldots, X_k\beta_k] \text{ , and} \quad (9)$$

$$\mu = [\mu_1 \ldots \mu_5] \quad (10)$$

$WTP_{1 \ldots N}$ are the are the dependent variables (measured as willingness to pay) for the 5 estimated equation, $X_1$ to $X_k$ are vector of explanatory variables in each equation and $\beta_1$ to $\beta_k$ are respective coefficients to be estimated, while $\mu_1$ to $\mu_5$ are the error terms assumed to be correlated for an individual respondent, but uncorrelated across individual respondents. The five equations are estimated for Kabode, Jewel, Ejumula, New Polista and New Ukerewe sweetpotato varieties respectively.

## 3. Data and sampling procedures

This study used data collected from sweetpotato farmers in January and February 2013 in four regions of Tanzania. Multi-stage sampling technique was used to select farmers. The study focused on Mara, Mwanza, Shinyanga, and Kagera regions of Tanzania, which were targeted by a project that sensitized farmers on the benefits of planting and consuming OFSP and of using clean/quality planting materials. Hence these regions were purposively selected. Next, fourteen districts were also purposively chosen based on the areas where the project was actually implemented. The specific districts covered are shown in Figure 1. As shown in the map, the project reached beneficiary households with vines using 2 strategies namely through decentralized vine multiplier (DVM) and through mass distribution of the vines (MD). The former involved an individual farmer redeeming a voucher for subsidized vine while the latter targeted many farmers and issued one vines for free. The subsidy in the DVM model was about 50% of the price.

A list of all the administrative Wards in these districts was the drawn and Wards randomly sampled from the list. Similarly, for each ward, a list of all villages was compiled and a random sample of villages drawn. In each of the sampled village, separate lists of households that participated in the project and those that did not was compiled, and a random sample drawn from each list using probability proportional to size sampling technique. Each farm household was then interviewed using pretested questionnaires. In total 481 project participants and 251 non-project participants were interviewed.

The analysis in this paper is based only on the 481vhouseholds that participated in the project and who therefore benefited from project activities and hence were selected to participate in the willingness to pay study.

Figure 1: A map showing study areas

## 4. Results and discussion

Definitions of the variables used in the Seemingly Unrelated Regression model (SURE) and their summary statistics are given in Table 1. It shows that, among the OFSP varieties, the respondents were willing to pay Tsh 140 and Tsh 141 more Kabode vines than for a bundle of 100 (30-cm) vines of Ejumula and Jewel, respectively.

Paired t-tests of the hypothesis that there is no differences between the mean WTP for Kabode vines and the vines of Ejumula and Jewel varieties yielded p-values of 0.0008 and 0.0000, respectively, indicating that farmers are willing to pay statistically significantly higher price for Kabode than Ejumula and Jewel. This finding is attributed to the good attributes of Kabode roots, especially in terms of taste, dry matter content and resistance to diseases. Okello et al (2013), for instance, find that farmers rate Kabode much higher in terms of these attributes than the other varieties.

Results also show that farmers are willing to pay, on average, higher prices for same amount of quality vines of New Polista and New Ukerewe varieties than for the OFSP varieties, except for Kabode which has slightly higher price than New Ukerewe. The results therefore indicate that New Polista dominates all the OFSP and local varieties in terms of its demand. Pairwise comparison of the mean WTP show that the study respondents were willing to pay Tsh 133 and Tsh 124 more for New Polista than for New Ukerewe and Kabode, respectively. Further, the individual paired t-test of the hypothesis that there is no difference in mean WTP for New Polista vines and the vines of New Ukerewe and Kabode yield p-values of 0.0004 and 0.0000, respectively, indicating that farmers are willing to pay statistically significantly higher price for New Polista. A paired t-test of difference in mean WTP between Kabode and New Ukerewe however indicate that the difference in the price the study respondents were willing to pay for the vines of these two varieties (i.e., Kabode and New Ukerewe) is not statistically significant.

Table 1: Description and summary statistics of variables used in empirical estimations of the SURE model

| Variables | Description | Mean | Std Dev |
|---|---|---|---|
| ***Dependent variables*** | | | |
| WTPK | Willingness to pay for a bundle of one hundred (30cm) vines of Kabode variety (Tshs) | 1097 | 1041 |
| WTPJ | Willingness to pay for a bundle of one hundred (30cm) vines of Jewel variety (Tsh) | 956 | 1070 |
| WTPE | Willingness to pay for a bundle of one hundred (30cm) vines Ejumula variety (Tsh) | 957 | 1055 |
| WTNP | Willingness to pay for a bundle of one hundred (30cm) vines of New Polista variety (Tshs) | 1221 | 1213 |
| WTPNU | Willingness to pay for a bundle of one hundred (30cm) vines New Ukerewe variety (Tshs) | 1088 | 1223 |
| ***Independent variables*** | | | |
| Gender | Dummy variable 1=male, 0 female | 0.29 | 0.45 |
| Education | Years of formal schooling | 5.66 | 3.10 |
| Numchild | Number of children 5years of age and below | 1.21 | 1.13 |
| Age | Age of respondent in years | 45 | 12.17 |
| Asset index** | Asset index | 3.61 | 2.16 |
| Lncropinc | Natural logarithm of crop income (in Tanzania Shillings, Tshs) | 6.66 | 8.68 |
| Lndistmkt | Natural logarithm of distance to output market in minutes | 1.27 | 1.63 |
| Lndistvi | Natural logarithm distance to vine source in walking minutes | 3.19 | 0.81 |
| 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 strongly agrees or agrees that OFSP yield more than OFSP, 0 otherwise | 0.58 | 0.49 |
| Yld1 | Dummy variable = 1 if respondent strongly agrees or agrees that WFSP yield more than OFSP, 0 otherwise | 0.42 | 0 .49 |
| Tast1 | dummy variable =1 if respondent strongly agrees or agrees that OFSP taste better than WFSP, 0 otherwise | 0 .73 | 0.45 |
| Tast2 | dummy variable =1 if respondent strongly agrees or agrees that WFSP taste better than OFSP, 0 otherwise better than those that are orange inside,0 otherwise | 0.27 | 0.45 |
| Sale | Dummy variable=1 if sweetpotato was grown for sale | 0.36 | 0.48 |
| OFSP-experience | Dummy variable=1 if grew OFSP in 2010, 2011, or 2012 | 0.96 | 0.21 |
| Non-OFSP-experience | Dummy variable=1 if grew Non-OFSP in 2010, 2011, or 2012 | 0.79 | 0.41 |

Source: Survey results (2014); * The exchange rate at the time of this study was 1USD = Tsh 1750; ** Computed following McCulloch and Ota (2002)

The results of the paired t-tests of differences in means also indicate that mean willingness to pay for vines of New Ukerewe variety is higher than for the Jewel and Ejumula vines, and that the differences are statistically significant at 1% level. This indicates that farmers prefer the cleaner vines of this white fleshed sweetpotato variety to those of the two nutritionally enhanced varieties. Together, these findings suggest that even though OFSP varieties offer nutritional benefits, farmers still strongly prefer the white fleshed sweetpotato varieties, especially once they are cleaned from the diseases that affect their production.

Results further show that the mean education level of the study respondents is 6 years, indicating that majority of the farmers have, on average, attained only primary level of education. Past studies find mixed effect of education on WTP. Okello et al (forthcoming) indicate that education increases WTP for some value addition processes but not others. At the same time, Table 1 shows that most of the study respondents were of middle age (i.e., 45 years) and had at least one child that is under two years of age. This is the age period during which the effect of Vitamin A deficiency is most serious to a child's health.

Table 2 presents the results for regression analysis reflecting socio-demographic, financial and asset endowment factors as well as quality characteristics affecting willingness to pay. The equations were estimated simultaneously using *sureg* command (in Stata) which accounts for the correlation in the errors, thus yielding efficient estimates of the coefficients and standard errors. The dependent variables were the natural logarithm of the respondents' willingness to pay (measured in Tanzanian shillings (Tsh)) for each of the five sweetpotato varieties covered in this study namely, Kabode, Jewel, Ejumula, New Polista and New Ukerewe. We discuss the results of each model below.

Starting with Kabode, the results indicate that the number of children in the household, age of the respondent, yield performance of the clean OFSP variable, preference for Kabode, distance to market, asset index, crop income and the number of years a farmer has experimented with the non-OFSP during the project period affect the willingness to pay for clean planting materials of the Kabode variety, an OFSP. As expected, households with higher number of children under 5 are willing to pay higher amounts for the clean planting materials of Kabode, other things equal. This may be due to the fact the project emphasized the importance of OFSP to children under 5 years of age due to the elevated need of such children for vitamin A. Similarly, age of the respondent, perception that Kabode yields more than the other varieties, preference for Kabode over the other sweetpotato varieties, distance to market and asset index also increase the willingness to pay for quality planting materials of Kabode. An increase in the age of the respondent by one unit increased the willingness to pay for the clean planting materials of the Kabode variety by 0.76, other things constant. This suggests that older farmers are willing to pay more for clean sweetpotato planting materials than the younger farmers.

Results however show that income earned from the sale of crops has a negative effect on willingness to pay. The income elasticity of demand is -0.03. These results are comparable with those 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 roots by 0.309%. This finding suggests that consumers will substitute the planting materials of the other sweetpotato varieties for those of Kabode variety as their level of farm income increases.

Table 2: Determinants of willingness to pay for quality planting materials among Tanzanian sweetpotato growers: results of SURE regression

| | WTP Kabode | | WTP Jewel | | WTP Ejumula | | WTP New Polista | | WTP New Ukerewe | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | coeff. | p-value | coeff. | p-value | coeff. | p-value | coeff. | p-value | coeff. | p-value |
| Gender | 0.12 | 0.62 | 0.12 | 0.572 | -0.05 | 0.94 | -0.22 | 0.395 | 0.25 | 0.284 |
| Education | 0.01 | 0.85 | 0.01 | 0.75 | 0.02 | 0.598 | 0.04 | 0.255 | 0.04 | 0.404 |
| .Numchild | 0.22 | 0.031** | 0.33 | 0.004*** | 0.36 | 0.002*** | 0.14 | 0.108 | 0.26 | 0.016 ** |
| Lnage | 0.75 | 0.010*** | 1.04 | 0.001*** | 0.79 | 0.017** | 0.63 | 0.008*** | 0.67 | 0.027** |
| Yield | 0.80 | 0.000*** | 1.01 | 0.000*** | 1.31 | (0.000)*** | -0.45 | 0.025** | -1.17 | 0.000*** |
| Favourite variety | 1.03 | 0.000*** | 0.80 | 0.022** | 1.56 | 0.000*** | 0.70 | 0.000*** | 0.10 | 0.778 |
| Lncropinc | -0.03 | 0.074 * | -0.01 | 0.326 | -0.04 | 0.029 ** | -0.02 | 0.064* | -0.02 | 0.040** |
| Ln distmkt | 0.19 | 0.007*** | 0.13 | 0.082* | 0.15 | 0.038 ** | 0.15 | 0.011** | 0.25 | 0.002*** |
| Asset index | 0.12 | 0.019** | 0.12 | 0.049** | 0.09 | 0.112 | -0.01 | 0.841 | 0.00 | 0.988 |
| Lndistvi | 0.06 | 0.443 | 0.21 | 0.066* | 0.01 | 0.551 | 0.12 | 0.151 | 0.06 | 0.530 |
| Taste dummy | 0.12 | 0.512 | 0.39 | 0.218 | 0.61 | 0.024** | 0.34 | 0.096* | -0.38 | 0.200 |
| Sale dummy | 0.35 | 0.155 | 0.00 | 0.998 | 0.42 | 0.141 | -0.10 | 0.644 | -0.31 | 0.264 |
| OFSP-Experience | -0.30 | 0.607 | -1.65 | 0.017** | -0.97 | 0.158 | -1.03 | 0.046** | -0.86 | 0.192 |
| Non-OFSP-Experience | 0.50 | 0.091* | 1.03 | 0.003*** | 1.06 | 0.002*** | 0.78 | 0.003*** | 0.84 | 0.011** |
| Constant | 0.99 | 0.442 | -0.63 | 0.193 | -0.09 | 0.809 | 3.27 | 0.080* | 2.88 | 0.453 |

***; **; * = significant at the 1%, 5%, and 10% level, respectively

Source: Survey results (2014)

The results further indicate that farmers with more assets are willing to pay more for the Kabode variety. The asset elasticity of demand is 0.12. While this finding may look contradictory to that on income on a casual glance, it probably suggests that farmers with more assets see much more value in purchasing and growing a variety of sweetpotato that is nutritionally enhanced. On the other hand, farmers who had experimented with non-OFSP during the project were willing to pay more for Kabode, further suggesting that knowledge of nutritional value in OFSP varieties influences willing to pay for their planting materials.

The results of the Jewel and Ejumula, the other two OFSP varieties closely resemble those of Kabode. They show that the number of children under age 5 years, age of the respondent, perception about the yield performance, distance to the market, and the number of years farmers had experimented with non-OFSP during the project increase the willingness to pay for both Jewel and Ejumula vines. However, while the level of income earned from crop sales affect the willingness to pay for Ejumula vines, it has no effect on the willingness to pay for Jewel vines. Results also show that distance to the source of clean materials has an effect on the willingness to pay for Jewel vines but not for Ejumula variety. Indeed, the results indicate that the higher the distance to source of vines, the greater the willingness to pay for quality planting materials of the Jewel variety, other things constant. The results further show that taste of cooked OFSP roots affects the willingness to pay for clean planting materials of the Ejumula variety but has no effect on the willingness to pay for the vines of other OFSP varieties. The results specifically indicate that farmers are willing to pay a higher price for Ejumula vines due to its taste. Moreover, the results show that the number of years a farmer experimented with OFSP over the project life has weak but significant effect on the willingness to pay for Jewel vines but not on Ejumula or the rest of the OFSP varieties.

The results of the willingness to pay for the quality planting materials of the white-fleshed sweetpotato (WFSP) varieties are presented in the last four columns of Table 2. They bear much similarity to the results of OFSP varieties. In particular, farmers' perceptions about yield, level of income from the crop sales, distance to market, and the years a farmer has experimented with non-OFSP all affect the willingness to pay for both New Polista and New Ukerewe, just as it was the case with the OFSP varieties. However, while perceptions about yield increased the willingness to pay for the OFSP, it is inversely related to the willingness to pay for New Polista and New Ukerewe. Between the two WFSP varieties, the findings suggest that taste of the roots increases the willingness to pay for quality vines of New Polista but has no effect on New Ukerewe. On the contrary, the number of children under five years old in the household increases the willingness to pay for quality vines of New Ukerewe but has no effect on the New Polista. This finding though similar to those of Kabode above, is likely to be due to a different reason. The positive relationship between number of children and willingness to pay for New Ukerewe variety may be due to food security role sweetpotato plays in general. A large-sized family may therefore want to plant more vines/sweetpotato hence the higher WTP for vines. As expected, results further indicate that number of years that the farmers had experimented with OFSP has negative effect on willingness to pay for New Polista but does not influence willingness to pay for New Ukerewe. This finding suggests that farmers who have experienced the benefits of OFSP have a lower demand for planting materials of WFSP.

## 5. Summary, conclusions and implications

This study used data collected from 481 sweetpotato growing households to assess the willingness by smallholder farmers to pay for quality sweetpotato planting materials. The materials were previously cleaned for the major diseases (especially viruses) that affect sweetpotato. The study is based on a carefully designed field experiment conducted in Tanzania that generated the WTP data for quality planting materials of three OFSP and two WFSP varieties. The data were analyzed using SURE model that accounts for correlation across the error terms of the equations representing the different OFSP and WFSP varieties.

The study finds that, among the orange-fleshed sweetpotato (OFSP) varieties, Kabode vines have the highest willingness to pay hence is the most preferred, and that white-fleshed sweetpotato (WFSP) varieties still dominate OFSP in terms of popularity. The study specifically finds that a farmer’s perceptions about the taste of OFSP roots, and its benefits to children under five years of age, have a significant influence on the willingness to pay for these varieties. However, this preference for OFSP vanishes when farmers have a choice between them and the popular white fleshed varieties. In other words, the nutritional benefits of OFSP do not beat the popularity of the two white fleshed varieties examined in this study. These results therefore corroborate those of the descriptive statistics above, which suggested that New Polista and New Ukerewe vines have higher demand than the OFSP vines.

The study concludes that demand for OFSP vines is high, as evidenced by the high willingness to pay. To put this into context, farmers currently share vines of local sweetpotato varieties for free while this study finds a willing to pay value of Tsh 1097, TSh 957 and Tsh 956 for Kabode, Ejumula and Jewel, respectively. However, farmers are willing to pay significantly more for non-biofortified sweetpotato varieties than for biofortified varieties. These findings imply that, for the farmer as a consumer, the attributes of sweetpotato is of considerable importance. They imply the need for greater effort in educating farmers about the importance of good nutrition. The finding that taste significantly affects willingness to pay implies the need to focus breeding efforts in producing OFSP varieties that appeal to farmers in terms of taste.

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