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Farmers' demand for quality and nutritionally enhanced sweetpotato planting material: Evidence from experimental auctions in Rwanda

Boscow Odhiambo Okumu, Srinivasulu Rajendran, Julius Okello, Patrick Ward, Marcel Gatto, Fleur Kilwinger, Mywish Maredia, Sindi Kirimi, Jean Claude Nshimiyimana, Jean Ndirigwe, Seraphine Uzamushaka, Denis Munyabarame, Damien Shumbusha, Guy Hareau, and David Spielman

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International Potato Center
P.O. Box 1558, Lima 12, Peru
cip@cgiar.org • www.cipotato.org

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FARMERS' DEMAND FOR QUALITY AND NUTRITIONALLY ENHANCED SWEETPOTATO PLANTING MATERIAL: EVIDENCE FROM EXPERIMENTAL AUCTIONS IN RWANDA

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ABSTRACT

Most farmers source sweetpotato vines from neighboring farmers or from cuttings taken from their own plots during the previous season. In the absence of "clean" vines prepared with more attentive production practices, farmer-to-farmer vine exchanges and own-saved vines tends to encourage the accumulation of pests and diseases that ultimately affect yields. In addition, the perishability and bulkiness of its primary propagation material – vines – there is relatively little articulated demand for vines through either market or non-market exchanges. In addition, demand for nutritionally rich variety and biofortified crop orange-fleshed sweetpotato (OFSP) is limited because of multiple factors including farmers' unfamiliarity with the product and its novel attributes such as its high beta carotene content, the search costs incurred in locating the product, and information asymmetries between buyer and seller about the quality and performance of the product. We investigate demand for quality vine and nutritional attribute of the crop using a second price experimental auction approach by determine the premium price farmers are willing to pay for these attributes and investigate drivers of demand. In the absence of information on the source of vines, maturity and resistance to diseases, farmers are willing to pay a premium of about 35 Rwandan Francs for high quality vines sourced from decentralized vine multipliers. However, on provision of information on the source of vines, maturity and resistance to diseases of the vines, the premium price increases significantly to 133.71 Rwandan francs and to 107.22 Rwandan Francs after provision of visual information depicting the performance of the vines in demonstration plots. The premium price also increases significantly for vines sourced from neighbors to about 74.35 Rwandan francs, which further increases to 151.53 Rwandan francs when nutrition information is provided to the farmers. The study also revealed that demand for high quality vines is correlated with sex of household head, sex of the respondent, age of the respondent in years, household size, membership in a farmer organization, information from neighbors/other farmers, access to marshland, females make agriculture decisions in the household among other factors. In terms of policy, there is need to promote importance of quality vine and nutritional value of OFSP through sensitization on the field demonstration and nutritional values.

1. INTRODUCTION

Sweetpotato (Ipomoea batatas L.) is an important staple and food security crop in Rwanda. It is widely consumed by many households, mostly in boiled form (Low et al. 2017). Per capita sweetpotato production in Rwanda is among the highest in SSA – 76 kgs per capita (Sindi and Ndirigue, 2015). Rwanda is densely populated, with 490 persons per square kilometer, with a relatively youthful population (i.e., 61% of the population is less than 25 years old) that is expected to double by 2020 thus increasing the demand for food staples. Additionally, despite Rwanda's impressive economic growth, chronic malnutrition and general food insecurity remain a challenge (Sindi and Ndirigue, 2015; Wirth et al., 2017). Sweetpotato, especially the biofortified orange-fleshed varieties with proven efficacy (Girard et al., 2017), can play a greater role on the immediate and long-term food and nutrition security in Rwanda. However, improving the productivity of sweetpotato is hindered by several factors, most importantly, the access to quality planting material. The existing material, mainly sourced informally from farmers, is recycled, hence oftentimes heavily infected with yield-degenerating virus diseases and pests (especially weevils). Consequently, yields of only 6 ton/hectare, as compared to the potential 21 ton/hectare, are typical (Low et al., 2017).

To strengthen sweetpotato seed system and improving nutritional status U5 children, several new improved biofortified varieties of sweetpotato have been introduced in Rwanda since 2014 through partnership between the International Potato Center (CIP) and Rwanda Agricultural and Livestock Board (RAB) (Namanda et al., 2011). Through this collaboration, a strong sweetpotato seed system with community-based decentralized vine multipliers (DVMs) as a source of quality sweetpotato planting material for farmers has evolved. The DVMs are linked to a source of early generation seed producers to ensure that vines produced are quality vines (i.e., free of major pests and diseases, such as sweetpotato virus disease (SPVD) and sweetpotato weevil) (Namanda et al., 2011; Rajendran et al. 2017), and to farmers through government extension efforts and projects. The projects, through NGO partners including Imbaraga and World Vision, promote the cultivation and consumption of orange-fleshed sweetpotato (OFSP) while providing nutrition education on the benefits of OFSP and consuming diverse diets including OFSP.

To date, markets for quality sweetpotato vines have been slow to emerge in Rwanda, though there is evidence to suggest that farmers do buy and sell vines in local exchanges, especially during the September-December rainy season (Season A) (Rajendran et al., 2017). Otherwise, NGO projects remain the major buyers of quality vines from DVMs themselves; in turn, distributing to farmers at highly subsidized rates or for free (Okello et al., 2015; Ogero et al., 2016; Bentley et al., 2018). As in other countries, quality vines are often purchased at highly subsidized prices or free of charge (Okello et al., 2015; Ogero et al., 2016; Bentley et al., 2018). Though majority of farmers obtain their sweetpotato planting material from own sources or neighboring farmers, a market for quality vines has started emerging in an area where farmers do not have facilities to conserve seeds, especially during the September-December season (Rajendran et al., 2017; 2021).

Often farmers feels that the commercial production of sweetpotato vines may be costly compared to the normal farmers practices despite the assurance of nutritive value and lower risk of diseases and higher productivity. However, Namanda et al (2019) found that Sweetpotato root production (per kilogram) is cost-effective and root producers can reduce their production costs by 21% if they buy planting material from commercial multipliers who use mini-screenhouses for conservation of planting material. Therefore, it is important to break this vicious cycle of low production year in year out due to use of low-quality vines. There have been no previous studies that have looked at the willingness to pay premium price for quality sweetpotato planting materials when farmers receive information on importance of using quality planting materials and methods of producing those materials, nutritional attribute, and visual observation of performance of planting materials on root yield through farmers' demo plot.

This leads to the following research questions: what premium price are farmers willing to pay for quality vines when they receive information about importance of quality planting materials by explaining the source and methods of producing quality planting materials and how does this contribute to root yield and what are the drivers of the demand for quality vines? In addition to quality attribute, are farmers willing to pay a premium for the high beta carotene nutritious biofortified varieties as opposed to the non-biofortified dominant local ones? What is the effect of information and visual observation regarding the quality of vines on the demand for quality vines and the biofortified sweetpotato varieties?

Although studies have used various stated and revealed preference methods to measure willingness to pay for different attributes which have various limitations due to their hypothetical nature, experimental auctions adopted in this study do not exhibit those challenges. Experimental auctions combine advantage of both stated and revealed preference methods as it uses real goods, real money exchange and repeated market participation to simulate real market situation (Lee et al 2001). Experimental auctions also tend to elicit more accurate estimates of WTP since it is based on actual behavior as opposed to intentions and consumers are reminded of their budget constraint. It also handles the problem of non-response bias as most often consumers would just bid lowest if not interested, hence there is no need to make assumption of the shape of the demand curve. However, due to disinterest of respondents some zero bids may be made. Given incentive compatibility, auctions do not suffer from problem of stated preference surveys since they are not hypothetical and involves real exchanges in active market (Canavari e al. 2019). Moreover, in incentive compatible experimental auctions, the price paid is separate from what the winner(s) bid, providing an incentive for bidders to truthfully reveal their preferences (Cox et al., 1982).

The study contributes to literature by adopting a novel approach-experimental auction-that looks at three different scenarios as quality signals to curtail the effects of information asymmetry in credence and experience attributes of quality seed. The first scenario is where no information is provided at all (naïve round), second when farmers are provided with information on the sources of the seed with its associated quality implication and when farmers are informed on the nutritional content and lastly when farmers are shown the performance of the planting materials in demonstration plots (i.e., visual observation along with other scenarios). The uniqueness of the study is time of implementation of the experimental auction where planting seasons has started and buyers who won the bids paid their own money carried away with their desired planting materials. In addition, all rounds are conducted in the same day. The detailed experimental design discussed in the methodological framework.

2. LITERATURE REVIEW

Studies have tried to assess the demand for quality planting materials for various products looking at different attributes. Using Choice experiment in Ghana, Etumnu (2016), found that farmers had high WTP for OFSP to traditional white fleshed and yellow fleshed sweetpotatoes roots. However, they found that respondents socioeconomic characteristics had no significant effect on consumer acceptance for OFSP roots. On the other hand, provision of information about the nutritional benefits of OFSP were found to increase their acceptance significantly. In terms of gender, results have been mixed with female participants found to bid higher than male participants in auctions (see chen etal 2009; Pearson et al. 2013) others find males bidding higher especially African studies (Demont et al. 2017). However, this study focuses on nutritional attributes of roots rather than planting materials.

In Mozambique, Naico et al (2010) using choice experiment data investigated consumers' willingness to pay premiums for OFSPs, they found that although there was preference for the new orange flesh varieties as opposed to the white variety, the most important quality attribute was the dry matter content. They also found that sources of preference heterogeneity were mainly information about nutritional value and whether one resides in rural or urban area. Provision of health information to rural consumers did not have any significant effect on WTP.

Similarly, Adesina et al. (2017) assessed the WTP for quality orange fleshed sweetpotato vines in northern central Nigeria using descriptive statistics and tobit model and found that farmers were willing to pay for OSFP vines due to its maturity period, Beta carotene and yield. The WTP were found to be mainly influenced by various socioeconomic characteristics of respondents such as, age, sex and off farm income. In addition, other factors such as quality of vine bundles, resistance to disease and yield, farm characteristics such as land size and market aspects of OFSP i.e. revenue from OSFP were also found to influence the WTP.

In recent study Mwiti et al. (2020) focuses on farmers' willingness to pay for pest and disease-free vines of biofortified and popular non-biofortified sweetpotato using seemingly unrelated regression model, found higher willingness to pay for clean non-biofortified sweetpotato vines than biofortified sweet potato vines of similar health due to their higher nutritional content, good taste, and firmness of the roots of the former. They also found that a farmers age, number of children, taste, preferences, sweetpotato yields and income were the main determinants of demand for clean vines. Reviews by Talsma et al. (2017) have also revealed that beta-carotene rich OFSP prepared traditionally by boiling is well embraced by consumers in low-income countries. Though there is a strong linkage between demand for nutritional sweetpotato and planting materials of those roots, but most literature focuses on nutritional attribute of sweetpotato roots rather than quality of planting materials (i.e., OFSP vs non-OFSP).

Whereas some studies have studied demand for quality planting materials other Vegetatively Propagated Crops (VPC) including quality seed, Bartle et al (2019) found that seed producers in selected counties in Kenya also revealed strong signs of quality signaling through branding and that although farmers trust the existing institutions, most farmers were still hesitant to engage in the formal and semi-formal seed systems due to exogenous and endogenous factors.

There has also been a myriad of studies on other staple crops such as maize, beans etc. To gauge the relative demand for three seed types with differences in price and quality, Maredia et al. (2019) used double blind field experiments and experimental auctions among bean and cowpeas farmers in Tanzania and Ghana. They found that there were significant differences in perceived quality of the seed products evaluated and that farmers were willing to pay significantly more for the higher rated seeds relative to their low rated seeds although for most farmers the stated WTP was lower than the current price differential between certified seeds. Moreover, they found that the number of farmers willing to pay declines as the price increases.

Mastenbroek et al. (2021) using randomized evaluation to test the effect of an information intervention on farmers knowledge of seed certification found that randomized information treatment enhanced farmers knowledge of the certified seed. However, when the information is used as an instrument for knowledge there is no causal effect. While analyzing consumer acceptance of biofortified orange maize in rural Zambia using framed choice experiment approach and a range of econometric models Meenakshi et al (2010) found that there is a premium for orange maize with nutritional information and that orange maize is well liked despite the negative perception towards orange maize as opposed to white maize. In addition, they found that product experience does not translate to lower willingness to pay and that the mode of nutritional message dissemination does not have a large impact on consumer acceptance.

In Zimbabwe, Kassie et al. (2017) used generalized multinomial logit model on choice experiment data, to estimate the implicit prices farmers are willing to pay for drought tolerance in maize in comparison to other traits, found that farmers were willing to pay a premium for drought tolerance. Banerji et al. (2016) also used hedonic testing methods and the Becker-DeGroot-Marshack mechanism to estimate consumer demand for biofortified high iron pearl millet (HIPM). They found that consumers assign small but significant premiums on HIPM variety relative to local variety even in the absence of nutrition information may be due to prior knowledge on bio-fortified foods. However, nutrition information on the health benefits increased the premium substantially. Market access has also been found to plays a significant role and farmers with available market are more willing to pay for services than those without available market (Ulimwengu et al. 2011).

In Ghana, Boadu et al. (2019) using the choice experiment and latent class models to assess farmers preferences for seed yam certification systems and their WTP for certified seed yam, found that farmers were willing to pay for fully certified seed yam but had high utility towards medium sized pona seed yam. Similarly, Baidoo et al. 2012 using CVM found that in West Akim District of Ghana, over 50 percent of farmers were willing to pay for improved cassava variety. The WTP was also found to be mainly affected by cassava variety, and family labour while the area under cassava cultivation was dependent on the total acre of land the farmer owns, number of children and type of labour.

Mastenbroek et al. (2021) using incentive compatible Becker-DeGroot-Marschak auctions to elicit WTP for quality assured improved seed and found that only 14% of the sampled farmers were willing to pay for market price. However, using randomized information treatment as an instrumental variable for knowledge revealed no evidence of a causal effect of knowledge on WTP. In India, Barnejia et al. (2016) using hedonic testing and Becker-DeGroot-Marshak mechanism found that even in the absence of nutrition information consumers assign a small but significant premium to the high iron pearl millet (HIPM) variety relative to local variety. The premium was found to increase significantly with nutrition information.

Overall, there has been a significant number of scientific papers on promotion of biofortified OFSP and quality seed (see Meenakshi et al. 2010; Ulimwengu et al. 2011; Etumnu 2016; Adesina et al. 2017; Mwiti et al. 2020; Naico et al.2020). Several studies have used various methods ranging from Choice Experiments (CE), Contingent Valuation Methods and Hedonic Pricing which are hypothetical (see Masumba et al 2007; Kikulwe et al. 2020; Meenakshi et al 2010; Naico et al 2010, Mwiti et al 2020). For instance, the hypothetical discrete choice experiments do not include monetary exchanges, making it difficult to account for hypothetical bias (Steur et al. 2016). Others have used experimental auctions (see Maredia et al 2018; Nalley et al. 2006). A major drawback with some of the methods like Contigent Valuation Method is the failure to elicit and estimate real WTP for multiple goods or attributes making identification of cross price effects difficult (Lusk et al 2004). The hypothetical nature of CV environment also makes it prone to hypothetical bias (List et al 2001). Most of these studies are also single case studies with different econometric approaches making comparison difficult. The definition of variables and method of measurement is also varied hence prone to measurement errors. Due to the heterogenous nature of most countries especially in terms of the climatic and topographical features, “a one size fits all’ approach may not be appropriate. A context specific study is therefore critical. we extend the literature by using real bids where farmers who win the bid pay with real money for the quality sweetpotato planting materials.

3. METHODOLOGY

3.1 Experimental design

The auction study had three products:

1. **Product 1 (P1):** A Kabode variety seed sourced from a Decentralized Vine Multipliers (DVM) producing quality seed. Kabode is the most popular OFSP variety in Rwanda owing to good taste and relatively high dry matter content.

2. **Product 2 (P2):** Kabode (OFSP) seed sourced from neighbors (farmer's seed). This product represents a recycled seed of biofortified sweetpotato variety. It is expected to have accumulated SPVD/virus disease and weevils and hence of lower performance (yield, etc) than P1. The hypothesis is that given this information, participants will bid lower for this product (i.e., P2) than P1.

3. **Product 3 (P3):** Non-biofortified dominant (white-fleshed) local variety from neighbors (farmer's seed). As in P2, this product is expected to have accumulated virus diseases and pests (weevil), and hence of lower performance in terms of yield, compared to P1. However, P2 will be superior to P3 nutritionally due to high beta-carotene (the precursor for vitamin A) content. It is also late maturing compared to P1 and P2. It is therefore hypothesized that participants, given this information, will bid higher for P2 than P3.

P1 and P2 varieties are same, the only quality attribute is different between these two products. whereas, P2 and P3, both products are sourced from neighbors (farmer's seed), but varieties are different to capture the nutritional attribute as P2 is OFSP which is rich in Vitamin A nutrient and P3 is non-OFSP.

The auction rounds are as follows:

1. **Round 1 (Naïve):** ALL the 3 products were presented without any information and participants asked to bid their maximum bid for the different products. While the market for vines in Rwanda is relatively nascent, Round 1 mimics what happens when farmers buy seed from the market or neighboring famers (that is, a vines sales point). The farmer in this case uses visual characteristics (stem color and size/thickness, leaf shape, symptoms of a disease on stem/leaves, etc) for cues about the quality of seed and the variety being sold.

Photo 1. Experimenter displaying all three products in round 1

2. **Round 2 (vine quality):** In this Round only P1 and P2 are auctioned. Information on the source of vines (hence implications on agronomic traits such as maturity period, disease/pest infestation, etc) was provided as follows:

   P1 is from a clean source, free from pest/diseases, and matures early (3-4months)
   P2 is from a farmer who has recycled his/her seed for several seasons1, but matures early (3-4 months), as P1

[1] We will try to control for number of cycles of recycling.

Photo 2. 2nd round of the auction where product 1 and 2 are displayed

3. **Round 3 (nutrition):** Two products, namely P2 and P3, are auctioned in this Round. Nutrition information that distinguishes P2 from P3 was provided. Participants specifically informed that:

   P2 is a rich source vitamin A and that vitamin A is good for ones' eyes and mental development, is sourced from a farmer who has recycled seed for several seasons.
   P3 does not contain vitamin A, it has also been obtained from farmer who recycled seed for many seasons. The participants lastly asked to state their maximum bid for P2 and P3 based on this information.

Photo 3. Product 2 and 3 are displayed and the experimenter trying to remove the product 1 from the display and include product 3

4. **Round 4 (visual observation on vine quality):** Double blind demonstration – participants need to observe the actual performance of the two biofortified sweetpotato products (P1 and P2) in the demo plot at harvest to observe differences in yield from these two products.

   During the auction process, the participants asked to bid their maximum bid for the two products based on this actual observation of how the different products have performed in the field.

Photo 4. Agronomist is explaining about the demo plot in round 4

Photo 5. Assistant experimenter is showing the yield level to the participants in round 4

Photo 6. Agronomist and junior agronomist monitor the data in round 4

Based on this design, each participant receives a total of 9 bids (3 bids in Round 1 and 2 bids in the subsequent 3 rounds). The design allows for the estimation of demand for:

(i) Seed quality, holding variety/genetics constant (that is, bidding for P1 against P2),
(ii) Variety – that is, bidding for an orange-fleshed versus a low-beta carotene dominant local variety, both of unknown but lower quality than seed from decentralized vine multiplier source (i.e., P2 versus P3).

3.2 Auction procedure

This study used the 2nd price auction, with bidders informed a priori that: i) there was four rounds of auctions, ii) they used their own money to purchase the product if they "won", and iii) a binding round in which there was a purchase randomly selected at the end of four rounds and products within the round. The bidders have informed that "winners" will be issued with a coupon to be redeemed at the time of planting for the volume of vines auctioned (a bundles of 8 kgs, each 30cm long). The auction was carried out with various steps (Figure 1).

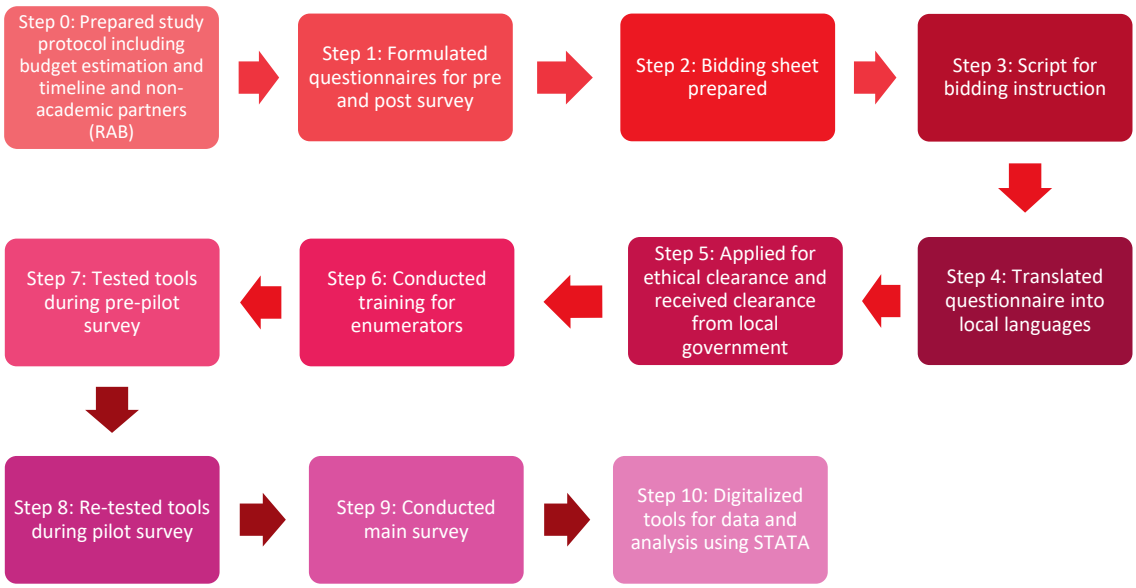

Figure 1. Methods used for conducting auctions

The auction team contains auctioneer (experimenter) with an assistant (pack-up strategy) and 11 enumerators who will be assisting farmers while bidding. The auctioneer(experimenter) first starts with describing the complete auction procedure with well-written script to participants in the auction (Photo 7). The script is attached in Annexure B1.

Photo 7. The auctioneer(experimenter) describing the complete auction procedure with well-written script to participants in the auction

The survey designed depicted in figure 2. There were two surveys with participants in the auction, those are pre- and post-auction. The questionnaire was developed for both surveys and attached in Annexure B2. These questionnaires were tested with pre-pilot and pilot surveys before rolled out in the main survey. Similarly, the questionnaire was developed for monitoring the demo plots and attached in Annexure B3. The auctions were also demonstrated and revised the auction scripts.

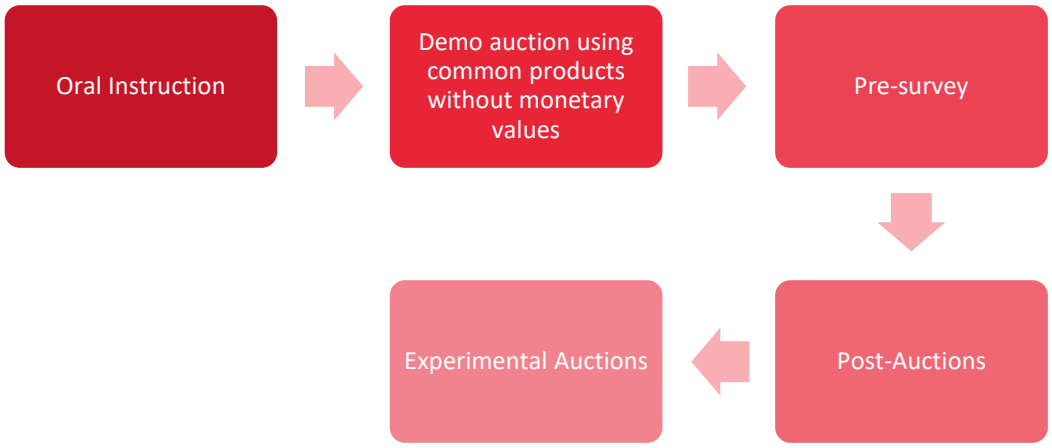

Figure 2. Survey design

Every auction, we have conducted a demo auction to ensure that participants were understood the auction well. During the main auction, in each round, the presentation of the products and the treatment information made, the participants asked to make individual bids for the product (with 0 bids allowed, to cater for, among others, the fact that farmers often obtain seed for free from neighbors).

Bids were collected a sealed envelope bearing the participant's ID and seal it. The experimenter then collected the sealed bids and display them in descending order. Following Maredia et al (2019), at the end of the bidding rounds (i.e., Round 4), a binding round was randomly selected from among the four and one product. The highest2 bidders in that binding round will get to purchase the products3 but pays the second highest price/bid (not his/her bid) using own money (i.e., no endowment). The photo 8 depicts on how participants using her own money and makes her payment.

Photo 8. The winning bidder pays her own money to buy the planting materials from the experimenter and assistant experiment holding the bidding final results

[2] In case of a tie in the highest bid, the winner will be decided by tossing a coin.
[3] The other option here would be to also randomly select a binding product to be purchased. However, it might mean that, in some instances, bidders will be purchasing farmer seed which is often obtained free. The decision on which criteria to use will be made during/after the pre-test of the auction experiment.

During the auction, every subject/participant, there is an enumerator Supporting the subject during the Auction and make sure that they don't talk each other. Non-truthful bidding due to strategic behavior avoided by the experimenter giving "cheap talk" that emphasizes the importance of truthfulness and need not to consider what other participants are likely to bid. Participants who "win" in the auction will buy and take home the vines they have won the same day. This is because the study auctions were conducted at the time when the farmers are actually doing planting (which mostly occurs in November and December).

3.3 Study sample and design

The auctions were conducted in 29 villages during the months of September and November (when the demo crops are expected to be ready for harvest). The villages were selected from 7 leading sweetpotato producing districts in Rwanda (i.e., Gakenke, Kayonza, Muhanga, Musanze, Ngororero, Rubavu, and Rulindo) where there has not been vine dissemination programs (Figure 5).

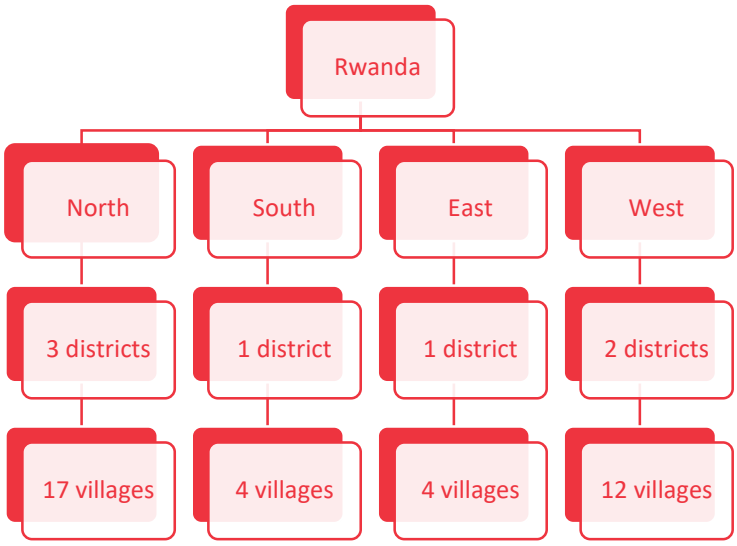

Figure 5. Sample distribution across administrative layers in Rwanda

Thus, the districts and villages were purposively selected based on the availability plots in the lowlands where demos can be established. To minimize contamination from TAAT demo plots, PIM demo sites were separate villages, and as far as possible from the former. There was one auction per village with participants randomly drawn from a validated census list of sweetpotato growers in the village. Each auction had 24 participants, yielded a total of 697 participants for the entire study. This sample size is based on power calculations with upward adjustment to allow for gender comparison and potential absenteeism. The participants were stratified by gender of the sweetpotato grower (12 women and 12 men), to gain understanding of gender differences in WTP for quality seed.

3.4 Ethical standard

Official approval was not obtained through internal review board for collecting data from the field, but the study was adhered high ethical standard and received an approval letter from Rwanda Agriculture and Animal Resources Development Board (RAB) to conduct a survey in the study areas. In addition, this study was approved by the project and study teams of the International Potato Center (CIP). The study team maintained highest ethical standards using standardized questionnaire modules and informed consent forms which were used in other PIM study and other projects which was conducted in Rwanda and other East African countries which have received official ethical clearance from the respective authorities. Before each interview, the research objective, confidentiality, voluntary participation and anonymity of respondents were clearly explained. Verbal consent of each respondent was recorded.

3.5 Analytical framework

The study adopted a framework similar to Holden et al. (2002) in modelling WTP as a sacrifice of current income in order to sustain or increase yield of sweetpotato quality planting material in future. The minimum expenditure level necessary to achieve the utility is given by $e(\mathrm{p}, \mathrm{EU_o}, \mathrm{F_o})$ where p is a vector of prices, $\mathrm{EU_o}$is the current expected utility level, and $\mathrm{F_o}$ is the set of old sweetpotato vines and farm characteristic. We then have WTP given by

$$WTP = e(\mathrm{p}, \mathrm{EU_o}, \mathrm{F_o}) - e(\mathrm{p}, \mathrm{EU_o}, \mathrm{F_1}) \quad (1)$$

Where WTP is the amount that leaves a farmer indifferent between expected marginal utility under the old set of sweetpotato vines and discounted expected marginal utility of the change in the future income due to acceptance of quality vines. F_1 is the new set of planting materials with attributes and farm characteristics. If we assume that individual farmers maximize expected intertemporal utility, we have

$$E[-U_{io}(C_{io}) + U_{i0}(C_{i0} - WTP_i) + \sum_{t=1}^{\infty}(1+\delta_i)^{-t} U_{it}(C_{1it} - C_{0it})] = 0 \quad (2)$$

Where δ_i represents a household's constant rate of time preferences; C is household consumption; and $\mathrm{U_{it}(C_{1it} - C_{0it})}$ is the level of utility of a farmer i from the difference in land productivity as a result of adoption of quality planting material.

The Euler equation of (2) is given by

$$U_{i0}^{i}(C_{io})(WTP_i) = \sum_{t=1}^{\infty}(1+\delta_i)^{-t} EU'(C_{1it})dC_{it} \quad (3)$$

Therefore

$$WTP = \sum_{t=1}^{\infty}(1+\delta_i)^{-t}\{EU'(C_{it})/U'_{io}(C_{io})\}dC_{it}] \quad (4)$$

According to Birner et al.(2006), the WTP approach can estimate the direct benefit of quality planting material with nutritional benefits in the absence of market. This study uses the experimental auction approach to elicit WTP estimates.

3.6 Empirical model

As our naïve estimates we first estimated the standard OLS regression model following equation 5.

$$WTP_{itj} = \alpha + \beta' X_{itj} + \gamma' W_{ij} + \varepsilon_{itj} \quad (5)$$

Where WTP_{itj} is the elicited bid from the i-th farmer for vine j in bidding round t. for each 8 kg vine bundle in every round by each farmer, $WTP_{itj} \geq 0$. X_{itj} is a vector of explanatory variables covering the different quality attributes (observable, experience and credence) of each vine bundle (j) for each round (t). β represents a vector of coefficients while W_{ij} is a vector of vine specific explanatory variables for farmer i such as his or her prior experience and use of the product. ε_{itj} Is the error term that also captures farmer specific disturbance for farmer i. Since the differences among farmers have some influence on the WTP for quality vines, the random effects model would be the appropriate model.

The analysis is then extended to a random effects model, as specified in equation 6.

$$WTP_{itj} = \alpha + \beta' X_{itj} + \rho' W_{ij} + \gamma' Z_i + U_{ij} + \varepsilon_{itj} \quad (6)$$

To measure the impact of household and individual farmer characteristics on WTP for quality vines (j), Z_i a vector of farmer characteristics including demographic, education, and experience is included in the model. U_{ij} is between farmer errors and $\varepsilon_{itj}$is within farmer error. The random effects model was also used to explore the effect of information provision, nutrition information and demo plots on WTP as well. The three were captured as dummies in the random effects model.

4. RESULTS AND DISCUSSIONS

4.1 Distribution of the average WTP

The first step was to assess the distribution of the average WTP. The distribution revealed the presence of some outliers especially above 2000 Rwandan francs. We therefore dropped any WTP greater than 2000 Rwandan Francs. This could be because some figures could have been a result of "warm glow" feeling and trying to show off their financial might. The outliers were therefore excluded from the analysis see Figures 1 for the distribution after elimination of outliers.

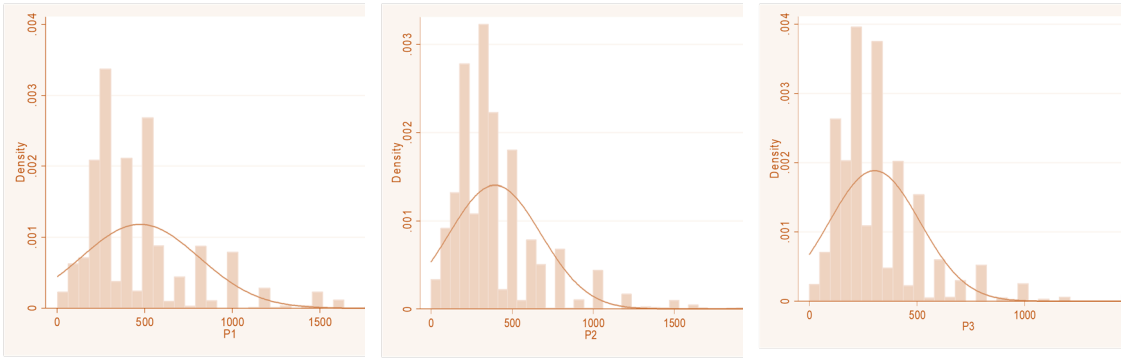

Figure 1. Distribution of the WTP for product 1, 2 and 3

4.2 Descriptive statistics

A summary statistic of the dependent and explanatory variables employed in the analysis are presented in Table 4.1. The results revealed that on average farmers are WTP more for high quality vines sourced from trained seed multipliers/decentralized vine multipliers (DVM), and lower for planting materials sourced from neighbor (farmer's seed). The results also show that on average 77.3% were male headed households and that about 47% of the respondents in the study were male showing that the participation in the auction constituted about half of both genders. However, the level of education among sampled farmers was found to be a bit low with farmers on average having five years of education. The average household size was found to be about 5 members. In addition, the average household income was found to be about 356 thousand Rwandese Francs (1 USD = 904 RWF as on 1st Nov 2019). The other characteristics are as presented in Table 4.1.

Table 4.1. Experimental auction participant and household sociodemographic characteristics.

N=697				
Variable	**Mean**	**Sd**	**Min**	**Max**
Dependent Variables				
P1 – quality seed from DVM (Kabode (OFSP) variety)	473.10	327.65	30	2000
P2- farmer's seed (Kabode (OFSP) variety)	396.06	289.45	20	2000
P3- farmer's seed (local non-OFSP variety)	308.14	208.72	15	1500
Explanatory Variables				
HH income "000" (Rwanda francs)[4]	356.2	1024	0	20700
1if HH head is male	0.773	0.419	0	1
1 if respondent is male	0.468	0.499	0	1
Age of respondent in years	46.31	14.43	18	97
1 if immediate family is in formal employment	0.185	0.389	0	1
Years of formal education	4.802	3.255	0	16
HH size	5.108	1.986	1	12
No of children under 5 yrs	0.696	0.809	0	5
No of members pregnant/breastfeeding	0.288	0.496	0	5
No of years growing sweetpotato	28.09	16.54	0	77
No of years lived in the village	30.95	19.20	1	86
1 if member of farmer group or organization	0.390	0.488	0	1
1 if trained n sweet potato vine multiplication	0.152	0.359	0	1
1 if received information from neighbors/other farmers	0.878	0.327	0	1
1 if has access to marshland	0.403	0.491	0	1
1 if save vine for next season	0.948	0.221	0	1
1 if multiply sweetpotato and provide farmers with vine	0.242	0.429	0	1
1 if consider themselves commercial vine multiplier	0.112	0.315	0	1
1if aware of DVM	0.538	0.499	0	1
1 if purchased vines from DVM	0.138	0.345	0	1
Distance to nearest main road (mins)	23.66	23.51	0	99
Distance to nearest market (mins)	29.06	21.62	1	99

[4] 1 USD = 904 Rwf as on 1st Nov 2019

In addition to the sociodemographic characteristics of the respondents, the study also collected information on perception of the framers. The table 4.2 shows that vines that are free from pests and diseases and the root size of the vines were the most important characteristics. Specifically, root size and free from pests and diseases were indication of high yields while flesh color were indicative of tastes and nutritional content. Overall, all the characteristics mattered to farmers since over 80 percent of respondents considered them important.

Table 4.2. Important attributes in sweetpotato vine selection decision

Variable	N	Mean	Sd
Root size	697	0.927	0.261
High Growth vigor	697	0.805	0.397
Free from pests and diseases	697	0.933	0.251
Flesh color	697	0.842	0.365
Trustable seed source	697	0.842	0.365

The previous table 4.2 shows the important attributes for in selection of planting materials irrespective of varieties. Whereas table 4.3, focuses on attributes in sweetpotato variety selection decision. The results revealed that the important attributes in sweetpotato variety selection were: Yield (99.6%), early maturity (94.7%), good taste (94.1%) and marketability (93.5%) in that order were found to be the most important characteristics (See Table 4.3).

Table 4.3. Important attributes in sweetpotato variety selection decision

Variable	N	Mean	Sd
Cooking Quality	697	0.594	0.491
Yield	697	0.996	0.0655
Marketability	697	0.935	0.246
Good Taste	697	0.941	0.235
Early Maturity	697	0.947	0.224
Late Maturity	697	0.0674	0.251
Storability in soil	697	0.608	0.488
Storability on shelf	697	0.423	0.494
Good leaves for vegetable	697	0.419	0.494

On the other hand, as pertains to sources of information on sweetpotato good agricultural practice, quality seeds and variety, most farmers (87.8%) revealed that they got information from neighbors or other farmers (See Table 4.4). Agro-dealers and traders were the least sources. This shows farmer-to-farmer diffusion is higher for sourcing information on sweetpotato good agricultural practices, quality seed and varieties.

Table 4.4. Sources of information on sweetpotato good agricultural practice, quality of seed and new varieties

Variable	N	Mean	Sd
Neighbor/other farmers	697	0.878	0.327
Agro-dealers	697	0.0430	0.203
RAB-researchers	697	0.0832	0.276
Government extension officer	697	0.568	0.496
NGOs	697	0.0732	0.261
Traders	697	0.0359	0.186
Radio	697	0.451	0.498

4.3 Willingness to pay for different seed products

One of the main objectives of the study was to determine the premium price a farmer is willing to pay for quality vines (early maturing, pest and disease free, and high nutritional content). As an initial step, we first present the average WTP for the various products (i.e., sweetpotato planting materials sourced from difference sources) and round. The average WTP for the various rounds is presented in Table 4.5.

Table 4.5. Estimated average willingness to pay (WTP) for quality vines

Product	Round 1: Naïve		Round 2: Information		Round 3: Nutrition		Round 4: Demo plots	
	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)
P1 – seed sourced from DVM (expected to have high quality) (Kabode variety – OFSP)	443.51 (342.21)	25, 2000	489.81 (348.99)	15, 2000			488.10 (316.48)	15, 2000
Sourced from neighbors (Farmer's seed), recycled several times but same maturity level (Kabode variety – OFSP)	408.71 (305.77)	20, 2000	360.20 (272.61)	15, 2000	421.55 (275.27)	8, 2000	385.35 (278.02)	10, 2000
Sourced from neighbors, recycled several times but same maturity level (dominant variety – Non-OFSP)	334.39 (222.72)	10,1500			273.73 (194.17)	6, 1500		

Source: Authors estimation based on experimental auctions data (2019). 1 USD=947 Rwandan Francs at time of the survey.

The results in Table 4.5 revealed that for the first round of auction (i.e. naïve round-no information), WTP for the three products included in the auction was higher for product 1 sourced from seed multiplier followed by those sourced from neighbors (i.e. product 2) but extremely low for non OFSP (i.e. product 3). This was also the case when we considered the average WTP by sex of the respondent (see Table A1 and Table A2 in the annex) although females had high WTP than males. However, in the 2nd round of the auction, when farmers were informed about the source of vines and quality attributes (pest free and cleaned material), the WTP increased significantly for the vines sourced from seed multiplier while the WTP for the vines sourced from neighbors dropped significantly. Information had the same effect except that the effect of information on the male respondents' average WTP was higher than the average WTP for female (See Table A1 and A2 in the annex). Here, the variety was kept constant for the product 1 and 2, but the source of vine is different. This revealed the effect of information as a signal on WTP for the quality attribute through information intervention.

In the 3rd round, when farmers were informed about the nutritional contents of product 2 and 3. Products 2 and 3 were different varieties although from same source. Product 2 is OFSP which is nutritionally rich, and early maturing as compared to product 3 which is non-OFSP but locally dominant variety. In the 3rd round, the WTP for OFSP vines (Kabode variety) sourced from neighbors increased significantly while for non-OFSP (locally dominated non-OFSP variety) although increased but not as much as for OFSP vines. However, with provision of nutrition information, female participants had higher average WTP for OFSP vines sourced from neighbors than their male counterparts. This could be because female participants are often the caregivers hence will easily sacrifice to ensure their children get the necessary nutrients. In the fourth round that involved demonstration of the performance of the vines, the OFSP vines sourced from vine multipliers had higher WTP than those sourced from neighbors although the WTP was slightly lowered compared to when information on type of vine was provided. In terms of gender lens, the field demonstration increased the average WTP for male participants than their female counterparts. However, female had very low WTP for OFSP sourced from neighbors compared to their male counterparts. We can therefore infer that with provision of more information and visual demonstration male respondents are more likely to pay more as compared to female participants.

The test of mean difference also revealed the significant difference in WTP for product 1 and 2 and product 2 and 3 (see Table 4.6).

Table 4.6. Test of mean difference in WTP

P1		P2		Mean difference	
Mean	s.e	Mean	s.e	Mean	s.e
471.63	7.32	379.79	6.04	91.84***	4.14
P2		P3		Mean difference	
Mean	s.e	Mean	s.e	Mean	s.e
415.42	7.85	302.47	5.60	112.94***	5.49

**** pairwise one-sided t-test revealed significant differences in mean WTP at 1% significance level*

Overall, the results depict the actual descending market value for the respective products with vines from vine multiplier being the most expensive to the least expensive non-OFSP sourced from neighbors. Moreover, while the standard deviations and means are of interest, the range of the differences in WTP is substantially large especially comparing the three products types. This is expected since in the first-round, farmers only relied on visual characteristics and no other information. However, as new information is provided the WTP changes as depicted in Table 4.5. The study then proceeded to estimate the farmers willing to pay premium for quality attributes through information and visual observation interventions. We looked at the premium price that farmers are willing to pay for product 1,2 and 3. The results are presented in Table 4.7.

Table 4.7. The premium price that farmers are willing to pay for quality vines and nutritional attribute for the vine through information and visual observation interventions

Product	Round 1: Naïve	(Min, max)	Round 2: Information	(Min, max)	Round 3: Nutrition	(Min, max)	Round 4: Demo Plots	(Min, max)
Base comparison	Product 3		Product 2		Product 3		Product 2	
Source from seed multiplier, clean and pest free early maturity (OFSP Kabode)	35 (183.82)	-655, 1500	133.71 (190.05)	-600, 1500			107.22 (174.72)	-1300, 1200
Sourced from neighbors, recycled several times but same maturity level (OFSP Kabode)	74.35 (210.32)	-1000, 1400			151.53 (188.56)	-900, 1850		

Standard deviations in parentheses

The results in Table 4.7 revealed that farmers are willing to pay significantly higher premiums for high quality vines sourced from DVM, however the size of premium differs based on type of interventions (i.e., information and visual observation of performance of planting materials). Further, to identify the drivers of demand for quality vines, we explored the drivers of price differential between product one sourced from seed multiplier and product two sourced from neighbors while keeping variety constant for both products. We presented the results for pooled OLS regression that ignores the panel structure of the data and the random effects model that treats the data as panel. Further, we explored the drivers of price differential between product 2 and product 3 sourced from neighbors that is recycled severally but variety is different for product 2 is OFSP and product 3 is non-OFSP. We used the natural logarithm of the price differential. We also explored a model controlling for round effects and incorporated an index of important attributes in sweetpotato vines selection decision and another one of sweetpotato varietal selection constructed using principal component analysis (see Table A3 in the annex). However, we found a better fit in the former model without inclusion of the rounds and indices. The results are presented in Table 4.8.

Table 4.8. Determinants of premium price5 for 8kg of quality OFSP vines: Random effects model

Variables	(1) Pooled OLS LN(P1-P2)	(2) Random Effects LN(P1-P2)	(3) OLS LN(P2-P3)
Natural Log of HH income	0.00313	-0.000994	0.0266
	(0.0173)	(0.0221)	(0.0222)
1if HH head is male	-0.153**	-0.172**	-0.130*
	(0.0652)	(0.0778)	(0.0775)
1 if respondent is male	-0.453***	-0.477***	-0.0188
	(0.128)	(0.166)	(0.178)
Age of respondent in years	-0.0128***	-0.0128***	-0.00843***
	(0.00205)	(0.00264)	(0.00267)
Years of formal education	-0.00496	-0.00236	-0.0102
	(0.00709)	(0.00911)	(0.0112)
HH size	0.0219*	0.0216	0.0313**
	(0.0115)	(0.0145)	(0.0153)
No of members pregnant/breastfeeding	-0.0311	-0.0253	-0.124
	(0.0453)	(0.0569)	(0.0812)
No of years lived in the village	0.00142	0.00167	0.00104
	(0.00148)	(0.00190)	(0.00193)
1 if member of farmer group or organization	0.139***	0.142**	0.0845
	(0.0447)	(0.0570)	(0.0575)
1 if received information from neighbors/other farmers	-0.154**	-0.134*	-0.0356
	(0.0618)	(0.0797)	(0.0807)
1 if has access to marsh land	-0.143***	-0.137**	-0.0536
	(0.0437)	(0.0557)	(0.0566)
1if aware of DVM	0.0275	0.00503	-0.0109
	(0.0434)	(0.0554)	(0.0568)

[5] The difference between price of product 1 and product 2, and product 2 and product 3

1 if female make agric decision	-0.307**	-0.325**	0.101
	(0.123)	(0.160)	(0.175)
HH Head male*Information	0.131**	0.153***	
	(0.0638)	(0.0432)	
#children under5*Information	0.0305	0.0543*	
	(0.0435)	(0.0315)	
Male respondent*Demo plots	0.180**	0.200***	
	(0.0704)	(0.0592)	
No of members pregnant*Nutrition			0.117
			(0.103)
Years of education*Nutrition			0.0192*
			(0.0104)
Constant	5.722***	5.730***	4.999***
	(0.188)	(0.242)	(0.256)
Observations	1,488	1,488	1,023
R-squared	0.076		0.039
Adjusted R squared	0.066		0.025

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Although in the model we did not control for household income or any measure of household wealth, we believe that the biasness of the result will still be minimal since we also controlled for other critical variables like access to information. The results in Table 4.8 show that holding all factors constant, the sex of household head and sex of respondent is a significant determinant of WTP, and that male respondents and male headed households had lower WTP compared to their female counterparts lending support to the works of Chen et al. (2009) and Pearson et al. (2013) but contradicting findings by Demonte et al. (2017). In addition, an increase in age by one year reduces the premium by about 2.8 %. Members of farmers groups were also willing to pay higher premiums for quality vines than households without members of farmer groups. In addition, an increase in household size increases the premium WTP for quality vines. This could be because as household size increases, the more mouths to feed calls for diversification of food sources. However, those who received information on the quality seeds from neighbors were willing to pay less premiums than those who had not received information from neighbors. Surprising households where female made agriculture decision were willing to pay lesser premiums than other households in which males made decision on agriculture. This could be because most men often have alternative sources of income. Households with access to marsh land were also willing to pay lower premiums compared to those without access. This could be because of possibility of farming other crops in the marsh land which could be productive than venturing into sweetpotato farming. Another reason could be that they can multiply their vines in the marshlands hence doesn't need to buy vines. In addition, farmers with access to marshland can multiply their own seed during the dry season hence will pay less for DVM seeds.

Moreover, it was also found that male headed households with information and households with under five children with information on the quality of vines had significantly high premium for quality vines compared to those without information. We included interaction terms that were significant jointly and individually and dropped the insignificant ones. The results revealed that male respondents who visited demo plots, male headed households with information and informed households with children under five were willing to pay significantly higher premiums. Although the model estimates with inclusion of rounds and indices was not adopted, the analysis was extended to explore determinants of WTP premium under different rounds. The results are presented in Table 4.9. The results confirmed the previously mentioned characteristics to be the significant drivers of the WTP (See Table 4.9).

Table 4.9. Determinants of demand under different scenarios: OLS Model Estimates

Variables	(1) NAIVE-LN(P1-P2)	(2) NAIVE-LN(P2-P3)	(3) INFORMATION-LN(P1-P2)	(4) NUTRITION-LN(P2-P3)	(5) DEMOPLOT-LN(P1-P2)
Natural log of HH income	-0.000249	0.0297	0.0283	0.0258	-0.0171
	(0.0399)	(0.0362)	(0.0267)	(0.0280)	(0.0273)
1if HH head is male	0.128	-0.108	-0.162*	-0.151	-0.171*
	(0.134)	(0.130)	(0.0922)	(0.0960)	(0.0960)
1 if respondent is male	-0.248	0.0958	-0.509***	-0.0765	-0.333*
	(0.285)	(0.308)	(0.197)	(0.216)	(0.197)
Age of respondent in years	-0.0116**	-0.0135***	-0.0116***	-0.00548	-0.0150***
	(0.00466)	(0.00445)	(0.00326)	(0.00340)	(0.00326)
Years of formal education	-0.0345**	-0.00784	0.00347	0.00565	0.00297
	(0.0162)	(0.0154)	(0.0109)	(0.0117)	(0.0114)
HH size	0.0210	0.0287	0.00842	0.0380*	0.0418**
	(0.0272)	(0.0268)	(0.0186)	(0.0199)	(0.0188)
No of children under 5 yrs	-0.0161	-0.124*	0.0189	0.0492	-0.0195
	(0.0775)	(0.0728)	(0.0529)	(0.0563)	(0.0550)
No of members pregnant/breastfeeding	-0.0725	-0.00173	-0.0547	-0.0638	0.0759
	(0.111)	(0.108)	(0.0808)	(0.0868)	(0.0839)
No of years lived in the village	0.000799	0.00262	-0.000882	-0.000121	0.00413*
	(0.00333)	(0.00320)	(0.00234)	(0.00243)	(0.00231)
1 if member of farmer group or organization	0.209**	0.0573	0.0743	0.107	0.158**
	(0.102)	(0.0937)	(0.0688)	(0.0728)	(0.0713)
1 if received information from neighbors/other farmers	-0.0780	0.0487	-0.225**	-0.0996	-0.135
	(0.136)	(0.131)	(0.0960)	(0.102)	(0.0998)
1 if has access to marsh land	-0.162	-0.0529	-0.168**	-0.0675	-0.113
	(0.101)	(0.0933)	(0.0667)	(0.0713)	(0.0696)
1if aware of DVM	0.00386	-0.0182	0.0506	-0.0149	0.0301
	(0.0996)	(0.0941)	(0.0667)	(0.0712)	(0.0688)
1 if female make agric decision	-0.0871	0.323	-0.450**	-0.0353	-0.292
	(0.281)	(0.306)	(0.192)	(0.212)	(0.192)
Constant	5.295***	4.964***	5.973***	5.046***	5.704***
	(0.434)	(0.439)	(0.293)	(0.317)	(0.297)
Observations	350	424	586	599	552
R-squared	0.067	0.050	0.098	0.036	0.086

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Similarly, the analysis was extended to assess the determinants of demand by gender of the respondents. The results are presented in the annex Table A4 and Table A5 for males and females respectively. The determinants of premium WTP were found to be slightly different for the two sexes.

4.4 Effect of information on WTP

The results on the average WTP indicates that information on the type of vines has significant impact on farmers' WTP for different products (see Table 4.5 and Table 4.7). However, this comparison is not sufficient to discern the magnitude of the effect of information. We used treatment models to tease out the effect. We estimated a simple OLS model and the random effects model. The results are presented in columns (1) and (2) respectively in Table 4.10. Both random effects and OLS model revealed that on controlling for sociodemographic characteristics as well as the interaction terms both OLS and Random Effects Model revealed that provision of information has significant positive impact on the premium WTP for quality vines supporting works of Mwiti et al. (2020). This reveals the essence of information as a signal in increasing demand for quality vines.

Table 4.10. Effect of information treatment on WTP: OLS and Random Effects Model

Variables	(1) OLS information LN(P1-P2)	(2) RE Information LN(P1-P2)
Information	0.271**	0.193**
	(0.128)	(0.0849)
Natural log of HH income	-0.00160	-0.00644
	(0.0175)	(0.0220)
1 if respondent is male	-0.376***	-0.378**
	(0.126)	(0.163)
1if HH head is male	-0.0696	-0.107
	(0.0735)	(0.0797)
Age of respondent in years	-0.0109***	-0.0130***
	(0.00274)	(0.00266)
Years of formal education	-0.00485	-0.00250
	(0.00716)	(0.00910)
HH size	0.0304**	0.0275*
	(0.0151)	(0.0161)
No of children under 5 yrs.	-0.00660	-0.0217
	(0.0410)	(0.0463)
No of members pregnant/breastfeeding	-0.0230	-0.0103
	(0.0518)	(0.0700)
No of years growing sweet potato	-0.00242	
	(0.00231)	
No of years lived in the village	0.00202	0.00179
	(0.00155)	(0.00189)
1 if member of farmer group or organization	0.163***	0.157***
	(0.0566)	(0.0599)
1 if received information from neighbors/other farmers	-0.148**	-0.134*
	(0.0621)	(0.0793)
1 if has access to marsh land	-0.149***	-0.149***
	(0.0443)	(0.0557)
1 if save vine for next season	-0.0449	
	(0.0972)	

1if aware of DVM	0.0131	-0.00449
	(0.0438)	(0.0553)
Distance to nearest market (mins)	0.000566	
	(0.000999)	
1 if female make agric decision	-0.291**	-0.313**
	(0.123)	(0.159)
Male HH head*Information	-0.0715	-0.0227
	(0.107)	(0.0709)
HH size*Information	-0.0191	-0.00862
	(0.0239)	(0.0158)
Member of farmer group*information	-0.0550	-0.0408
	(0.0866)	(0.0569)
No of children under 5 yrs. *Information	0.0293	0.0378
	(0.0557)	(0.0451)
Index of seed Variety selection	0.301**	0.276*
	(0.117)	(0.148)
No of members pregnant/breastfeeding *Information		0.0216
		(0.0676)
Constant	5.341***	5.440***
	(0.239)	(0.277)
Observations	1,488	1,488
R-squared	0.080	
Adjusted R squared	0.066	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The analysis was also extended to explore the effect of provision of nutrition information on WTP for quality vines. The results are presented in Table 4.11. Since nutrition information was provided and only product 2 and product 3 were displayed to the farmers in round 3. We therefore estimated the effect using the simple OLS regression model instead of the random effects model. The results revealed that all factors constant, provision of nutrition information to farmers equally has significant positive effect on farmers WTP (see Table 4.13). The study findings lend support to the works of Naico et al. (2010) and Meenakshi et al (2010) who found a premium attached to nutritional information. Moreover, as the index of seed variety selection increases, so does the WTP especially when farmers know the nutritional contents of the vines.

Table 4.11. Effect of nutrition information

Variables	(1) OLS_Nutrition LN(P2-P3)
Nutrition	0.165**
	(0.0674)
Natural log HH income	0.0212
	(0.0222)
1if HH head is male	-0.0790
	(0.0737)
Age of respondent in years	0.0227**
	(0.0115)
Age of respondent in years squared	-0.000297***
	(0.000115)
Years of formal education	0.00265
	(0.00930)

No of children under 5 yrs	0.0112
	(0.0426)
No of members pregnant/breastfeeding	-0.0446
	(0.0673)
No of years growing sweet potato	-0.00251
	(0.00300)
No of years lived in the village	0.00189
	(0.00201)
1 if member of farmer group or organization	0.0731
	(0.0576)
1 if received information from neighbors/other farmers	-0.0301
	(0.0808)
1 if has access to marsh land	-0.0725
	(0.0569)
1 if save vine for next season	0.0580
	(0.129)
Distance to nearest market (mins)	-0.000950
	(0.00127)
1 if female make agric decision	0.115*
	(0.0615)
Aware of DVM*Nutrition	-0.00998
	(0.0727)
Index of seed Variety selection	0.323**
	(0.155)
Constant	4.002***
	(0.355)
Observations	1,023
R-squared	0.047
Adjusted R squared	0.030

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4.5 Effect of visual information

Since farmers already had information on the type of vines, they were taken to demonstration plots to see the performance of the different vines. We therefore explored the effects of visual information on the WTP premium. We estimated the effects of visual information using the random effects model (see Table 4.14). The results in column 1 show that demo plots lead to increased premium WTP holding other factors constant which increases further after controlling for information. This therefore implies that both demo plots and provision of information on type of vines both have positive significant effect on the premium WTP as shown in Table 4.14.

Table 4.14. Effect of visual information

Variables	(1) REDemoplots ln(P1-P2)	(2) REDemoInform LN(p1-P2)
Demo Plots	0.132**	0.184***
`	(0.0606)	(0.0639)
Information		0.140**
		(0.0568)
Natural log of HH income	-0.00569	-0.00462
	(0.0221)	(0.0222)
1if HH head is male	-0.122	-0.122
	(0.0759)	(0.0760)
1 if respondent is male	-0.356**	-0.354**
	(0.162)	(0.162)
Age of respondent in years	-0.0105***	-0.0106***
	(0.00340)	(0.00341)
Years of formal education	-0.0145	-0.00957
	(0.00932)	(0.00955)
HH size	0.0257*	0.0253*
	(0.0152)	(0.0152)
No of children under 5 yrs	-0.0103	-0.00975
	(0.0438)	(0.0438)
No of members pregnant/breastfeeding	-0.0213	-0.0108
	(0.0685)	(0.0687)
No of years growing sweet potato	-0.00107	-0.00111
	(0.00283)	(0.00283)
1 if member of farmer group or organization	0.112*	0.118*
	(0.0654)	(0.0654)
1 if received information from neighbors/other farmers	-0.135*	-0.133*
	(0.0796)	(0.0797)
1 if has access to marsh land	-0.139**	-0.144**
	(0.0561)	(0.0561)
1 if save vine for next season	-0.0140	-0.0163
	(0.125)	(0.125)
1if aware of DVM	-0.0134	-0.0116
	(0.0638)	(0.0640)
Distance to nearest market (mins)		0.000601
		(0.00126)
1 if female make agric decision	-0.304*	-0.304*
	(0.159)	(0.160)
Aware of DVM*Demp Plots	0.0244	0.0211
	(0.0735)	(0.0733)
Member of farmer group*Demo plots	0.0585	0.0424
	(0.0747)	(0.0748)
No of members pregnant/breastfeeding *Information	0.0709	0.0367
	(0.0507)	(0.0525)
Years of formal education*Information	0.0348***	0.0196**
	(0.00579)	(0.00845)
Index of seed Variety selection	0.272*	0.274*
	(0.147)	(0.148)
Constant	5.414***	5.331***
	(0.299)	(0.302)
Observations	1,488	1,488
Number of farmer_id	659	659

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

5. CONCLUSION

The study sought to: determine the premium price farmers are willing to pay for quality vines and the drivers of the demand for quality vines; determine if farmers are willing to pay a premium for the high beta carotene nutritious biofortified varieties as opposed to the non-biofortified dominant local ones; and to determine the effect of information regarding the quality of vines on the demand for quality vines and the biofortified sweet potato varieties. The study found that in the absence of information, farmers are willing to pay a premium of about 35 Rwandan Francs for high quality OFSP Kabode vines sourced from decentralized vine multipliers. However, on provision of information on the type and source of vines, the premium price increases significantly to 133.71 Rwandan francs and to 107.22 Rwandan Francs after provision of visual information in the demo plots. It clearly indicates that when farmers observe performance of quality planting materials on root yield, the WTP premium for quality attribute is lower as compared to the premium farmers offered for quality attributes received from information intervention. The reason behind, though they value higher for the quality attributes when they receive information as they had high hope on the performance of the quality planting materials based on information, they received but when farmers see the performance on the field through demo plots, their expectation is lower. It means when we provide information, it is important to keep the trust by providing more appropriate information.

For the round 3 (nutritional intervention), the premium price also increases significantly for OFSP Kabode vines sourced from neighbors to about 74.35 Rwandan francs which increases to about 151.53 Rwandan francs when nutrition information is provided to the farmers. The study therefore confirms that farmers are willing to pay a premium for the kabode variety which is orange fleshed and early maturing as opposed to the local variety which is non OFSP. The study findings support findings from the works of Banerji et al. (2016), Wongprawmas et al. (2016), Adesina et al. (2017), Cobbinah et al. (2018), Boadu et al. (2019), and Mwiti et al. (2020) among others who found that farmers were willing to pay a premium for high quality vines with early maturity, high nutritional content and resistant to diseases among others.

In terms of the drivers of demand for quality vines, the study revealed that the demand for quality vines is influenced by sex of household head, sex of the respondent, age of the respondent in years, household size, membership to farmer organization, whether farmer received information from neighbors/other farmers, whether a household has access to marshland, whether females makes agriculture decision in the household, and whether household head is male, has access to information in OFSP Kabode variety and if household has under-five children and has access to information on OFSP Kabode variety. The findings lend support to the works of Mwiti et al. (2020); Adesina et al. (2017); (Thorne et al. 2017); and Amusa

et al. (2015) but contradicting some findings from the works of Etumnu (2016). These factors therefore need to be adequately considered in promotion of OFSP kabode from seed multipliers. The study also revealed that access to information, nutrition information and visual information through demo plots has a positive and significant effect on demand for quality vines supporting findings by Banerji et al. (2016), Maredia et al. (2019) and Mastenbroek et al. (2021).

In conclusion, the study revealed that providing information alone will not increase the demand for quality planting materials but also demonstrating the quality of planting materials is much more important for the adoption of improved variety and increases the effective demand. In addition, visual presentation through demo plots of the performance of the Kabode variety from certified seed multiplier would play a critical role especially since most farmers have low levels of education and would therefore learn more from seeing as opposed to explanation. Although awareness of DVM was insignificant, farmers still need to be sensitized on sources of quality vines. However, quality of information must ensure increasing in trust by providing appropriate information based on performance of the planting materials.

Further, demand for quality planting materials increases by adding nutritional attributes particularly among women farmers which is a niche market. Therefore, promoting uptake of biofortified beta carotene OFSP sweetpotato variety is important as it have its niche market segments as compared to non-OFSP, policy makers need to sensitize farmers on the benefits of OFSP kabode variety from decentralized vine multipliers such as the nutritional information, early maturity and resistance to diseases among others taking into consideration factors that influence demand for quality vines.

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Annex A

Table A1. Estimated average willingness to pay for quality vines for females

Product	Round 1: Naïve		Round 2: Information		Round 3: Nutrition		Round 4: Demo plots	
	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)
P1 – DVM OFSP	450.43 (356.75)	(25, 2000)	485.55 (343.66)	(15, 2000)			481.67 (317.53)	(30, 2000)
Sourced from neighbors, recycled several times but same maturity level (OFSP Kabode)	414.28 (310.76)	(30, 1850)	354.11 (271.21)	(20, 2000)	426.54 (264.98)	(20, 2000)	371.50 (263.66)	(30, 2000)
Sourced from neighbors, recycled several times but same maturity level (Non OFSP)	338.99 (225.57)	(10, 1500)			273.58 (194.32)	(25, 1500)		

Table A2. Estimated average willingness to pay for quality vines for males

Product	Round 1: Naïve		Round 2: Information		Round 3: Nutrition		Round 4: Demo plots	
	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)	Mean (Std. Dev)	(Min, Max)
P1 – DVM OFSP	435.54 (325.03)	(30, 2000)	494.69 (355.48)	(20, 2000)			495.49 (315.61)	(15, 1840)
Sourced from neighbors, recycled several times but same maturity level (OFSP Kabode)	402.33 (300.32)	(20, 2000)	367.21 (274.45)	(15, 2000)	415.87 (286.82)	(8,200 0)	401.19 (293.206)	(10, 2000)
Sourced from neighbors, recycled several times but same maturity level (Non OFSP)	329.16 (219.67)	(15, 1500)			273.91(19 4.30)	(6, 1500)		

Table A3. Determinants of premium price for 8kg of quality OFSP vines on controlling for rounds: Random Effects model

Variables	(1) Pooled OLS LN(P1-P2)	(2) Random Effects LN(P1-P2)	(3) OLS LN(P2-P3)
Natural log HH income	-0.00125	-0.00590	0.0235
	(0.0173)	(0.0221)	(0.0223)
1if HH head is male	-0.0508	-0.0979	-0.129*
	(0.0722)	(0.0794)	(0.0777)
1 if respondent is male	-0.358***	-0.361**	-0.0227
	(0.126)	(0.164)	(0.179)
Age of respondent in years	-0.0128***	-0.0131***	-0.00861***
	(0.00206)	(0.00265)	(0.00271)
Years of formal education	-0.00442	-0.00211	0.00184
	(0.00709)	(0.00908)	(0.00933)
HH size	0.0229*	0.0250	0.0312*
	(0.0119)	(0.0152)	(0.0160)
No of children under 5 yrs	0.00537	-0.0179	-0.0159
	(0.0400)	(0.0452)	(0.0447)
No of members pregnant/breastfeeding	-0.0284	-0.00505	-0.0436
	(0.0515)	(0.0667)	(0.0675)
No of years lived in the village	0.00169	0.00189	0.00133
	(0.00148)	(0.00189)	(0.00194)
1 if member of farmer group or organization	0.135***	0.137**	0.0881
	(0.0446)	(0.0568)	(0.0577)
1 if received information from neighbors/other farmers	-0.150**	-0.130	-0.0518
	(0.0622)	(0.0800)	(0.0815)
1 if has access to marsh land	-0.158***	-0.152***	-0.0693
	(0.0437)	(0.0556)	(0.0569)
1if aware of DVM	0.0218	-0.00327	-0.0176
	(0.0436)	(0.0555)	(0.0572)
1 if female make agric decision	-0.287**	-0.301*	0.0907
	(0.123)	(0.160)	(0.176)
HH Head male*Information	-0.105	-0.0418	
	(0.102)	(0.0668)	
#children under5*Information	0.00984	0.0354	
	(0.0522)	(0.0337)	
Index of seed selection	0.0710	0.0952	-0.168
	(0.111)	(0.142)	(0.146)
Index of seed Variety selection	0.274**	0.254*	0.343**
	(0.119)	(0.152)	(0.160)
Round 1(Naïve)	-0.200***	-0.215***	-0.156***
	(0.0543)	(0.0452)	(0.0548)
Round 2 (Information)	0.111	0.0416	
	(0.0941)	(0.0647)	
Constant	5.415***	5.470***	4.924***
	(0.231)	(0.291)	(0.309)
Observations	1,488	1,488	1,023
R-squared	0.087		0.044
Adjusted R squared	0.075		0.028

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A4. Determinants of premium price6 for 8kg of quality OFSP vines for Male respondents: Random Effects model

Variables	(1) Pooled OLS LN(P1-P2)	(2) Random Effects LN(P1-P2)	(3) OLS LN(P2-P3)
Natural Log HH income	-0.0427	-0.0517	-0.0183
	(0.0274)	(0.0355)	(0.0348)
1if HH head is male	-0.278*	-0.324*	-0.238
	(0.155)	(0.188)	(0.180)
Age of respondent in years	-0.0176***	-0.0169***	-0.00787**
	(0.00299)	(0.00382)	(0.00380)
Years of formal education	0.00294	0.00818	-0.0247
	(0.0114)	(0.0147)	(0.0171)
HH size	0.0342**	0.0334	0.0431*
	(0.0171)	(0.0218)	(0.0227)
No of members pregnant/breastfeeding	-0.0320	-0.0306	-0.131
	(0.0624)	(0.0793)	(0.106)
No of years lived in the village	0.00221	0.00225	-0.00215
	(0.00204)	(0.00264)	(0.00264)
1 if member of farmer group or organization	0.0999	0.116	0.149*
	(0.0699)	(0.0895)	(0.0873)
1 if received information from neighbors/other farmers	-0.0344	-0.0498	0.0237
	(0.0931)	(0.121)	(0.118)
1 if has access to marsh land	-0.198***	-0.187**	0.0757
	(0.0663)	(0.0852)	(0.0839)
1if aware of DVM	0.0289	-0.00739	0.0858
	(0.0682)	(0.0877)	(0.0863)
HH Head male*Information	0.198**	0.197***	
	(0.0953)	(0.0629)	
#children under5*Information	-0.00547	0.0476	
	(0.0652)	(0.0464)	
Male respondent*Demo plots	0.205**	0.231***	
	(0.0829)	(0.0682)	
No of members pregnant*Nutrition			0.257*
			(0.140)
Years of education*Nutrition			0.0240
			(0.0155)
Constant	5.633***	5.655***	5.179***
	(0.251)	(0.317)	(0.300)
Observations	697	697	491
R-squared	0.091		0.065
Adjusted R squared	0.073		0.040

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

[6] The difference between price of product 1 and product 2, and product 2 and product 3

Table A5. Determinants of premium price[7] for 8kg of quality OFSP vines for female respondents: Random Effects model

Variables	(1) Pooled OLS LN(P1-P2)	(2) Random Effects LN(P1-P2)	(3) OLS LN(P2-P3)
Natural Log HH income	0.0415*	0.0402	0.0681**
	(0.0223)	(0.0284)	(0.0286)
1if HH head is male	-0.0676	-0.0929	-0.0124
	(0.0760)	(0.0900)	(0.0901)
Age of respondent in years	-0.00821***	-0.00903**	-0.00944**
	(0.00290)	(0.00379)	(0.00385)
Years of formal education	-0.0105	-0.00950	0.00311
	(0.00910)	(0.0118)	(0.0148)
HH size	0.0121	0.0135	0.0243
	(0.0156)	(0.0200)	(0.0210)
No of members pregnant/breastfeeding	-0.0450	-0.0377	-0.156
	(0.0680)	(0.0849)	(0.129)
No of years lived in the village	0.00131	0.00184	0.00588**
	(0.00222)	(0.00287)	(0.00290)
1 if member of farmer group or organization	0.183***	0.172**	0.0168
	(0.0592)	(0.0760)	(0.0774)
1 if received information from neighbors/other farmers	-0.271***	-0.218**	-0.0872
	(0.0826)	(0.107)	(0.110)
1 if has access to marsh land	-0.0999*	-0.0987	-0.184**
	(0.0588)	(0.0752)	(0.0763)
1if aware of DVM	-0.00619	-0.0138	-0.120
	(0.0568)	(0.0729)	(0.0754)
1 if female make agric decision	-0.328***	-0.341**	-0.00324
	(0.119)	(0.156)	(0.171)
HH Head male*Information	0.0595	0.108*	
	(0.0857)	(0.0595)	
#children under5*Information	0.0710	0.0662	
	(0.0584)	(0.0430)	
No of members pregnant*Nutrition			-0.0846
			(0.155)
Years of education*Nutrition			0.0157
			(0.0139)
Constant	5.477***	5.467***	4.938***
	(0.227)	(0.294)	(0.310)
Observations	791	791	532
R-squared	0.071		0.052
Adjusted R squared	0.055		0.026

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

[7] The difference between price of product 1 and product 2, and product 2 and product 3

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Annexure B1

Auction script - WTP for seed quality and variety of sweetpotato study in Rwanda

Researcher: Good morning/afternoon; Welcome to this workshop, we thank you for your participation. My name is _____ and with me today is my colleagues _____.

We are carrying out research for the International Potato Center (CIP) and Rwanda Agriculture and Animal Resources Development Board (RAB) to understand farmers acquisition of sweetpotato planting material. Today we are going to carry out a series of auctions of the different types of sweetpotato vines. We will ask you to make purchase decisions just as the one that you would in the market if you were to purchase vines from the market or neighbor or other sweetpotato farmers. During the course of the workshop you will have an opportunity to buy the vines we will be auctioning, if your bid is the highest among other bidders bid. But remember to be truthful and honest about your decisions.

As the first part of this activity, you will complete a pre-auction survey administered by one of our team members.

From this point onwards we will issue you with card with a number. That number will be your ID. Therefore, do not write your name anywhere in the answer sheets we will give you for recording/writing your responses. Your responses will therefore only be known to us and will be confidential. We will give you more details on this shortly.

The whole workshop, including the auction sessions, will last **approximately 3 hours**. There will be a refreshment break during the duration of the interview.

[PAUSE]

Do you have any questions?

[Wait, and address any questions raised before proceeding].

Now we will proceed to start the workshop by asking you individually a few questions. This individual interview session will last about 15 minutes. We will inform you when it is your turn to be interviewed. Thank you.

[PART 1 BEGINS]

[Read the informed consent statement verbatim and obtain consent]

Researcher: [Background Questionnaire]. I would like to ask some questions about you, your family and farm using this short background questionnaire. This questionnaire will help us understand your background as a sweetpotato farmer.

[Part 1 ENDS]

[Part 2: Auction begins]

[Assemble all the auction participants into the auction venue/hall.]
Researcher: Thank you all, again, for agreeing to participate in this study. We will now embark on a series of group auctions. At this time, we would like you to confirm that i) you have completed the first one-to-one (pre-auction survey) interview and ii) that you can dedicate at least 2 hours for the group auction workshop. It would be unfortunate if someone leaves before finishing.

[Give time for people to adjust. Before starting …..:

- *Ask if there are any participants who have not completed the pre-auction survey.*
- *If someone cannot participate the whole time period, please request that they leave. Listeners are not allowed.*
- *Make any final reordering of the group.]*

Researcher: We are going to begin the auctions now. At this time, we request that you please turn your cell phones into silent mode. [Allow time to turn cell phones off].

Today you will participate in an auction activity divided into 4 rounds. In each round, you will have a chance state your maximum bid for the seed types being auctioned. At the end of the ROUND 4 (i.e., all the bidding rounds), one round will be randomly selected, and the persons with the highest bid will get the chance to buy the seeds that were auctioned in that round. In case of a tie in the highest bid, we will decide the buyer by tossing a coin. To guarantee the confidentiality, it is very important that you do not speak among each other during the auctions, and that you strictly follow the instructions we will be giving you.

If you have any doubts, please ask any of us. It is very important that you follow the instructions; if not, you will be disqualified from further participation.

Researcher [*Say to the whole group*]: The result of this auction workshop is completely confidential. To guarantee this, use only your ID number during this auction. The ID number will also serve as part of your identification when collecting sweetpotato vines, if you win during the auction.

Because this is the time for planting sweetpotato, any vines you buy during this auction will be made available to you today and here so you can proceed and plant it.

[Show a card with ID number for illustration purposes]

Researcher: Do you have any questions about what we have talked about so far? *[Wait and answer questions raised].*

Now, we will demonstrate to you how the auction process will work. Please pay very close attention. Don't be afraid to ask if anything is not clear to you.

[Practice Auction]

For this practice auction, each of you will bid on the two types of bar of soaps *[hold the bar soaps up].* Like some auctions you may have participated in in the past, in this auction only one person will buy ONE bar soap which will be RANDOMLY SELECTED.

Let me walk through how you will bid and how we will determine who buy a bar of this soap.

First, we will hand out a bidding sheet like this one.

[Hold up bidding sheet.]

On these bidding sheets you will:

i. Write down your ID number.
ii. Write down the maximum amount of money you would be willing to pay for each bar of soap in increments of whole Rwanda Francs (RF) - not cents. So, for example, 10 RF is an acceptable bid, but 10.50 RF is not acceptable.
iii. If you don't want to bid, you're allowed to write zero, but you will not be able to buy this product even if you like.

Once everyone has written the MAXIMUM amount of money they are willing to pay for each bar of soap, we will collect the bidding sheets. Then we will randomly select one of the bar soaps and move on to determine the buyer of that bar soap.

To determine who buys, we write on this flip chart *[show the flip chart]* the bids for the randomly selected bar soap from the highest to the lowest. As in some of the auctions you know or have participated in, the participant with the HIGHEST bid will be the buyer. However, instead of paying his/her bid (the highest), he/she will pay the **second highest bid**. So, there will only be ONE BUYER of the randomly selected bar soap. If there is a tie in the highest bid for the bar soap, we will decide who the buyer is by tossing a coin.

So, for example, suppose that *[name an enumerator1 in the room]* bids 20, I bid 16 and *[name an enumerator2 in the room]* bids 25 for the randomly selected bar soap, we will first arrange the bids from the highest to the lowest as below:

RANDOMLY SELECTED BAR SOAP 25

1. 20
2. 16

In this case *[name of enumerator2]* has the highest bid for randomly selected bar soap A and therefore gets to buy the bar soap, but he/she pays 20 RF for it, not the 25 RF bid.

Are there any questions?
If there are no questions, I will now ask you a few questions about what we are to do based on what I have just said. I would like to be sure you understand the process well *[Give some quiz on the auction procedure].*

Before we hand out the practice round bidding sheets, let me explain the best strategy in this type of auction. The BEST thing to do is to bid the MAXIMUM amount you are willing to pay for the product. This is because it is very likely you will actually pay LESS if you buy.

However, bidding less than what you would be willing to pay might mean that you miss out on buying the soaps at a price lower than you would be willing to pay.

Similarly, bidding more than what you would be willing to pay for the bar soaps might mean that you end up having to pay more for the soap than you really want to. For example, if you are willing to pay a maximum of 25 RF, but you bid 30 RF and the second highest bid ends up being 27 RF, then you would pay 27 RF – more than you were willing to!

Overall, your best strategy is to bid the MAXIMUM amount you are willing to pay for the product and you feel reflects real value of that product to you.

[Ask if this is clear, and wait.]

We will now hand out the bidding sheet to each of you.

[Hand out bidding sheet to each participant]

First, go ahead and write down your ID number from the card you received at the start– this helps us keep track of everyone's bids- and your bid for a bar of soap. Please do not talk with others until we have collected the bids. If you do, you will be disqualified. Instead ask any one of us if you have a question.

[Collect bidding sheets, making sure that bids and numbers are entered and legible and that the bid is in whole RF increments (i.e., 20.50 FR is not a valid bid).]

Now we will display all the bids on the flip chart from the maximum to minimum.

[Write bids on a flip chart in a descending order]

The highest bid/price is RF _____

This buyer pays the 2nd highest price which is RF _____

Therefore, this bar of soap won/bought by *[name ID of the winner].*

[Ask] Are there any final questions on how this auction works?

[Give time to address all questions about the illustration of the auction procedure. Ask again if there are still further questions on the procedure] [Based on your judgement, a second illustration can be given, but this will require use of a different auction item – not bar soap]

Any final questions?

[Seed Auction Begins]

Now, you understand how the auction will operate. The vine auction will be very similar to the practice auction we just did with the bar soaps, but please note the following:

First, you will be bidding to purchase [1 bundle of 8kg] of sweet potato vines each containing 200 pieces of 30-cm-long cuttings. The bundles are for FOUR different seed/vine types (or products). We will have 4 rounds of auctions. You will therefore be making 4 bids in first round and 2 bids in each subsequent rounds – one for each seed type/product.
Second, at the end of the 4 rounds, one round will be will be randomly selected and the bidders with the highest bids for the products in that round will be the buyers of the products that were auctioned in that round. They will however pay the second highest price for each of the products.

Third, from randomly selected round, one product will be selected randomly again.

Fourth, as in the practice auction we have illustrated, you will pay for the vine type(s) (product(s)), if you bid highest for, using your own money.

Fifth, buyers will be issued with the vines of the seed type they have bid highest today and here (at the end of the auction sessions).

Are there any questions? *[Wait and answer any questions raised] [If no questions, give brief quiz on the actual auction procedure, then continue]*

[Auction round 1 begins]

Now, let's go to the first round. Before we hand out the bidding sheets for this round, let me just remind you that your best strategy is to bid the MAXIMUM amount you are willing to pay for each seed type (product). *[Repeat the cheap talk here]*

Also, remember that since you will only be able to buy ONE randomly selected seed type, you do NOT need to try and spread your money across the 4 seed types, thus place lower bids than you would really wish to.

As before, please do not talk with others until we have collected the bidding sheets. Otherwise, you will be disqualified from further participation in the auction.

[Hand out bidding sheet. Ask if anybody has not received the bidding sheet before you continue. If none, ask….]

Are there any final questions? *[Wait and respond to any questions before continuing.]*

Now go ahead and write down your ID number (from the card) on your bidding sheet.

[Give the description of the products]: In this round, you will bid for 3 products (vine types) before us. The products are labelled Product 1, Product 2 and Product 3. Just as you would find in market or neighbor's field, the products (seed types) have no name telling you what they are. Take a few minutes to look closely at each product to assess it, as you would do when selecting vines to plant, before you bid. You can feel, smell, and touch but DO NOT discuss it with others. Based on your OWN assessment of the 3 seed types, write down in your bidding sheet the maximum bid you are willing to pay for each seed type. Remember that bidding is in multiples of 1 RF.

[Allow time for participants to assess the products and write their bid on the bid form.]

[Collect bidding sheets, making sure that bids and numbers entered are legible and in multiples of 1 RF]

Thank you very much for submitting your bids.

Bid price for Product #1 is _____
Bid price for product #2 is RF_____
Bid price for product #3 is RF_____
Bid price for product #4 is _RF_____

Thank you very much, now let's go to the second auction

[Auction round 2 begins]

We will now give you more information about two of the seed types (products) we are using in this second round, and which we have before us. Please listen carefully to me.

Product #1 *[Hold up the bundle]* is vines obtained from a trained vine multiplier and it is OFSP. They are therefore free from pest/diseases, is higher yielding

Product #2 *[Hold up the bundle]* is vines of the same variety as **Product #1** *[point at the bundle or hold up]* but are obtained from a farmer just like you. It has been replanted severally, therefore has accumulated the pests and diseases that can reduce yield.

Now take time to think about the differences in these 2 products and what it means to you as a farmer. Feel free, again, to assess/examine the products (look closely, feel, touch, smell) as you would typically do when obtaining vines to plant. I remind you that discussing the products with another participant is NOT allowed.

[Allow time for the participants to assess and evaluate the products in view of the new information. As they do, hand out bidding sheets for this round]

Now, write down in your bidding sheet we have received your ID and the MAXIMUM amount you are willing to pay for each product, given the information you have just received. Submit the sheet to us when you finish.

Bid price for product #1 is _____
Bid price for product #2 is _____

[Collect the bids making sure that they are legible and in multiples of 1 RF]

[Auction Round 3 begins]

In this round, we will again bid for 2 products. But before we do that, I want to give you some additional information about each product.

Product #2 *[hold it up]* is vines of an orange-fleshed sweetpotato variety. It produces roots that contain vitamin A which prevents blindness and childhood diseases such as diarrhea. Vitamin A is also very important for brain development and is required by pregnant women especially during the last months of pregnancy when both her and the unborn child have greatest need for vitamin A.

Product #3 *[hold it up]* is, on the other hand, vines of a local variety [name of product #3]. Its roots do not contain vitamin A, unlike the first 2 products. Thus, consuming it does not help vulnerable household members meet their vitamin A needs.

Now carefully consider that **Product #2** is more nutritious than **Product #3**. And, remember also that **Product #2** is from a farmer just like you. Also remember that besides not being nutritious, **Product # 3** is also from a farmer just like you. With this information in mind, I would like you to first examine/assess the two products, as you would do when obtaining sweetpotato vines to plant. Once you have done so, and are satisfied, you will be asked to write down, on bidding sheet, the MAXIMUM amount of money you are willing to pay for each of these 2 products.

Let me again remind you that your best strategy is to bid the MAXIMUM amount you are willing to pay for each seed type. *[Repeat the cheap talk.]*

[Allow time for respondents to reflect on this information as you hand out bidding sheets]

Now, use the bidding sheets you have just received to write down your bids. Let me remind you that you are not allowed to discuss with your fellow participants what you plan/want to do. Don't forget to write your ID number on your bidding sheet.

[Allow time for participants to write their bids. When everybody is done, collect the bidding sheets]

Bid price for product #2 is _____
Bid price for product #3 is _____

Thank you all very much!

[Auction Round 4 begins] *[This auction should preferable be done at the demo site]*

[Take the participants to the demo site and have the 2 plots harvested as they watch. Then ask them to return to the auction arena for final auction]

[Wait for participants to assemble in the area and settle down]

During this FINAL round, we will again bid for the 2 vine types (products) before us. They are Product #1 and Product #2. But before bidding, I want us to harvest the crops that are grown using these seed types. You visited and observed Plot A [label of the plot where Product #1 was planted] and also Plot B [label/name of plot where Product #2 was planted]. During that visit you specifically observed the differences in growth vigor of these vine types (products). Remember:

Product #1 *[Hold up the bundle]* is vines of orange-fleshed sweetpotato variety obtained from a trained vine multiplier. They are therefore free from pest/diseases, is higher yielding. In addition, it contains Vitamin A which is good for health. It prevents blindness and childhood diseases such as diarrhea. Vitamin A is also very important for brain development and is required by pregnant women especially during the last months of pregnancy when both her and the unborn child have greatest need for vitamin A.
Product #2 *[Hold up the bundle]* is vines of the same variety as **Product #1** *[point at the bundle or hold up]* but are obtained from a farmer just like you. It has been replanted severally, therefore has accumulated the pests and diseases that can reduce yield. However, just like **Product #1**, it contains Vitamin A which is good for health. It prevents blindness and childhood diseases such as diarrhea. Vitamin A is also very important for brain development and is required by pregnant women especially during the last months of pregnancy when both her and the unborn child have greatest need for vitamin A.

Today, we have harvested roots from these 2 vine types (products) and you have observed the yield of each product (seed type). I would now like to ask you to take a few minutes to carefully reflect on the growth vigor and yield of the 2 products. After that, you will be asked to write down the MAXIMUM amount of money you are willing to pay for each seed type.

[Give the participants time to think through the performance of the different product types during the demo and the yield. As they do so, handout the bidding sheets for this round]

Now, use the bidding sheets you have just received to write down your bids. Let me remind you, again, that your best strategy is to bid the MAXIMUM amount you are willing to pay for each seed type [Repeat the cheap talk].

[Allow time for participants to write their bids. When everybody is done, collect the bidding sheets]

Bid price for Product #1 is RF _____
Bid price for product #2 is RF_____

Selection of Binding round/product(s)

Now we will proceed to select the round that allows the one with the highest bids to purchase the vines. This round will be selected randomly. We will start by giving the auction rounds numbers so that Round #1 =1, Round #4 = 4.

[Have one participant randomly pick a number from folded papers with 1, 2, 3, 4 representing the Rounds. Show the number selected.]

The selected Round is _____

The products auctioned in the selected Round were *[specify as appropriate]:*

1. _____
2. _____
3. _____
4. _____

Next, we will now select a product to be purchased randomly. Once we have selected randomly the product and round, we determine the highest bid prices for the randomly selected product/vine type above and people who made those bids (today's buyer!). We will do by arranging the bids in this round for each product.

[Arrange the bids for each of the products in a descending order on a flip chart/board. Announce the highest bid and the price to be paid]

Remember that ONLY the highest bidder for the randomly selected product gets to buy the product, but she/he pays the 2nd highest bid price. Remember also that the highest bidder buys the product using own money. Looking at the board/flip chart *[if there is a tie in highest bid, decide buyer by tossing a coin]*:

The highest bid price of Product *[name of product]* is RF _____

The 2nd highest bid price of Product *[name of product]* is RF _____

[Announce the bidder with the highest bid for each product. Then collect the payments and hand the purchased vines]

END OF THE AUCTIONS

Thank you all very much! We have finished with auctions. You have done a terrific job!

We will now take a break. During this break, some refreshments will be served. It will be followed by PART 3 of the study during which we will ask each of you individually, again, some few additional questions about yourself and household. So please don't leave. Also, if you didn't do the first interview, you so do it.

After the individual (pre and post) interviews you will receive a token of appreciation for coming to the auction workshop to help you meet your transportation cost to this workshop. We will also give each of you a document/handout that will help you understand how to be a better sweetpotato farmer.

[Part 3 begins]

Each participant is interviewed using the 2-pager post-auction questionnaire. The participant is then given transport compensation, handout on basic sweetpotato agronomics practices, and allowed to leave at his/her own pleasure.

Annexure B2

Eliciting farmers' demand for quality and nutritionally enhanced sweetpotato planting material in Rwanda

Pre-Auction Survey

Part 1. Farmer Identification and site identification

<table>
<tr><td colspan="3">0. First read the Consent Statement. Proceed if the farmer consents. Farmer consented:</td><td>1-Yes
0-No</td><td>1a. Date of interview:</td><td>1b. Time of interview
Start:
End:</td></tr>
<tr><td colspan="5">2. Are you the main (or one of the main) decision maker in your household for sweetpotato cultivation and practices?</td><td>1-Yes
0-No</td></tr>
<tr><td>4. Farmer Name (last, middle, first):</td><td rowspan="2">6. Gender (farmer)</td><td rowspan="2">1-Male
0-Female</td><td rowspan="2">7. Farmer's age (yrs)</td><td rowspan="2"></td></tr>
<tr><td>5. Name of enumerator:</td></tr>
<tr><td>8. Telephone number (farmer):</td><td>9. Type of phone [select all that apply]</td><td colspan="3">1-Basic phone 2-Smart phone 3-Landline</td></tr>
<tr><td>10. District name:</td><td>11. Sector:</td><td colspan="2">12. Cell:</td><td>13.Village:</td></tr>
</table>

Part 2. Information about the farmer and his/her household (hh)

1. Number of **years of formal education** completed?	
2. Can you **read and write Kinyarwanda, French, English or other language?**	0-No 1-Yes, both Kinyarwanda and English 2-Yes, only in Kinyarwanda 3-Yes, only in French 4-Yes, in English (regardless of others) 5-Yes, Kinyarwanda and French 6-Yes, all
3a. Total number of household members	
3b. How many live and eat together during the last 6 months?	
4. Number of members less than 5 years of age	
5. Number of members pregnant or breastfeeding	
6. Your relationship to the head of the HH	
7. What is the gender of the Head of your HH?	1-Male 0-Female
8. Number of years living in this village	
9. Number of years growing sweetpotato	
10. Are you related to….. 1-Yes 0-No	a. Village chief b. Any sweetpotato seed producer c. Agriculture officer/ extension agent/farmer promoter d. Any political appointee/ official
11. Who in the household is involved in….. (multiple response)	0- Man; 1- Woman; 3- Both; 4- Collective household; 5- Family; 6- Landowner; 7- Other
a. Management of sweetpotato	
b. Decision making on planting material of sweetpotato	
c. Involved in the sales of sweetpotato	
d. In charge over revenues gained from sweetpotato	

Man: means only the man in the household is involved. Woman: means only the woman in the household is involved. Both: means both the man and the woman in the household are involved. Collective household: if more household members than the man and woman are involved. Family: if family members who are NOT household members are involved. Landowner: if the owner of the land who is NOT part of the household or the family is involved. Other: Any other person involved who is NOT a household member, family member or the landowner.

Part 3. Group membership and social network

1. Are you a member of farmer group/organization?	1-Yes 0-No
2. If Yes, does this farmer group/organization deal with sweetpotato	1-Yes 0-No
3. If 2 is YES, does the group help in marketing of sweetpotato roots and vines?	1-Yes 0-No
4. Have you ever received any training on sweetpotato production?	1-Yes 0-No
5. If YES 4, how many times, over the last one year?	
6. Did any of the training include topics on sweetpotato seed quality maintenance?	1-Yes 0-No
7. Have you ever received training on sweetpotato vine multiplication?	1-Yes 0-No

8. Which type of savings and credit (*Ikimina, SACCOs, BPR*) scheme do you belong in?	1-Formal 2-Informal 3-Both 4-None
9a. What is your most common mode of transportation?	1-Walking 2-Bicycle 3-Motorcycle 4-Public service vehicle 5-Other
10. Distance to the nearest main (paved/tarmac) road in walking minutes?	
11. Do you have any immediate family engaged in formal employment (on salary)	1-Yes 0-No
12. Do you regularly receive information about sweetpotato farming, new varieties, sweetpotato seed availability, etc. from any of these sources? 1-Yes 0-No	a. Neighbors / other farmers b. Agro-dealers c. RAB – researchers d. Government extension officers/agri-promoters e. NGOs f. Traders g. Radio h. Other (specify)

Part4. Importance of seed quality and varietal characteristics.

	[*Please rate on a scale of 1 to 5. Mark the appropriate column*]				
	1	**2**	**3**	**4**	**5**
	Not at all important	**Un-important**	**Neutral**	**Important**	**Very Important**
1. In your sweetpotato seed selection decision, how important are each of the following characteristics?					
a. Root size					
b. High growth vigor					
c. Vines that are free from pests and diseases					
d. Flesh color					
e. Source of seed is trustable (known to be good)					
2. In your sweetpotato varietal selection, how important are each of the following characteristics.					
f. Cooking quality					
g. Yield					
h. Marketability					
i. Good taste					
j. Early maturity					
k. Late maturity					
l. Storability in the soil					
m. Storability on the shelf (postharvest)					
n. Good leaves for vegetables					

Part 5. Prior use of seed from different sources and quality rating

	Multiplication own farm	Farmer inside community	Farmer outside community	Market	Decentralized vine multiplier	NGO	Government	Farmer cooperatives
1. Have you ever sourced sweetpotato planting material from this source before? 1-Yes 0-No								
2. *(If yes)* What is the *common* acquisition type if you use this source? 0 = free; 1 = in kind; 2 = terms & conditions (e.g. payback); 3 = loan; 4 = coupon; 5 = cash; Fill NA in case it is not applicable								
3a. Did you use this source *previous planting season*? 1-Yes 0-No								
3b. How much planting material did you obtain from this source in previous planting season (specified in units)? kg								
3c. What was the method of acquisition *last season*? 0 = free; 1 = in kind 2 = terms & conditions; 3 = loan ; 4 = coupon ; 5 = cash								
3d. In case it was a cash transaction how much did you pay? (in RWF)								
4. How would you rank the quality of sweet potato planting material from each source? 1 = very poor; 2 = poor; 3 = neutral; 4 = good 5 = very good; 6 = NA								
5. Could you rank the importance of each source (i.e., one you depend on) for your own seed provision in ascending order [*use 1, 2, 3, …*]? Fill NA in case source not used								

Part 6. Household assets

1. How much income did your household earn in 2018 from:		
1. Agricultural employment:		
2. Non-Agricultural employment:		
3. Farming income:		
4. Other business:		
5. Other (specify ……)		
2. Value of farm assets	**Number of assets**	**Value (RWF)**
1. Ox plough		
2. Hoes		
3. Motorcycle		
4. Wheelbarrow		
5. Spray pump		
6. Bicycle		
7. Other		
3. Value of non-farm assets	**Number of assets**	**Value (RWF)**
1. Radio		
2. TV		
3. Mobile phone		
4.		
5.		
6.		

Part 7. Housing characteristics

	Questions		Answers
1	Main walling material of main residential house	Codes A	
2	Main roofing material of main residential house	Codes B	
3	Main source of lighting?	Codes C	
4	Main source of energy for cooking?	Codes D	
5	Main source of water for domestic use?	Codes E	
6	Do you have a pit latrine	0. No; 1. Yes	

Codes A:	Codes B:	Codes C:	Codes D:	Codes E:
1. Burned bricks	1. Iron sheet	0. None	1. Firewood	1. Piped inside house
2. Concrete blocks	2. Tiles	1. Public-electricity supply	2. Charcoal	2. Piped outside house
3. Mud bricks	3. Grass thatched	2. Solar	3. Bio-gas	3. Borehole
4. Stone	4. Asbestos sheet	3. Generator	4. LPG gas	4. Well
5. Timber/wood	5. Other (specify)	4. Kerosene	5. Electricity	5. Spring
6. Timber and wattle		5. Torch	6. Cow dung	6. Stream/River
7. Mud		6. Candles	7. Saw dust	7. Lake/pond
8. Other (specify		7. Firewood	8. Other (specify)	8. Dam
		8. Other ……		9. Harvested rain water (tank)
				10. Other (specify)

Thank you for your time!

Eliciting farmers' demand for quality and nutritionally enhanced sweetpotato planting material in Rwanda

Post-Auction survey

1. Name of enumerator:	**2.** Date of interview:	**3.** Time of interview Start: End:
4. Name of farmer:	**5.** District:	**6.** Sector:
7. Cell:	**8.** Village:	

Information about sweetpotato farming practices

Part 1. Land holding

Question	Area (Total)	Unit (Codes A)
1. Total amount of land holdings owned		
2. Total amount of land under sweetpotato in 2019 season B		
2a. Quantity area owned:		
2b. Quantity area rented in:		
2c. Quantity area borrowed:		
Codes A: 1. Ares; 2. Meters squared; 3. Paces/Steps; 4. Hectares; 5. Other		

Question	Answer
3. Do you have access to swamp/mash land for farming	1-Yes 0-No
3a. If YES, how far is the nearest swamp/mash land from your homestead? (In walking minutes)	
4. Do you know any other NGOs or developmental organizations working on sweetpotato?	1-Yes 0-No
4a. If YES, how many NGOs or/and developmental organizations working here?	
4b. Please describe name of the developmental organizations or/and NGOs	1. 2. 3.
5. What is your **major/primary** season for growing sweetpotato?	1-Season A 2-Season B 3-Season C
6. Do you save sweetpotato vines for your **own use** in the next planting season?	1-Yes 0-No
7. Do you multiply sweetpotato vines and provide them to fellow/other farmers?	1-Yes 0-No
7a. If YES, under which transaction type do you provide them? [Select all that apply].	0-Free 1-In-kind 2-Terms & conditions (e.g., payback) 3-Loan (cash paid later) 4-Coupon 5-Cash
8. Do you consider yourself to be a sweetpotato commercial vine multiplier?	1-Yes 0-No
9. Have you aware about Decentralized Vine Multiplier (DVM)	1-Yes 0-No
9a. If 9 is YES, have you ever purchased vines from a decentralized vine multiplier (DVM)?	1-Yes 0-No
9b. If 9a is NO, why not? [Select all that apply]	1-Expensive/cannot afford /cash constraint 2-Don't trust the quality 3-Not available 4-Not available on time 5-Don't know of any multiplier 99-Other (specify):

9c. If 9a is YES, why? [Select all that apply]	1-High root yield 2-Higher vine yield 3-Less diseases 4-Quality roots 5-Other (specify):
10. Distance to the nearest decentralized vine multiplier? [Walking minutes]. If no multiplier is known, put N/A	
11. On average, after how many seasons do you purchase or acquire fresh sweetpotato vines from outside your farm for planting purpose? Write N/A if they don't.	
12. When it comes to adopting new technology, inputs or farming practices, which of the following best describes your behavior [read the list]	1-I am usually one of the first ones to adopt NEW technologies 2-I usually wait until a few farmers I know have used those inputs/technologies/practices, and then based on their experiences I make the decision 3-I usually wait until most farmers in this village are already using those inputs/technologies/practices, and I am 100% sure that those technologies work 4-I rarely change my farming practices as I am not comfortable doing new things 5-I rarely change my farming practices because I am constrained to do so

Part 2. Varietal use and information

13. In the last season, how many sweetpotato varieties did you plant?	
14. Name of the variety (Variety Codes)	1. 2. 3. 4. 5. 6.
15. Total quantity of seed of this variety?	
15a. Units [use code]	1-Bundle (100- 30cm vines) 2-Bundle (….kg) 3-Bag (50kg) 3-Bag (….kg) 4-Kg 5-Other (specify)
16. Year you first became aware of this variety? YYYY	
17. Year you first planted this variety on your farm YYYY	
Codes for variety: 1-Mugande; 2-Kadyaubwerere; 3-Kabode; 4-Vita	

Part 3. Farmer perceptions and knowledge

18. Could you rank of the following constraints in sweetpotato cultivation how applicable they are to your personal situation 1 to 5: 1=Not at all constraining; 2=Not constraining; 3=Neutral; 4=Somewhat constraining; 5=Most constraining	
Land	
Labor	
Cash	
Availability of vines	
Pests and diseases	
Access to market	
Market price (roots)	
Knowledge of good agricultural practices	
Other (specify and rate)	

Part 4. Behavioral aspects

19. Attitude toward new technology [Scale: 1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree]	
a) I consider myself as a progressive farmer	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
b) I like to try new agricultural technologies or farming practices	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
c) I actively seek information from others	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
d) I like new ideas in general	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
20. Perception of others	
a) Other farmers think I am a progressive farmer	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
b) Other farmers ask my opinions about agricultural technologies or farming practices	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
c) Other farmers will not object to how I cultivate sweetpotato on my fields.	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree

21. Perceived Behavioral Control	
a) It is easy for me to collect information about the new agricultural technologies and practices	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
b) I have good contacts with extension workers	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
c) I can adopt new agricultural technologies as long as they are profitable	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
22. Quality perceptions (it is applicable only when farmers used planting material from vine multiplier). Rank the item below as 1 = strongly disagree; 2 = disagree; 3 = Neither agree or disagree; 4 = agree; and 5 = strongly agree	
a) I think quality of planting sourced from multiplier provide better yield	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
b) Other farmers, such as opinion leaders, think quality planting material provides better yield	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
c) It is easy to source and plant. d). Compared with other source of seed, quality planting material sourced from a multiplier has good establishment rate.	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
e) Compared with other source of seed, quality planting material sourced from a multiplier is less disease and pest problem	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
f) Compared with other source of seed, quality planting material sourced from multiplier has uniformity in plant growth	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
g) Compared with other source of seed, quality planting material sourced from multiplier is high growth vigor	1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree
h) Considering all things, in your opinion, what is the main advantage of using seed from a vine multiplier?	1=good establishment rate 2=less disease and pest problem 3=Uniformity in plant growth 4=high growth vigor 5=high yield 99=other (specify) 88=have not used seed from vine multiplier

Thank you!

Annexure B3

MODULE 09- DEMO SITE MONITERING

District		**Sector**		**Cell**		**Village**	
M09_08A	FARMER NAME			**M09_08B**	Cellphone		
M09_8C	SEX OF THE FARMER	1=MALE; 0=FEMALE					
M09_08C	Farmer type	(*1-Trained multiplier; 2-Lead farmer; 3-average farmer; 4-Randomly selected farmer; 5-Extesion agent;/training center*)					
M09_09 Longitude (S)			**M09_10 Latitude (E)**			**M09-11A Elevation** (meters)	
M09_11B Accuracy (m)							

M09-12			**M09_13**	**M09_13A**	**M09_13B**	**M09_14A**	**M09_14B**	**M09_15A**	**M09_15B**	**M_09_16**	**M09_17**
			Variety characteristics			**Plot details**					
Date of planting			Variety name	Variety CODE	PRODUCT CODE (P1=1 OR P2=2	Plot location (1-High; 2-Middle; 3-Low)	During the previous season this plot had SP (0-No; 1-Yes)	Was manure applied before planting ? (0-No; 1-Yes)	Was inorganic fertilizer applied before planting (0-No; 1-Yes)	Was this SP field sprayed to control pests (0-No; 1-Yes)	How many times was this field weeded since planting? (#)
DD	MM	YY									

M09_18	**M09_19**	**M09_20**	**M09_21**	**M09_22**	**M09_23**	**M09_24**	**M09_25**	**M09_26**
What is the planting style (1-ridges; 2-Mounts; 3-Flat)	Number of plants counted on the plot	Distance between plot and the home) In walking minutes	Soil type 1) Very sandy 2) Sandy 3) Sandy-loam 4) Light clay 5) Heavy clay	Number of generation (Number)	Number of roots (marketable)	Number of roots (non-marketable)	weights of roots (marketable) Kg	weights of roots (non-marketable)

M09_29	M09_30	M09_31	M09_32	M_09_33	M09_34	M09_35	M09_36A	M09_36B
Irrigation method		**Plant density**		**Use organic fertilizer**	**Use of inorganic fertilizer**			
Was the plot irrigated (0-No; 1-with a can; 2-drip; 3-furrow; 4-Other)	Specify **other**	Distance between plants in ridges (cm)	Distance between ridges (cm)	Manure/ compost used in this SP (0-No; 1-Yes)	Used (0-No; 1-Yes)	Type 1. DAP 2. CAN 3. UREA 4. TSP 5 NPK 6 Other	Amount	Units 1. Bottle caps 2. Grams 3. Kgs 4. Cup 5. Liters 6. Other

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International Potato Center
Apartado 1558 Lima 12, Perú • Tel: 51 1 349 6017 • email: cip@cgiar.org