Behavioral Determinants of Biofortified Food Acceptance: The Case of Orange-fleshed Sweet Potato in Ghana

Chinonso Etumnu, Elizabeth Katz, Ernawati Abidin, Edward Carey

Abstract

Biofortified foods are being introduced in sub-Saharan Africa as an important strategy to help address micronutrient malnutrition. However, there has been little research on factors that could play decisive roles in their successful introduction. This paper investigates the determinants of consumer acceptance of biofortified orange-fleshed sweet potato (OFSP) using data from a choice experiment conducted in Ghana. We find that OFSP is preferred to traditional white-fleshed and yellow-fleshed sweet potatoes. We also find that consumers' socio-economic characteristics do not have a significant effect on OFSP acceptance. Conversely, providing consumers with information about the nutritional benefits of OFSP exert a substantial, positive and significant effect on their acceptance of the produce. Providing nutritional information thus appears to be more crucial in the successful introduction of OFSP and other biofortified foods.

Keywords: Biofortification, information, orange-fleshed sweet potato, choice experiment, Ghana.

Chinonso Etumnu (corresponding author) is a graduate student in the Department of Agricultural Economics at Purdue University; his email address is cetumnu@purdue.edu. Elizabeth Katz is an associate professor in the Department of Economics at the University of San Francisco; her email address is egkatz@usfca.edu. Ernawati Abidin is a project manager at the International Potato Center, Ghana; her email address is P.Abidin@cgiar.org. Edward Carey is a project leader and country manager at the International Potato Center, Ghana; his email address is E.Carey@cgiar.org. We would like to thank Bruce Wydick, Alessandra Cassar, Jayson Lusk, Justus Lotade, Simone Tijdink, Dan Gilligan, John Bidzakin, Catherine Meola, Jan Low and participants of the 2016 Creative Activity and Research Day at the University of San Francisco, the 2016 Agricultural Economics Society conference and the 2016 Agricultural and Applied Economics meeting for useful inputs. We gratefully acknowledge funding from the University of San Francisco, the International Potato Center and the Chester McCorkle, Jr. Scholarship of the Agricultural and Applied Economics Association. The RTB-University Gender Partnership initiated this collaboration.

1 Introduction

The United Nations World Food Programme estimates that over 700 million people in the world do not have enough food to lead a healthy, active life. Though less obvious, many more people (more than 2 billion people) are estimated to be suffering from micronutrient malnutrition (Qaim et al., 2007). A common form of micronutrient malnutrition is vitamin A deficiency (VAD). VAD causes blindness, impairs growth and cognitive development, and increases the risk of other infections that can lead to death especially among children and pregnant and lactating women. It is prevalent among poor households in developing countries who largely depend on staple food crops for their nutritional needs. Although staple foods are relatively cheap and rich in calories, they lack essential vitamins and minerals.

The threat posed by VAD has long been recognized, and the world has rallied to combat the scourge. Many international donors and agencies including Canadian International Development Agency (CIDA), United Nations Childrens Fund (UNICEF), the United States Agency for International Development (USAID), the World Health Organization (WHO), among others, have been supportive both at national and global levels to promote efforts to implement effective and affordable solutions (Rice et al., 2004). Several targeted interventions are being implemented in Asia, Africa and South America such as provision of micronutrient supplements, processed food fortification, and more recently biofortification – a term used to describe a breeding strategy that aims to increase the micronutrient content of staple food crops (Nestel et al., 2006).

Through biofortification, staple food crops that are enriched with beta-carotene, a precursor of vitamin A in the body, have been bred. Orange-fleshed sweet potato (OFSP) is one of these crops. Owing to its beta-carotene content, OFSP is orange in color which raises concerns about its acceptance by consumers relative to traditional sweet potato which is mostly white or yellow in color. However, studies have shown that farmers and consumers are receptive to OFSP in Tanzania, Uganda and Mozambique (Masumba et al., 2007; Tumwegamire et al., 2007; de Brauw et al., 2013). This finding is consistent with willingness to pay studies conducted by Chowdhury et al. (2011) and Naico and Lusk (2010), who report that consumers are

willing to pay for OFSP as much as they would pay for the traditional alternatives with similar attributes. Although both studies conclude that receiving nutritional information about the OFSP increases consumer willingness to pay a premium, a closer look at their results showcases some perverse information estimates. Chowdhury et al. (2011) found that the impact of receiving prior information on the benefits of OFSP on OFSP acceptance is significantly negative. In addition, a comparison of the WTP between consumers who received prior information and those who did not, shows that those who did not receive prior information were willing to pay 7% more for OFSP relative to the former group. In the study by Naico and Lusk (2010), providing health information to the rural consumers did not have a significant effect on their WTP for OFSP. These puzzling results about the effect of prior information and information presented during an experiment on consumers, particularly rural consumers, warrants further investigation because of the potential public health impact of the OFSP intervention.

Aside from providing consumers with nutritional information about OFSP and ensuring that OFSP possesses attributes similar to the traditional alternative, are there other factors yet to be investigated that can play a crucial role in the success of the OSFP intervention? As an agricultural intervention with an objective of improving the nutrition and health status of poor households especially children and women in developing countries, socio-economic characteristics of poor consumers such as their income, amount of land owned, age, education level, household size and number of young children they have in their household might play an important role to the success of the OFSP intervention and the entire biofortification program. Therefore, we use experimental data from Ghana to investigate the effects of OFSP attributes, socio-economic characteristics of consumers and nutritional information on OFSP acceptance. We disaggregate these effects by gender to examine differences in preferences between male and female rural consumers.

The following research question is addressed in this paper: what are the determinants of consumer acceptance of OFSP relative to other sweet potato varieties? We use a choice experiment to elicit these responses from rural consumers in northern and upper east regions of Ghana, and model the responses with conditional logit models. The choice experiment

has theoretical and econometric foundations from Lancaster (1966) and McFadden (1973), respectively. It also depicts real life purchasing decisions. However, due to the hypothetical nature of the choice experiments (the consumers did not actually pay for the sweet potato) conducted in this study, there is a potential problem of hypothetical bias in the results (Lusk and Schroeder, 2004). To mitigate hypothetical bias, we adopted "cheap talk" in the experiment, which was used by Chowdhury et al. (2011) although they concluded that it did not seem to entirely eliminate the problem.

Keeping the hypothetical bias caveat in mind, we find that Ghannian consumers value OFSP more than the white-fleshed sweet potato (WFSP) and the yellow-fleshed sweet potato (YFSP). What were the drivers of consumer valuation of the OFSP relative to the other sweet potato varieties? To answer this question, we estimated more conditional logit models using both consumers' socio-economic characteristics and health information proxies as determinants of OFSP acceptance. We find that socio-economic characteristics of education, household income, amount of land owned, age, household size and number of children under 5 in a household do not significantly affect consumer acceptance of OFSP. This result implies that any increase or decrease in any of these characteristic will not affect consumer acceptance of OFSP significantly. Thus focusing on how to increase household income, for instance, as a means to spur the acceptance of OFSP is unlikely to be crucial to the success of the OFSP intervention and biofortification in general. In contrast, providing consumers with information about the nutritional benefits of OFSP seem to be a key driver of OFSP acceptance. This is indicated by the large, positive and significant coefficients of nutritional information – both prior information and information received during the experiment – in all the specified models. This finding suggests that nutritional campaigns should be an integral part of the OFSP intervention and it could help in asserting or modifying aspects of the biofortification program to better achieve its intended goals. It also provides useful information for designing future agricultural programs targeted at women and children as this results are consistent even when disaggregated by gender. Since the attention paid to the role of gender in the success of agricultural technologies has been limited, this study contributes to the literature in this subfield of research as well.

The rest of this paper is organized as follows: Section 2 reviews the advantages of biofortification, consumer acceptance of biofortified crops; Section 3 presents the methodology, which outlines how the data was collected and the empirical model and hypothesis; Section 4 focuses on the results; Section 5 presents the conclusions and implication of the study.

2 Literature Review

2.1 Advantages of Biofortification

Biofortification has been promoted by donors, researchers and policymakers due to its demonstrated potential to combat micronutrient malnutrition. Its advantages over other micronutrient interventions makes it very promising as a sustainable strategy to end micronutrient malnutrition in the world.

Biofortification is a pro-poor intervention strategy. Since most poor households in developing countries suffer from micronutrient malnutrition and they largely depend on staple food crops for their nutritional needs, consuming biofortified crops will result in improvements in their nutrition and health status. Due to the predominance of staples in the diets of the poor, biofortification implicitly targets poor households. Biofortified crops may also serve as nutritional buffer during economic shocks because the poor normally reduce their intake of higher-value food commodities when adverse events occur (Qaim et al., 2007).

In addition to being a pro-poor intervention, biofortification is highly cost-effective compared to other micronutrient malnutrition interventions (Meenakshi et al., 2010). The recurrent costs of biofortification is quite low because after the initial outlay of investments on seeds, germplasm can be shared internationally and farmers can easily disperse the planting materials and varieties to their extended families, friends or neighbors at little or no additional costs (Mwaniki, 2009). It is estimated that $80 million will be enough to fund the research, development, dissemination, and evaluation of six biofortified staple crops to be used indefinitely in the world while the same amount of money cannot provide regular vitamin A supplements to 7% of the South Asian population (Stevens and Winter-Nelson, 2008).

Other micronutrient interventions such as processed food fortification and provision of

supplements tend to focus on urban markets while biofortification reaches out to rural areas where most dwellers are farmers. Most farmers consume part of their produce, so continuous supply of nutritious crops is ensured for farmers who adopt biofortified crops. If farmers adopt biofortified crops, there may be no need for them to seek for free micronutrient supplements or purchase processed food that are fortified with micronutrients which are only easily accessed in the urban areas. Biofortification can therefore be used as a solitary intervention or as a complement to other interventions which are readily available in urban areas.

Biofortification also has the advantage of eliminating the risk of toxicity especially in the case of vitamin A. Poisoning by excess consumption of processed food fortified with micronutrients or massive doses of supplements is avoided through the consumption of biofortified crops (Stevens and Winter-Nelson, 2008). Furthermore, breeding micronutrient dense crops does not incur any penalty in terms of the agronomic characteristics of the crop, particularly with regards to yield and resilience to pests and diseases. Instead, nutrient-packed crops are more likely to resist diseases and survive environmental stresses. This implies that farmers have nothing to lose by adopting biofortified staple crops.

2.2 Consumer Acceptance of Biofortified Foods

The impact of biofortification is influenced by a number of factors. These factors can be broadly grouped into technology efficacy and technology coverage (Qaim et al., 2007). Technology efficacy involves the micronutrient content of a biofortified crop, its micronutrient retention ability after processing and the bioavailability of the micronutrient when it is consumed. Many studies (Haas et al., 2011; Hotz et al., 2012; Low et al., 2007; van Jaarsveld et al., 2005; Van Jaarsveld et al., 2006) confirm the efficacy of biofortified staple crops in combating micronutrient malnutrition while a growing literature investigates issues of technology coverage. Technology coverage entails farmer adoption and consumer acceptance of biofortified staple crops. Biofortification could be carried out by conventional breeding or by genetic modification as in the case of golden rice. But due to strong opposition to genetic modification, there seem to be focus on those staple crops that are biofortified through conventional breeding (González et al., 2009). However, accepting biofortified crops that are convention-

ally bred may require a change in the behaviour of farmers and consumers since some of the biofortified crops differ in colour and texture relative to the traditional staple crops.

One of the staple crops that has been enriched with beta-carotene is maize. Stevens and Winter-Nelson (2008) examine the acceptance of provitamin A maize in Mozambique. Using taste tests and a trading experiment, they find that participants in their experiment ranked the appearance of their local white maize over an orange biofortified variety. They also find that the existing preferences for white maize do not preclude acceptance of the orange biofortified variety since a large share of the participants showed willingness to consume meals made with the orange biofortified maize. However, the study was conducted in the urban area – in the city of Maputo – which might affect its external validity especially in the case of biofortification which is a pro-poor and pro-rural intervention. De Groote et al. (2011) estimate consumer willingness to pay for yellow and fortified maize in both rural and urban regions of Kenya using experimental auctions. Their results show that consumers in Kenya are willing to pay premiums for fortified maize even though there was a general preference for the white maize over the fortified maize. Nonetheless, they also find that the preference of white maize over the yellow maize is less pronounced in western Kenya and that consumers in Siaya district of Kenya actually prefer the fortified yellow maize over white maize.

Another staple food crop that has been biofortified with beta-carotene is cassava. Cassava is important to the welfare of about one billion people in developing countries who depend on it for their food, feed and industrial needs (Jansen van Rijssen et al., 2013). Biofortified cassava seem to be well received in Brazil, where González et al. (2009) investigate consumers attitude toward the hypothetical product. Using a combination of choice experiment and contingent valuation techniques to improve the robustness of their results, they estimate mean willingness to pay for vitamin A biofortified cassava at 60-70 per cent above market prices for traditional cassava. They also find that consumers value the white attribute of cassava over the yellow attribute of the biofortified variety but the product as a whole is well received as indicated by the high mean willingness to pay obtained. However, they based their analysis on stated preference data which is prone to hypothetical bias, so placing particular confidence on the exact WTP numbers might be misleading. Using experimental auctions, Oparinde et al. (2014)

investigate consumer WTP for a product made from biofortified yellow cassava (garri) and the effect of nutritional information on consumer WTP for the product in two states of Nigeria that exhibit distinct habitual product colour differences. They find that consumers are less likely to pay for garri in Imo (in the southeast) while in Oyo (in the southwest) consumers are willing to pay a premium for the yellow cassava. In both states, they find that nutritional information results in a price premium for biofortified yellow cassava.

Sweetpotato, a widely consumed staple crop in both developed and developing countries, is one of the first staple crops to be biofortified with beta-carotene. Chowdhury et al. (2011) and Naico and Lusk (2010) use data from choice experiments to study consumer acceptance and their willingness to pay for OFSP in Uganda and Mozambique respectively. Chowdhury et al. (2011) find that consumers in Uganda are willing to pay sizable premiums when informed about the nutritional value of OFSP. Even in the absence of nutritional information, they find that consumers are willing to pay for OFSP as much as they are willing to pay to the traditional white sweet potatoes. They find that some of the determinants of willingness to pay include taste and demographics. Similarly, Naico and Lusk (2010) find that consumers in Mozambique value the pulp of the OFSP more than the traditional variety. Attributes valued by the consumers include dry matter content and the size of roots. Furthermore, they find nutritional information about OFSP to boost acceptance and possible consumption of OFSP in urban areas more than in the rural areas. Both studies conclude that OFSP has great potential to compete successfully in the market against traditional sweet potatoes.

An emerging theme in the above literature is the important role nutritional information plays in the acceptance of biofortified crops. But none of the studies mentioned above, except Oparinde et al. (2014), was conducted in West Africa, a region with one of the worst records of micronutrient malnutrition. This necessitates studies that will help in establishing the external validity of current studies and that will further investigate other factors that can also influence the success of biofortification. One of such factors might be socio-economic characteristics of consumers. This study uses experimental data to investigate the determinants of consumer acceptance of OFSP in Ghana.

3 Methodology

3.1 Choice Experiment

We use the choice experiment valuation technique to elicit consumer acceptance of OFSP in northern and upper east regions of Ghana. The choice experiment suits this study because it allows for the estimation of potential consumer demand for a multi-attribute product that is spurred by nutritional value to be studied, and the socio-economic and information hypotheses to be tested at the same time. The advantages of using the choice experiment relative to other valuation methods includes that we have control over the experiment and the attributes associated with passive uses that cannot be valued in the market place for a relatively new product. Another advantage is that choice experiment closely mimics actual purchasing decisions that both producers and consumers make, and it is based on the random utility theory introduced by McFadden (1973) and theory of consumer behavior introduced by Lancaster (1966), which states that the utility derived from a product is because of the attributes of the product.

From some interviews that we conducted and the economic literature, the attributes of OFSP that warrant investigation in Ghana includes dry matter content, taste, pulp color, size of roots, nutritional value, appearance, and price. Although it seems ideal to present all these attributes to consumers in the experiment, considering all the attributes simultaneously renders the choice sets unmanageable because they become too large and confusing. Thus, because of this potential problem, we focus on price and color attributes in this study, and prepared choice sets based on them. These attributes were varied to create choice scenarios from which respondents made repeated selection among four alternatives that differed by these attributes. Price of the sweet potato roots was varied at four levels for each of three alternative sweet potato differentiated by their pulp color. Color was varied at three levels: white, yellow and orange.

Since the market for sweet potato is seasonal in northern Ghana and it was out of season when this experiment was conducted, we relied on information from those that conducted market surveys on sweet potato in the past year in determining the prices and quantity of

sweet potato. Depending on the season, sweet potato roots are typically sold in the range of 2-4kg heaps in Ghana, so we resolved to keep the weight constant at 3kg across all varieties. The prices of the three varieties encompass the possible minimum and maximum price that we received from those who have knowledge of the sweet potato market. It is also worth noting that the varieties are not differentiated in prices.

From these attributes and their corresponding levels, we constructed choice sets. The respondents were presented with four choice sets to choose from. The first option was WFSP and the second option was OFSP, the third was the YFSP and the last option was none of the three–a none option. In this set-up, there are three sweet potatoes, varied at four different price levels. This implies that respondents would have to be shown $4^3 = 64$ different choice sets for the roots experiment. In order to reduce the number of choice sets that respondents have to choose from, we follow Lusk and Schroeder (2004) and Chowdhury et al (2011) in generating a list of choice sets in such a way that none of the prices are correlated with each other. This results in 16 choice sets but in order to have a basis for comparison, we included a 17th choice set where all the sweet potatoes have the same price.

Data were collected from respondents via in-person interviews in northern and upper east regions of Ghana in June 2015. The village contact persons were contacted and the permission of village chiefs requested for villagers to be interacted with. The availability of a respondent determined if the he or she took part in the experiment. To reduce hypothetical effect of the purchasing decisions and to increase realism, "cheap talk" was employed and participants were informed that after making their choices, they would receive a gift – "a key soap" that worth about three Ghana Cedis. Respondents were not paid the value of the product because payments from past experiences created hysteria in the study areas. Each participant was randomly assigned to one of two treatment groups. One treatment group received nutritional information about OSFP while the other treatment group did not receive nutritional information. Participation and assignment was only once and to only one treatment group. Four well-trained enumerators carried out the survey. Two enumerators provided nutritional information about OFSP to consumers (treatment 1) and the other two enumerators did not provide nutritional information (treatment 2). The enumerators first

collected demographic information of the respondents and then elicited their preferences about the sweet potatoes, providing nutritional information if required.

The experimental sequence of steps are as follows: 1) Randomization 2) Demographic module 3) Provision of nutritional information if applicable, and 4) Choice experiment itself. The study sites were randomly selected from a list of villages that have been selected as pilot sites for the works of a team of researchers from the International Potato center. Four villages were selected in the northern region and additional four villages were selected in the upper east region, making a total of eight villages for the study. The villages are Nayoku, Golinga, Voggu-Kushibu and Dimabi in the northern region, and Binduri, Naaga, Gaani and Damentenga in the Upper east region. These villages are representative of the two regions. The demographic module consists of a series of survey questions that collected information on respondents socio-economic characteristics such as income, educational level, amount of land owned, household size and age, which were used as determinants in the empirical estimation. The demographic module was followed by provision of nutritional information. Consumers that were assigned to the information treatment were provided information on the nutritional benefits of OFSP while those that were assigned to treatment without information were not provided nutritional information. The nutritional message given to the information treatment was similar to the one used by Chowdhury et al. (2011), Harvestplus and the International Potato Center. All consumers were asked about whether they had received prior information on OFSP and their responses are used as a determinants in the empirical estimation. Finally, respondents were given instructions on how the choice experiment works and provided with scenarios to make their choices.

3.2 Model and Specification

The conceptual framework of this study is rooted in the works of Lancaster (1966) and McFadden (1973). Lancaster proposed that consumer demand for a product is spurred by the attributes of that product while McFadden proposed the random utility theory which assumes that an individual's utility comprises of systematic and stochastic components. In this case where respondents were asked to choose between three different sweet potato varieties and a

none option, we assume that the utility derived by the ith consumer in choosing option sweet potato j is given by

$$U_{ij} = V_{ij} + \epsilon_{ij} \tag{1}$$

where V_{ij} is the systematic component of the utility function determined by the attributes of the sweet potato and ϵ_{ij} is the unobserbale stochastic component. The probability that a consumer chooses alternative j is

$$Prob\{V_{ij} + \epsilon_{ij}\} \geq Prob\{V_{ik} + \epsilon_{ik}\}; \qquad for\ all\ j \neq k \tag{2}$$

Assuming ϵ_{ij} is independently and identically distributed across the j alternatives and N individuals with an extreme value distribution, the conditional logit results (Lusk and Schroeder, 2004; Louviere et al., 2000; McFadden, 1973). Based on these assumptions, the probability of choosing alternative j is

$$Prob\{j\ is\ chosen\} = \frac{\exp^{V_j}}{\sum_{k=1}^{j} \exp^{V_k}} \tag{3}$$

where V_{ij} is as previously defined and j is the sweet potato options. The objective of this study is to examine consumer consumer acceptance of OFSP and to investigate determinants of such preferences. In order to do this, we need an econometric specification.

Each respondent chooses one option from four alternatives (OFSP, WFSP, YFSP or 'none'), which they prefer most (derived highest utility from) in each of the five choice sets for the roots. We assume that these choices are driven by an attribute-based utility function as specified below:

$$V_{ij} = \beta_1 OFSP_j + \beta_2 WFSP_j + \beta_3 YFSP_j + \alpha P_j + \gamma X_i + \theta Z_i \tag{4}$$

where $OFSP_j$ takes the value of 1 if alternative j is an OFSP, $WFSP_j$ takes the value of 1 if alternative j is a WFSP, $YFSP_j$ takes the value of 1 if alternative j is YFSP, $\beta_1,\ \beta_2\ and\ \beta_3$ are alternative-specific constants representing the utility of orange-, white- and yellow-fleshed

sweet potato relative to 'none' option, respectively, P_i is the price of alternative j, X_i is a vector of the nutrition information received by respondent i and γ is the effect of nutritional information, Z_i is a vector of socio-economic characteristics of respondent i and θ is the effect of the characteristics on the deterministic component of the utility. The null hypothesis of the study is that θ is zero, while the alternative is that θ is non zero; however the direction of the effect is not specified.

4 Results

4.1 Sample Description

The sample for the study comprise of 628 individuals. The summary statistics of the respondents' demographic characteristics are reported in Table 1 and are disaggregated by gender.

For the full sample of 628 individuals, 52 percent of the respondents are female and the average age of the respondents is 40 years. Most of the respondents received very little (lower primary) or no formal education, which can be attributed to the sites of the study. The study was conducted in rural villages in the northern and upper east regions of Ghana. The reported average household size is 14 with 4 children and 1 pregnant or lactating mother. The average monthly income of a household is GHC 204 and the average monthly personal contribution of a respondent to the household income is GHC 104. On average, the total land area owned by a respondent is 4.15 acres and the total land area that the respondent do not own but has access to is 2.88 acres. Most (72 percent) of the respondents have received information on OSFP prior to the choice experiment.

Furthermore, respondent demographics are disaggregated by gender and treatment. The differences in characteristics by gender indicate the difference in roles of men and women in the study areas and also calls for improvement to women's access to education, personal income and land. In particular, on average, women (1.32) are less educated than men (1.63) and they contribute on average GHC 75 to their household income while men contribute GHC 135. Women also own less land, 2.85 acres compared to 5.54 acres of men. They also reported to have access only to 1.62 acres of land, which they do not own, while men have access to 4.23

acres. These values are statistically different and thus showcase the disparity in empowerment between men and women in this part of the world. With regard to the disaggregation of the sample by treatment, 300 respondents received information about the nutritional benefits of OFSP during the experiment while 328 respondents did not receive nutritional information during the experiment.

4.2 Consumer Preferences

A total of 12560 observations were obtained from the respondents, 6060 observations from male respondents and 6500 from female respondents. The 12560 observations represent 3140 choices made by all the respondent, 1515 choices by the male respondents and 1625 choices by the female respondents. From these observations and choices, we calculated the relative preferences of all the respondents, and these results are shown in Table 2. Out of the possible 3140 choices for the most preferred variety at different price levels in the full sample, the OFSP received 2790 (89%). The WFSP received 176 (6%) while the YFSP received 171 (5%). This result suggests a huge preference for the OFSP irrespective of the price level used in the study. Similarly, in the disaggregated sample, OFSP received 1370 (90%) choices for male and 1420 (87%) for female, confirming that both subgroup have similar preferences towards the OFSP. We use these observations to estimate conditional logit models shown in the following sections, from which we examine the effects of socio-economic characteristics and nutritional information on their preferences.

We estimated a restricted version of the econometric model (equation 4) using conditional logit for the full sample and present the results in Table 3. In order to compare and discuss variations in estimates between male and female respondents and treatments, we estimate conditional logit models for both male and female subsamples. These results are also presented in Table 3. The independent variables (attributes of sweet potato) of the models explain more than 65% of the variation in the dependent variable (sweet potato choice made by the respondents) as indicated by the relative size of the $Pseudo - R^2$ in all the models.

For the full sample, the price coefficient is positive but statistically insignificant, meaning that sweet potato options with higher prices were more likely to be chosen even though the

coefficient does not have statistical power. The price coefficient for the male subsample is negative but statistically insignificant, which means that male respondent were less likely to choose sweet potato options with higher prices although the coefficient does not have explanatory power too. For the female subsample, the price coefficient is positive and statistically significant, which implies that female respondents were more likely to choose sweet potato options with higher prices than options with lower prices. Both the negative and positive signs of the price coefficient have intuitive interpretation. A negative price coefficient suggests a downward sloping demand curve as expected while the positive price coefficient suggests an upward sloping demand curve, which could be the general perception that a higher price represent better quality.

Table 3 also shows the different coefficients for the three alternative sweet potatoes. The results are similar for the full sample and the disaggregated sample. All the coefficients are positive and statistically significant, which shows that the respondents were more likely to choose either the OFSP, WFSP or YFSP relative to the "none" option. The sizes of the coefficients show that OFSP is preferred to WFSP and YFSP because the coefficents of the OFSP for the full sample and subsamples are about two times the coefficients of the WFSP and YFSP. This can also be interpreted that respondents obtain higher indirect utility from OFSP relative to the other alternatives. For instance, the coefficient of OSFP in the full sample is approximately 8 while the coefficients of the YFSP and WFSP are approximately 4 respectively. This result shows that choosing OFSP rather YFSP and WFSP increases indirect utility obtained by the consumer by about 4 *Utils*.

4.3 Determinants of Sweet Potato Acceptance

Table 4 presents estimated coefficients of conditional logit models that examine the effects of socio-economic characteristics of amount of land owned, education, household income, age, household size and having children under 5, and the effects of receiving nutritional information about OFSP prior or during the experiment on consumer acceptance of OFSP and the other sweet potato varieties.

All the socio-economic characteristics, except age and household size, appear to negatively

influence consumer acceptance of OFSP as shown in column 1, 2 and 3 of Table 4. The coefficient of household income is negative but not statistically significant for the full sample. It is also negative and insignificant for the male and female subsamples. This suggests that an increase in the respondents' income may lead to a decrease in their acceptance of OFSP. As their income increase, respondents are likely to substitute consuming OFSP with other foods. This is kind of intuitive since obtaining dietary diversity could provide the respondents with the nutritional benefits promoted through OFSP. An increase in income could be allocated to other foods such as milk and meat. It is notable that the size of the income coefficient is relatively small, a reduction in utility by 0.157 units. The coefficient of amount of land owned is also negative and statistically insignificant for the full sample, and the male and female subsamples. This result also suggests that an increase in the amount of land owned, an indicator of wealth in rural areas, may lead to a decrease in consumer acceptance of OFSP. Similarly, respondents who reported that they have received some form of formal education seem to be less likely to pay more for OFSP given the negative sign of the coefficient of education, although it is not statistically insignificant for the full sample, and male and female subsamples. Income, land ownership and education from the literature are good indicators of wealth and human capital and thus these results suggest that their sole increase in the household may not have a significant effect on OFSP acceptance. Results also suggest that having a child under 5 years in a household negatively and significantly affects OFSP acceptance if the respondent was male but the results are insignificant for the full sample and female subsample. Even if the coefficients of these socio-economic characteristics were all to be significant, being negative suggests that their sole increase may dampen the acceptance of OFSP and a decrease in its demand in the market.

Household size and age positively affects consumer acceptance of OFSP. The coefficient of household size is highly significant for the full sample and suggests that respondents with big households were more likely to accept OFSP. As the sweet potato is one of the major staples in rural Ghana, it is likely to be very important for bigger than smaller households for food security reasons. The coefficients of household size for the male and female subsamples are not significant. Despite this insignificance of these coefficients, their sign suggests that an increase

in the household size is likely to lead to higher demand for the OFSP and other sweet potato varieties. Similarly, the coefficients of age are positive though insignificant, which implies that older people were more likely to accept OFSP.

Providing nutritional information appears to very important as shown in regression columns 4, 5 and 6 of Table 4. The coefficient of the dummy variable about receiving nutritional information prior to the experiment is positive, highly statistically significant and large for the full sample and the male and female subsamples. This result is expected given the role promotional campaigns have been found to have in introducing new products in different spheres of life. It could be inferred from this result that accompanying nutritional campaign with the dissemination of OFSP could lead to its successful introduction. Specifically, accompanying interventions that aim to increase the welfare of poor rural households with nutritional campaign about OFSP could lead to both increase in household wellbeing and successful adoption and consumption of OFSP. That information may play an important role in joint interventions (empowerment programs and OFSP dissemination) is suggested by the magnitude of the estimated information coefficients across the full sample and subsamples, which is likely to completely mitigate negative effects from other factors. This finding is consistent with some of the literature on the impact of health information on food demand. Kinnucan et al. (1997) find that health information has a significant effect on meat demand in the United States, where cholesterol-related health information was widely disseminated. Similar results were found for biofortified cassava in Nigeria by Oparinde et al. (2014). It might be worth noting that these results contrasts the results of Chowdhury et al. (2011), who found that receiving prior information on OFSP has a negative effect on OFSP acceptance.

Also included in the conditional logit models presented in regression columns 4, 5 and 6 of Table 4 is a dummy variable for receiving health information during the experiment. This is the treatment variable. Receiving health information about OFSP during the experiment, as expected, appear to have a larger effect on consumer choice. The coefficients are about 3 times times larger than the coefficients of receiving information prior to the experiment. These coefficients are positive and highly significant, which suggests that an intensified information campaign may result in better nutritional outcomes in Ghana and elsewhere in sub-Saharan

Africa. This results contradicts the findings of Naico and Lusk (2010), who suggest that providing health information on OFSP does not have a significant effect on rural consumers' choices. My results are however consistent with the findings of Chowdhury et al. (2011). If the issue of trust with informants is taken care of in the rural areas, providing nutritional information is likely to result in the acceptance of OFSP throughout sub-Saharan Africa.

To examine the effects of nutritional information and socio-economic characteristics together on consumer choices, we estimated conditional logit models with interaction variables generated from multiplying nutritional information and socio-economic variables. First, we interacted socio-economic characteristics with receiving prior information and then interacted socio-economic characteristics with receiving information during the experiment. The results are presented in Table 5 and 6. Table 5: columns 4, 5 and 6 report regression results of interacting prior information with socio-economic characteristics, while Table 6: columns 4, 5 and 6 report the interaction between socio-economic characteristics and receiving information during the experiment.

The coefficient of the interaction variable between household income and receiving prior information is positive and statistically significant for the full sample, and insignificant for the male and female subsamples. This suggests that incorporating the information effect with the income effect could result in an increase in the acceptance of OFSP. An increase in the respondents' income if the respondent received health information prior to the experiment may lead to an increase in the acceptance of OFSP. As their income increase, respondents are no longer likely to substitute consuming OFSP with other foods. The coefficient of the interaction variable between the amount of land owned and receiving prior information is negative and statistically insignificant for the full sample, and male and female subsamples. This result suggests that irrespective of receiving prior information, an increase in the amount of land owned may lead to a decrease in consumer acceptance of OFSP. Similarly, the interaction variable for respondents who reported that they have received some form of formal education with prior information is negative and statistically insignificant for the full sample, and the male and female subsamples. Other results include the interaction with age and number of children under 5, which are insignificant and negative as well. Therefore only the interaction

between income, household and prior information could lead to increase in the acceptance of OFSP. Since the coefficients of land and education are still negative despite interaction with prior information, it suggests that their increase may dampen the acceptance of OFSP irrespective of prior information effects.

The results from interacting receiving information during the experiment with socio-economic characteristics appear to be quite similar to the results of the first sets of interactions in terms of income, land, education, and age, and different i terms of household size and children under 5. The most highly significant relationship is that of age, which shows that an increase in age for those who received information during the experiment reduces the utility of choosing OFSP. The coefficients of all the interaction variables affect OFSP acceptance insignificantly, except education, but in different directions. The interaction coefficient for income interaction is positive for the full sample and subsamples, though it is insignificant. The coefficient of the land interaction variable is negative for the full sample and female subsample, and positive for the male subsample. The coefficients of the education interaction variable is negative and significant for the full sample and female subsample, and insignificant and negative for the male subsample. Despite the varying signs of all these interaction coefficients between socio-economic characteristics and receiving information during the experiment, their level of significance suggests that only education and age could lead to rejection of the OSFP.

The effects of receiving prior information and information during the experiment are highly positive and significant, which suggests that the activities of International Potato Center and other NGOs that promote OFSP in the northern and upper east regions of Ghana are yielding expected results and may lead to market demand for OFSP in the short and long run. However, only empowering households, without adequate dissemination of the nutritional benefits of the OFSP is not likely to result in OFSP acceptance in the study area and other parts of sub-Saharan Africa.

5 Conclusions and Implication

What are the determinants of biofortified food acceptance in Ghana? Several conditional logit models of consumers' attribute-based utility functions were estimated to answer this research question using data from a choice experiment conducted in Ghana. The conditional model estimates were used to examine the influence of socio-economic characteristics and nutritional information on consumer acceptance of OFSP.

Results show that consumers valued the OFSP more than the WFSP and the YFSP. This finding is consistent with consumer preferences studies carried out by Naico and Lusk (2010) and Chowdhury et al. (2011), and suggest that choice experiment is a plausible technique for eliciting consumers' preferences. We further examined if socio-economic characteristics and nutritional information were driving the valuation of OFSP. Socio-economic characteristics of income, education, amount of land owned, age, household size and have children under 5 years in the household appear to influence consumer acceptance of OFSP insignificantly. This suggests that attempts to increase any of these characteristics alone may not result in the acceptance of OFSP. Conversely, results show that providing consumers with nutritional information could translate to sizable premiums for OFSP as indicated by the highly significant positive coefficients obtained in the conditional models for the full sample and the male and female subsamples. Both information variables – nutritional information received prior to the experiment and nutritional information received during the experiment – have positive and sizable effects on consumer acceptance of OFSP. The effects of the health information received during the experiment are larger which may be due to the one on one nature of the information treatment. These results suggest that OFSP dissemination programs should always incorporate nutritional and health information campaigns. It seems possible to empower households and successfully introduce OFSP simultaneously if empowerment interventions are also incorporated with nutritional information campaigns. Thus the OFSP intervention offer the potential of reducing the prevalence of vitamin A deficiency through a pro-poor and cost-effective means and providing nutritional and health information appears to be crucial to successfully introduce it and other biofortified foods.

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6]ROOTS	Option A	Option B	Option C	Option D
				I would choose none of the Options
Price/3kg (GHC)	3	2	3	
I would choose	☐	☐	☐	☐

Figure 1: A Sample of Choice Experiment Card.

Table 1: Summary Statistics of Respondent Demographics

Definition	Full Sample	Gender		Treatment	
		Male	Female	With info	Without Info
Gender: 1-female, 0-male	0.52[a]	0	1	0.49	0.55
	(0.50)[b]	(0)	(0)	(0.50)	(0.50)
Age in years	40.23	39.38	41.03	42.18	38.55
	(15.95)	(15.65)	(16.25)	(16.96)	(14.72)
From 1-No formal education	1.47	1.63	1.32	1.40	1.52
to 6-Higher education	(1.17)	(1.36)	(0.96)	(1.08)	(1.24)
Number of people	14.37	15.07	13.72	15.60	13.27
in a household	(9.57)	(10.02)	(9.09)	(10.76)	(8.14)
Number of children	3.93	4.32	3.58	3.91	3.96
under 5 years	(2.69)	(2.96)	(2.35)	(2.78)	(2.59)
Number of pregnant/	1.23	1.30	1.17	1.11	1.34
breastfeeding women	(1.42)	(1.40)	(1.42)	(1.41)	(1.42)
Household income	203.76	260.64	150.73	171.83	232.94
in GHC/month	(258.21)	(331.16)	(144.75)	(187.54)	(305.69)
Contribution to household	103.83	134.80	74.96	84.50	121.82
income in GHC/month	(126.85)	(155.93)	(82.12)	(105.15)	(141.26)
Total area of land	4.15	5.54	2.85	4.02	4.27
owned in acres	(3.42)	(3.82)	(2.36)	(3.48)	(3.35)
Total area of land not owned	2.88	4.23	1.62	3.87	1.97
but accessed in acres	(3.43)	(4.03)	(2.07)	(3.55)	(3.03)
Received information on OFSP	1.28	1.17	1.37	1.27	1.29
prior to experiment, 1-yes, 2-No	(0.45)	(0.37)	(0.49)	(0.45)	(0.45)
Number of Respondents	628	303	325	300	328

[a]Reported statistics are mean values

‘ [b]The numbers in parentheses are standard deviations

Table 2: Consumer Relative Preferences among the Sweet Potato Varieties

Varieties	Full Sample				Male				Female			
	Yes		No		Yes		No		Yes		No	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
White	176	6	2964	31	66	4	1449	32	110	7	1515	31
Orange	2790	89	350	4	1370	90	145	3	1420	87	205	4
Yellow	171	5	2969	32	77	5	1438	32	94	6	1531	31
None	3	0	3137	33	2	0	1513	33	1	0	1624	33
Total	3140	100	9420	100	1515	100	4545	100	1625	100	4875	100

Table 3: Conditional Logit Estimates of the Utility Function

Variables	(1) Full Sample	(2) Male	(3) Female
Price of sweet potato	0.0393	-0.0404	0.0985*
	(0.0407)	(0.0657)	(0.0512)
White-flesh relative to "none"	4.003***	3.615***	4.488***
	(0.761)	(1.028)	(1.030)
Orange-flesh relative to "none"	8.100***	8.028***	8.345***
	(0.758)	(1.012)	(1.036)
Yellow-flesh relative to "none"	3.972***	3.776***	4.327***
	(0.752)	(0.988)	(1.051)
Observations	12,560	6,060	6,500
Choices	3140	1515	1625
Respondents	628	303	325
Pseudo R-squared	0.691	0.725	0.662
Log likelihood	-1872	-804	-1060

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Determinants of Sweet Potato Acceptance

Variables	(1) Full Sample	(2) Male	(3) Female	(4) Full Sample	(5) Male	(6) Female
Price	0.0421	-0.0352	0.103**	0.0394	-0.0322	0.0926*
	(0.0405)	(0.0651)	(0.0505)	(0.0432)	(0.0691)	(0.0532)
White-flesh	3.998***	3.607***	4.480***	4.043***	3.633***	4.546***
	(0.761)	(1.031)	(1.032)	(0.765)	(1.035)	(1.038)
Orange-flesh	8.091***	9.014***	7.722***	6.900***	7.190***	6.806***
	(0.872)	(1.142)	(1.352)	(0.930)	(1.312)	(1.388)
Yellow-flesh	3.967***	3.768***	4.318***	4.014***	3.799***	4.384***
	(0.752)	(0.990)	(1.052)	(0.755)	(0.993)	(1.058)
Household income	-0.157	-0.280	-0.197	0.335	0.359	-0.109
	(0.534)	(0.575)	(1.458)	(0.592)	(0.696)	(1.417)
Land owned	-0.0200	-0.0315	-0.0777	-0.0498	-0.0424	-0.0555
	(0.0452)	(0.0608)	(0.0882)	(0.0568)	(0.0824)	(0.0969)
Education	-0.0772	-0.172	-0.0219	-0.128	-0.163	-0.0870
	(0.134)	(0.171)	(0.229)	(0.149)	(0.199)	(0.237)
Age	0.00251	-0.00792	0.0118	-0.00446	-0.0117	0.00209
	(0.00798)	(0.0111)	(0.0122)	(0.0101)	(0.0144)	(0.0146)
Household size	0.0380**	0.0443	0.0409	0.00752	-0.000752	0.0197
	(0.0188)	(0.0280)	(0.0275)	(0.0249)	(0.0389)	(0.0354)
Under 5 children	-0.100	-0.177*	-0.0322	-0.0352	-0.0643	0.00523
	(0.0721)	(0.101)	(0.0972)	(0.0926)	(0.131)	(0.125)
Prior information				1.188***	1.213*	1.119**
				(0.365)	(0.654)	(0.455)
During information				3.912***	4.070***	3.736***
				(0.369)	(0.570)	(0.502)
Observations	12,560	6,060	6,500	12,560	6,060	6,500
Choices	3140	1515	1625	3140	1515	1625
Respondents	628	303	325	628	303	325
Pseudo R-squared	0.693	0.729	0.665	0.734	0.765	0.707
Log likelihood	-1861	-791.5	-1049	-1613	-688.2	-918.1

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Determinants of Sweet Potato Acceptance 2

Variables	(1) Full Sample	(2) Male	(3) Female	(4) Full Sample	(5) Male	(6) Female
Price	0.0394	-0.0322	0.0926*	0.0358	-0.0346	0.0859*
	(0.0432)	(0.0691)	(0.0532)	(0.0424)	(0.0676)	(0.0521)
White-flesh	4.043***	3.633***	4.546***	4.058***	3.643***	4.576***
	(0.765)	(1.035)	(1.038)	(0.766)	(1.037)	(1.038)
Orange-flesh	6.900***	7.190***	6.806***	5.762***	7.067***	4.967***
	(0.930)	(1.312)	(1.388)	(1.202)	(1.941)	(1.743)
Yellow-flesh	4.014***	3.799***	4.384***	4.028***	3.810***	4.412***
	(0.755)	(0.993)	(1.058)	(0.756)	(0.995)	(1.058)
Household income	0.335	0.359	-0.109	-1.568	-1.072	-1.598
	(0.592)	(0.696)	(1.417)	(1.121)	(1.710)	(1.846)
Land owned	-0.0498	-0.0424	-0.0555	0.0932	0.0469	0.173
	(0.0568)	(0.0824)	(0.0969)	(0.133)	(0.289)	(0.195)
Education	-0.128	-0.163	-0.0870	0.0231	-0.0894	0.0766
	(0.149)	(0.199)	(0.237)	(0.280)	(0.459)	(0.380)
Age	-0.00446	-0.0117	0.00209	0.00441	-0.0292	0.0191
	(0.0101)	(0.0144)	(0.0146)	(0.0139)	(0.0318)	(0.0158)
Household size	0.00752	-0.000752	0.0197	-0.00203	0.00465	0.00564
	(0.0249)	(0.0389)	(0.0354)	(0.0500)	(0.107)	(0.0622)
Under 5 children	-0.0352	-0.0643	0.00523	0.122	0.0690	0.234
	(0.0926)	(0.131)	(0.125)	(0.144)	(0.225)	(0.204)
Prior information	1.188***	1.213*	1.119**	2.938**	1.088	5.045**
	(0.365)	(0.654)	(0.455)	(1.271)	(1.966)	(2.144)
"During information"	3.912***	4.070***	3.736***	4.005***	4.148***	3.988***
	(0.369)	(0.570)	(0.502)	(0.389)	(0.572)	(0.543)
Income*Priorinfo				2.448*	1.919	2.412
				(1.304)	(1.851)	(2.802)
Land*Priorinfo				-0.172	-0.0953	-0.349
				(0.148)	(0.302)	(0.224)
Education*Priorinfo				-0.191	-0.0775	-0.270
				(0.334)	(0.512)	(0.488)
Age*Priorinfo				-0.0160	0.0247	-0.0461
				(0.0205)	(0.0357)	(0.0317)
Household size*Priorinfo				0.0165	-0.00551	0.0189
				(0.0581)	(0.116)	(0.0756)
Children*Priorinfo				-0.241	-0.160	-0.391
				(0.183)	(0.273)	(0.260)
Observations	12,560	6,060	6,500	12,560	6,060	6,500
Choices	3140	1515	1625	3140	1515	1625
Respondents	628	303	325	628	303	325
Pseudo R-squared	0.734	0.765	0.707	0.736	0.766	0.714
Log likelihood	-1613	-688.2	-918.1	-1597	-683	-898

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Determinants of Sweet Potato Acceptance 3

Variables	(1) Full Sample	(2) Male	(3) Female	(4) Full Sample	(5) Male	(6) Female
Price	0.0394	-0.0322	0.0926*	0.0381	-0.0317	0.0963*
	(0.0432)	(0.0691)	(0.0532)	(0.0430)	(0.0686)	(0.0535)
White-flesh	4.043***	3.633***	4.546***	4.046***	3.630***	4.538***
	(0.765)	(1.035)	(1.038)	(0.764)	(1.035)	(1.038)
Orange-flesh	6.900***	7.190***	6.806***	6.632***	7.032***	6.440***
	(0.930)	(1.312)	(1.388)	(0.952)	(1.355)	(1.421)
White-flesh	4.014***	3.799***	4.384***	4.016***	3.796***	4.376***
	(0.755)	(0.993)	(1.058)	(0.755)	(0.993)	(1.058)
Household income	0.335	0.359	-0.109	0.299	0.373	-0.418
	(0.592)	(0.696)	(1.417)	(0.598)	(0.708)	(1.444)
Land owned	-0.0498	-0.0424	-0.0555	-0.0511	-0.0534	-0.0400
	(0.0568)	(0.0824)	(0.0969)	(0.0624)	(0.0934)	(0.100)
Education	-0.128	-0.163	-0.0870	-0.0983	-0.151	-0.0312
	(0.149)	(0.199)	(0.237)	(0.160)	(0.211)	(0.254)
Age	-0.00446	-0.0117	0.00209	0.00195	-0.00700	0.0100
	(0.0101)	(0.0144)	(0.0146)	(0.0110)	(0.0155)	(0.0159)
Household size	0.00752	-0.000752	0.0197	0.0112	0.00488	0.0232
	(0.0249)	(0.0389)	(0.0354)	(0.0276)	(0.0450)	(0.0378)
Under 5 children	-0.0352	-0.0643	0.00523	-0.0469	-0.0720	-0.0161
	(0.0926)	(0.131)	(0.125)	(0.0980)	(0.142)	(0.132)
Prior information	1.188***	1.213*	1.119**	1.172***	1.170*	1.136**
	(0.365)	(0.654)	(0.455)	(0.370)	(0.670)	(0.469)
"During" information	3.912***	4.070***	3.736***	7.951***	6.456***	10.21***
	(0.369)	(0.570)	(0.502)	(1.642)	(2.281)	(2.914)
Income*Duringinfo				4.716	1.076	16.01**
				(3.058)	(2.196)	(6.994)
Land*Duringinfo				-0.0249	0.178	-0.596**
				(0.115)	(0.189)	(0.236)
Education*Duringinfo				-0.692**	-0.312	-1.175**
				(0.315)	(0.414)	(0.463)
Age*Duringinfo				-0.0636***	-0.0514*	-0.0886***
				(0.0186)	(0.0295)	(0.0281)
H.size*Duringinfo				-0.0574	-0.0393	-0.0727
				(0.0485)	(0.0609)	(0.0669)
Children*Duringinfo				0.189	0.0540	0.371
				(0.212)	(0.202)	(0.308)
Observations	12,560	6,060	6,500	12,560	6,060	6,500
Choices	3140	1515	1625	3140	1515	1625
Respondents	628	303	325	628	303	325
Pseudo R-squared	0.734	0.765	0.707	0.736	0.766	0.711
Log likelihood	-1613	-688.2	-918.1	-1602	-685.4	-905.1

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1