Economic Valuation of Consumers' Preferences for Bush Yam Attributes: Implications for Breeding Commercial Crop in Ghana

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Abstract

Bush yam has been underutilized and underrated for long due to its undesirable attributes or traits, hence the commercial and food security potentials of the crop have been downgraded and unexploited. This paper, therefore, explored the Ghanaian bush yam consumers' decisionmaking behaviour towards the crop's cultivar selection and the values they place on its diverse attributes. With the aim of examining consumers' preference and willingness to pay for bush yam, we designed a choice experiment which was implemented through a cross-sectional survey, involving 390 bush yam consumers in the Western-North, Eastern and Central Cocoa Regions of Ghana. We employed Conditional logit to model consumers' preference behaviour for bush yam attributes from the choice experiment and, subsequently, computed their willingness-to-pay for each attribute, following the Lancaster consumer theory, using the ratios of specific product attributes and cost parameter. Our estimates of consumers' preferences for bush yam attribute revealed a highly significant preference for bigger tuber size, no colour change and sweet taste attributes. Age, education, marital status, and years of consumption were found to have influenced consumers' preferences for bush yam attributes. Furthermore, we found that bush yam consumers are willing to pay extra price value for improvement in tuber size, colour change and taste to meet their indicated preferences. We, therefore, recommend that, for breeding programmes to be more effective and sustainable towards developing a commercial cultivar, breeding institutions and policy makers should focus on the preferred attributes as indicated by consumers for a successful future commercialization of bush yam in the country.

***Keywords*:** Bush yam, attribute preference, choice experiment, willingness-to-pay, consumers, Ghana

Introduction

Yams are an important source of dietary energy, livelihoods and incomes in West Africa (Mensah, 2005). The West African yam belt accounts for over 90 percent of global yam production, with Nigeria, Ghana and Cote d'Ivoire being the top three producers, respectively (International Institute of Tropical Agriculture [IITA], 2014; Anokye, Tetteh & Otoo, 2014). In 2013, production in the yam belt was approximately 55 million tons on 4.4 million hectares of land (IITA, 2014), giving an average yield of 12.5 tons per hectare. In contrast to other food crops, yams are almost entirely consumed as food. Yam has a cultural value in West Africa as it symbolizes wealth and influence, and it is the food used for the celebration of some social ceremonies and festivals in West Africa (Obidiegwu & Akpabio, 2017; Idang 2015; Tetteh & Saakwa, 1991). Apart from the known commercial species of yam, there are other edible noncommercial yams, such as *D. burkilliana, D. minutiflora* and *D. praehensilis* (bush yam), which mostly grow as wild plants. These wild yams are mostly found in forest areas and were previously the main energy food for huntergatherers (Yasuoka, 2009; Sato, 2001). Among the edible wild yams, bush yam is said to be the most dependable staple food in Africa (Sato, 2006). Over the years, the crop has been tamed and grown on subsistence basis, predominantly in the cocoa-growing areas in the forest zone; and further in recent times, the commercial potential of the yam is strongly considered as a source of improving farm households' incomes and livelihoods. This calls for the concern of plant genetic breeders to come out with breeding cultivars with improved attributes to promote large scale commercial production by farmers.

Over the years, there have been initiatives to improve yams in Ghana and in West Africa. One of such interventions is the Root and Tuber Improvement and Marketing Programme (RTIMP). In 2008, the West Africa Agricultural Productivity Program (WAAPP) was initiated to develop improved technologies for roots and tubers in close collaboration with the RTIMP (Acheampong, *et al* 2017; World Bank 2007b). Nevertheless, these efforts have largely been targeted at the known commercial species and fail to exploit the prospects of edible bush yam. In Ghana, bush yam (known locally as '*Kookoase Bayerɛ,'* meaning 'yam grown under cocoa plantation') has been an important food and income security crop for cocoa farmers for years, but it has low consumption outside where it is grown due to some of its unwanted attributes

A major restriction to the commercialization and wider consumption of bush yam is the short postharvest shelf-life; and few days after harvesting, the tubers become hardened when cooked and, thus, difficult to eat (Abong, *et al*

2016; Dumont, Dansi, Zoundjihékpon & Vernier, 2005). This has limited the consumption and marketing of freshly harvested tubers to mainly the small production areas in the rural areas, hence, limiting supplies to urban markets. There exists a great diversity among cultivars with regard to post-harvest shelf life, cooking quality, yield and consumer preference. Bush yam has several benefits that can be exploited that would contribute significantly to the yam industry in Ghana, West Africa and the world at large. Bush yam has the potential of becoming the source of one of the most lucrative businesses in agriculture if it is well developed and managed.

The low rate of consumption of this unimproved bush yam in Ghana has been due to inability of breeding programmes to breed improved cultivars with desirable attributes for commercial production and consumption, since breeders had not properly factored into account the unique preferences and requirements of both the producers and consumers, or end users of the crop informed by appropriate research findings. This unimproved bush yam may be high yielding but may not be attractive to many consumers in the yam market unless they possess attributes that farmers and consumers consider more desirable. Studies on farmers' and consumers' crop variety choices consider crop as a bundle of multiple characteristics (Shiferaw, et al 2013; Goron, & Raizada, 2015; Wale, Mburu, Holm-Müller, & Zeller, 2005; Edmeades, Phaneuf, Smale, & Renkow, 2008). For bush yam, such bundle of attributes may include production characteristics (such as high yielding, early maturity and adaptability to harsh environments), consumption characteristics (such as taste, cookability, storability, multiple usage and colour), and other non-market benefits farmers and consumers get from the production and the consumption of yam. Bush yam possesses certain attributes that are superior to the equivalent traits in the commercial yam species that could be exploited for its improvement for commercial gains; and these desirable attributes can be identified through our current study findings.

In marketing, one is interested in how consumers react to products in the marketplace. Here, the marketer would want to know what makes a product attractive to a consumer and, thus, drives their willingness to pay a price for a product in a market. As such, and in the case of commercial bush yam, there must be tendencies for genetic breed improvement programmes to focus on certain attributes associated with production outputs, such as taste, size, postharvest shelf-life, or culinary properties, with an assumption of a profit maximizing objective function of farm-business when computing economic values of attributes to be included in a breeding programme (Bakulumpagi, 2018;

da Silva Dias, 2014). With our study objective of contributing to promote the commercialization of bush yam, we find the need to investigate the desirable attributes of this underutilized crop from the perspective of consumers. In order to design sustainable breed improvement programmes intended to breed improved commercial bush yam varieties, consumers' preferred attributes of bush yam need to be integrated into a breeding objective. The purpose of this paper was, therefore, to contribute to the development of improved bush yam cultivars by assessing consumers' preferences for bush yam attributes or traits.

This paper examined the Ghanaian bush yam consumers' decision-making behaviour towards cultivar selection and the values they place on different attributes as part of effort to scale up its production and consumption in Ghana and Africa. The paper specifically contributes to literature by identifying (1) bush yam attributes preferred by consumers and the importance of the crop's attributes on the consumers' choices (2) the determinants of consumers' preferences for bush yam attributes (3) consumers' willingness to pay for the preferred bush yam attributes. Our findings will help inform the crop breeding policy and programmes to successfully develop improved breeds and cultivars that will be desirable by both consumers. Here, the improved cultivars will enable farmers to produce commercial bush yams that consumers will not hesitate to purchase in the market. Accordingly, farmers will gain advantage of having ready and good market guaranteed for their produce, thereby getting stable incomes. The consumers will also be advantaged by getting value for their money, since they would now patronize bush yam produced to meet their preferences.

Literature Review

Theoretical Framework

Choice decisions, which are the underlying framework for choice experiments, are commonplace activities in all societies either at an individual, group, or organizational level (Ouma, 2007). Choosing comes about in several ways, for example, accepting one outcome and rejecting others, expressed through active responses, such as choosing to use certain products or services through purchases, or through passive responses, such as supporting particular views over an issue of interest (Louviere, Hensher, Swait & Adamowicz, 2000). The theoretical framework of choice experiments is derived from Lancasterian consumer theory, discrete choice and random utility theory.

The foundation for most microeconomic models of consumer behaviour is the maximization of a utility function subject to a budget constraint. According to Lancaster (1966), the essential point of departure of his consumer theory from classical consumer theory relevant to choose experiments is the claim that utility is derived from traits or attributes of goods rather than the good itself. This indicates that goods are either used based on individual attributes or combination of attributes in order to produce the satisfaction that is the source of a decision maker's utility. This is the basic point of departure from the traditional economic theory of demand, which assumes that goods are the direct objects of utility.

Discrete choice theory has provided a simple and direct approach to choose decisions, especially the one formulated for economic analysis by McFadden (1986). In discrete choice framework, the set of alternatives, called the choice set, are naturally discontinuous and must exhibit three characteristics, as described by Train (2003). Foremost, the alternatives must be mutually exclusive from the decision maker's perspective. Secondly, the choice set must be exhaustive, so that all possible alternatives are included. Finally, the number of alternatives must be finite. A universal set of alternatives denoted C is assumed to exist. The constraints, for example, the budget constraint faced by an individual decision maker n determines his or her choice set $C_n \subseteq C$. The third characteristic is restrictive and is the defining characteristic of discrete choice models, which distinguishes their realm of application from that of regression models. The assumption of rational decision makers in consumer theory is maintained. Rationality means that when decision makers are faced with a set of possible consumption bundles of goods, they assign preferences to each of the various bundles and then choose the most preferred bundle from the set of affordable alternatives. Consistency and transitivity of preferences are also assumed.

The concept of random utility theory, which was created by Thurstone (1927) and later improved by Luce in 1959 and further by Marschak (1960), forms an important framework for discrete choice modeling. Whereas classic consumer theory assumes deterministic behaviour, random utility theory introduces the concept that individual choice behaviour is intrinsically probabilistic. The notion behind random utility theory is that while the decision maker may have perfect information regarding his/her utility function, the analyst lacks precise knowledge about the decision maker's decision processes and, therefore, uncertainty must be taken into account in the utility function (Ouma, 2007). In addition, the deterministic discrete choice framework does not take into account the existence of unobserved heterogeneity in preferences

among decision makers with identical choice sets, attributes of alternatives and socio-economic characteristics. Therefore, utility is modeled as a random variable, consisting of an observable, deterministic component and an unobservable (random) component. The random utility theory assumes that an individual derives utility by buying or choosing an alternative from a set of alternatives. A utility maximizing behaviour is assumed, that is, a decision maker is assumed to buy or choose the utility maximizing alternative.

The Survey

The study was carried out in the Central, Eastern and Western-North Cocoa Growing Regions of Ghana and we used a mixed research approach and orthogonal factorial experimental designs. The target population was all bush yam consumers mainly from communities in six districts of the Central, Eastern and Western North Cocoa Growing Regions of Ghana. Bush yam consumers were identified as ideal target population for the choice experiment in order to ensure that the targeted bush yam consumers must have used or eaten bush yam before and are familiar with the attributes of bush yam.

In Ghana, bush yam (popularly known as *"Kokoase bayere"*) thrives well in all cocoa growing areas (i.e., all the seven cocoa growing regions). Its production and consumption are also becoming common in all cocoa growing regions. We thus considered it appropriate to give all cocoa growing regions equal chances of being part of the study. We, therefore, had to use the simple random sampling technique to select three regions from the seven cocoa growing regions in Ghana. We purposively selected two districts from each of the three selected regions and this was based on the perceived levels of bush yam production and consumption in those districts based on information obtained from a focus group discussion that preceded the quantitative survey. These districts were Abura-Asebu-Kwamankese and Twifo Hemang Lower Denkyira Districts in the Central Region; Upper Manya Krobo and Yilo Krobo Municipality in the Eastern Region, and Bibiani-Anhwiaso-Bekwai District and Sefwi Wiawso Municipality in the Western North Region. A total of 390 consumers were accidentally selected during a survey at market centres and villages in the selected districts, since the total number of bush yam consumers was difficult to obtain. The number 390 was made up of 146 consumers from Western Region, 119 consumers from Central Region and 125 consumers from Eastern Region. The rule of thumb for determining a suitable sample size for DCE proposed by Pearmain, Swanson, Kroes and Bradley (1991) suggests that,

for Discrete Choice Experiment (DCE) designs, sample sizes over 100 are able to provide a basis for modelling preference data. Further in their empirical experience, Lancsar and Louviere (2008) asserted that one rarely requires more than 20 respondents per questionnaire version to estimate reliable models but undertaking significant post hoc analysis to identify and estimate covariate effects invariably requires larger sample size. Hence, the number 390 was considered appropriate for a meaningful statistical analysis to be made.

With the help of an interview schedule instrumentation for data collection, face-to-face interviews were conducted from March to April, 2017 to collect cross-sectional choice experiment survey data from the 390 consumers who agreed to be part of the survey. We conducted interviews by literally explaining the choice experiment in the local dialect (Twi and Krobo) common to the respondents, since most of the respondents could neither speak nor understand the English language to ensure better communication and retrieval of reliable and accurate responses. The data were collected by the researchers and four trained research assistants.

The Choice Experiment

We used the fractional factorial designs to generate the choice set by selecting subsets of choice sets from the full factorial design. With the help of the information obtained through a reconnaissance survey, we selected five relevant bush yam attributes and determined their attributes levels to guide the design of the experiment for farmers. The bush yam attributes, and their levels used in the choice experiment are summarized, as presented in Table 1. Our full factorial design would have resulted in 96 (i.e., 3×2×2×2×2×2) generic choice sets for the study. In fact, a full factorial design is very large and not easy to manage in a choice experiment. We realised it was not practically feasible to work with such a large number of choice sets, and so a partially orthogonal main effect design was eventually generated from the full factorial design to create feasible choice sets. This was made possible, using experimental design techniques in SPSS Conjoint software (SPSS, 2008) to obtain an orthogonal design, which consisted of only the main effects. The design resulted in 40 fractional factorial profile alternatives.

We used the choice sets from our design to construct profiles, describing the differences in attributes and levels of bush yam, and these we presented to respondents in hypothetical settings. The profile alternatives were then grouped into 10 choice cards with four profile alternatives forming the choice sets. The

generic choice sets did not refer to any particular variety or label, but rather were members of a class of alternatives. The alternatives were simply bundles of attributes and the objective was to assess which attributes were important drivers of choice.

Table 1: *Attributes, Description, Attribute Levels, Codes and Expected sign, for Consumers*

Attributes	**Description**	**Attribute Levels**	**Codes**	**Expected si**
Purchase Price	The purchase of attribute will be based on the selling price pe tuber (5kg)	• price • This • <GH₵5.00 GH₵5.00-GH₵10.00 >GH₵10.00	1 2 3	Negative
Taste	Whether a particular bush yam cultivar tastes good or n	• • Sweet taste 1 Tasteless 0		Positive
Tuber size	Whether the is big or	• tuber • small Big Size 1 Small Size 0		Positive
Storability	Whether a particular culti is able to maintain its quality days or weeks or mont	• • At most a mont 0 More than month 1		Positive
Cookability	Ability of a particular bush yam cultivar to cook well	• • Good cookabili 1 Bad cookability 0		Positive

Colour chang	Whether a particular culti is able to maintain its colour after peeling or cutti	• No colour chan • Colour change	1 0	Positive

Source: Reconnaissance Survey (2016)

This study used verbal descriptions, and it was deemed plausible due to the fact that it was difficult to use the pictorial method. This is because almost all the attributes of bush yam used were qualitative traits in nature, though the visual materials would have helped respondents to process the information faster and in a more accurate way. Cards with the different levels of attributes were used to demonstrate each bush yam profile to the respondents. We did not include no "opt-out" in the choice sets, which is contrast to the traditional choice experiment, and so the consumers had to choose amongst one of the alternatives.

In conducting the choice experiment administration, we introduced ten choice sets to the respondents. We then asked them to choose one out of four given bush yam profiles from each choice set after explaining the whole experiment. At the end of the survey, each consumer made ten choices. Data were analysed, using descriptive statistics and regression. Table 2 presents an example of a choice card presented to the consumers.

Table 2: *An Example of a Choice Card Presented to Consumers*
Assuming that the following bush yam cultivars were your ONLY choices, which one would you prefer to buy and consume?

Attributes	***Bush Yam A***	***Bush Yam B***	***Bush Yam C***	***Bush Yam D***
Taste	Sweet Taste	Tasteless	Sweet Taste	Tasteless
Tuber Size	Big Size	Small Size	Big Size	Small Size
Storability	More than a month	At most a month	At most a month	More than a month
Cookability	Good Cookability	Bad Cookability	Bad Cookability	Good Cookability

Tuber Colour Change	No Colour Change	Colour Change	Colour Change	No Colour Change
Purchase Price (5kg)	> GH₵10.00	< GH₵5.00	GH₵5.00- GH₵10.00 >	GH₵10.00
I would prefer to buy	☐	☐	☐	☐

Source: Survey Questionnaire, Dadzie *et al.* (2016)

The Theoretical Model Explained: Conditional Logit

Independent and identically distributed (IID) error terms with a Type I extreme value distribution are assumed in the conditional logit model. The objective or interest of this study was to determine the importance of the preferred attributes of bush yam, and the willingness-to-pay for those attributes by consumers. The conditional logit model permitted the estimation of both interests and, therefore, was used. Meanwhile, all the information regarding some of the characteristics that make up the decision process was not in the possession of the researchers and so the random utility model split the total utility in two parts. According to Louviere et al. (2000), the first part is a deterministic or the observed component of utility function based on product attributes $k(V_{ik})$, and the other part is a stochastic, or random unobserved error component (ε_{ik}); hence, the resultant utility equation is given:

$$U_{ik} = V_{ik} + \varepsilon_{ik}, \; k = \text{alternative 1, 2, 3 and 4} \quad (1)$$

where U_{ik} is the utility of the i^{th} individual consumer choosing the k^{th} bush yam alternative (e.g., Bush Yam A in Table 2). The individual consumer i will choose product k only if $U_{ik} > U_{ih}$, where h represents an alternative product (e.g., Bush Yam B, or Bush Yam C or Bush Yam D in Table 2). The probability that consumer i will prefer alternative k out of a set of h alternatives is:

$$P_{ik} = P(V_{ik} + \varepsilon_{ik} \geq V_{ih} + \varepsilon_{ih}; \forall h \neq k), \quad (2)$$

for all h in the choice set not equal to k.

Assuming that the observable utility component (V_{ik}) is a linear function of the perceived product attributes (*x=price, taste, tuber size, storability, cookability and colour change*) and there are *w* attributes for each alternative (the number of bush yam attributes, *w* considered in our case is 6), the function of this utility components is given:

$$V_{ik} = \sum_{w=1}^{k} \beta_w x_{ikw} = \beta' X_{ikw} \quad w = \text{ attributes 1, 2, 3, 4, 5, and 6} \qquad (3)$$

where x_{ikw} is the w^{th} attribute value for the k^{th} alternative for the i^{th} consumer, and β_w represents the coefficients to be estimated, which represent the value the consumer places on a particular attribute.

Again, assuming that the error term (ε_{ik}) in the utility function is independent and identically distributed with an extreme value distribution and scale parameter equal to 1, the logistic model results (McFadden, 1974). This model is more appropriate and makes it possible to study the determination of the factors influencing consumers' preference when the explanatory variables consist of individual specific characteristics and these characteristics are the determinants of the choice (Bekele, 2004). In its multivariate generalization, it gives rise to the conditional logit model. In a conditional logit framework, the probability that consumer *i* chooses alternative *k* is:

$$P_{ik} = \frac{\exp(V_{ik})}{\sum_{k} \exp(V_{ik})} = \frac{\exp(x_{ik}'\beta)}{\sum_{k} \exp(x_{ik}'\beta)} \qquad (4)$$

The IIA condition is usually tested with the Hausman-McFadden test (McFadden et al., 1976; Hensher et al., 2005). For the calculation of the test statistic, each alternative is separately excluded from the model, and the parameters for restricted and unrestricted models are estimated as well as their variance–covariance matrices. The test criterion is chi-square distributed with the degrees of freedom given by the number of estimated parameters. To measure how well the model fits the data, the goodness-of-fit statistics on the basis of the log-likelihood function are usually used (for instance, Agresti, 2002). There exist many such statistics (Pecáková, 2007), but the most used in literature on discrete choice modelling, and which has been adopted in this paper, is McFadden's statistic:

$$D_{MF} = \frac{\ln L_0 - \ln L_E}{\ln L_0}, \qquad (5)$$

where L_o is the likelihood of the intercept-only model and L_E is the likelihood of the estimated model. For the purposes of comparison of models, the loglikelihood ratio statistic was used, and it is the statistic for testing the null hypothesis that, the restricted model (R) holds against the alternative unrestricted model (U):

$$D = -2(\ln L_R - \ln L_U) \quad (6)$$

It has an approximately chi-square distribution with degrees of freedom equal to the difference in the number of parameters between both compared models.

Empirical model specification of consumer's preferences

The estimation of the models requires a specification of the functional form of the utility function. In this paper, a linear parameters utility function is assumed. The vector X_{ik} in equation 4 above contains bush yam attributes (price, taste, tuber size, storability, cookability and colour change) and attribute levels of bush yam profiles from the choice experiment (see Table 1). The choice experiment was designed with the assumption that the observable utility function follows a strictly additive form. The model was specified so that the probability of selecting a particular bush yam profile was a function of attributes of that profile. That is, for the population represented by the sample, indirect utility from bush yam attributes takes the form below:

$$V_{Cnk} = \beta_1 X_{pur.price} + \beta_2 X_{taste} + \beta_3 X_{tubersize} + \beta_4 X_{storage} + \beta_5 X_{cookability} + \beta_6 X_{colourchange} + \varepsilon \quad (7)$$

where $\beta_{1\text{-}6}$ refers to the vector of coefficients associated with the vector of attributes describing the bush yam attributes preferred by consumers.

Estimated coefficient β, is interpreted in terms of the relationship between the explanatory variables and the probability of choice. The constant term was dropped in the above specification of the indirect utility function because the choice sets do not include a status quo or an opt-out option (Bateman et al., 2003). This is a base model which specifies the utility function with the main effects variables in the choice experiment. Each consumer made repeated choices for ten bush yam profiles.

Several socio-economic factors influence the consumer's preference and choice behaviour in a choice model framework. These factors entered into the models as interactions with the *X's* in the utility function in equation (7). Accordingly, the indirect utility function became as presented in equation (8):

$$V_{nj} = \beta_1 X_{pur.price} + \beta_2 X_{taste} + \beta_3 X_{storage} + \beta_4 X_{tubersize} + \beta_5 X_{cookability} + \beta_6 X_{colourchange}$$
$$\partial_1 \left(X_{pur.price} * age \right) + ... \partial_6 \left(X_{colourchange} * age \right) + ... \partial_n \left(X_{colourchange} * \text{last se. xtics} \right) + \varepsilon$$

(8)

Equation 8 is the base model which specifies the utility function with the interactive effects variables in the choice experiment.

The Estimation of Willingness to Pay (WTP)

The choice modelling results were used to estimate implicit prices or willingness to pay (WTP) values of the different attributes of bush yam. In the discrete choice model used, decision makers were consumers and the alternatives represent bush yam profiles available. With the assumption that the deterministic component of the consumer's utility function is linear in the explanatory variables (bush yam attributes, *X*), the simple random utility function for this can be expressed as:

$$U_{ik} = \alpha_k + \beta_i X_k + \beta_p P_k + \varepsilon_{ik}$$

(9)

where the constant α_k denotes individual's choice-specific intercept for alternative *k*, β_p is the coefficient for the cost parameter bush yam attribute and β_i represents the coefficient vectors for the other attributes of bush yam, for i^{th} individual consumer. The P_k denotes the cost parameter or price of alternative *k*, which was included as one of the attributes of the bush yam choice alternative, and X_k denotes the other observed attributes of bush yam choice alternative *k*. β_p and β_i were assumed to be random. The implicit prices for the attributes X_k were then estimated as the rate of change in the attributes divided by the rate of change of the cost parameter (marginal rate of substitution) represented as:

$$-\frac{\partial U/\partial X_k}{\partial U/\partial P_k} = -\frac{\beta_i}{\beta_p} \quad (10)$$

where β_i is the coefficient of attribute *i* and β_p is the price premium coefficient.

Results of the Study

Bush yam consumers' demographic characteristics

The outcome of the study, as presented in Table 3, suggests that about 62 percent of the respondents were females for the pooled sample with majority of this percentage coming from the Central Region followed by Western North Region. This contradicts the findings by Aidoo (2009), who reported about 55 percent of all households (consumers of yam) interviewed were male-headed, which was a reflection of the national situation, where majority (70.5%) of households in Ghana are male-headed (GSS, 2008). This outcome of the study may be because the data were collected mostly at market centres where, in most cases, women were found either buying or selling foodstuffs, hence the female dominance in this study.

The result in Table 3 on age distribution indicates that the average age of consumers was 34.9±12 with majority (82.1%) of them between 21 and 60 years for the pooled sample, and about 9 percent less than or equal to 20 years. This is similar to Aidoo's (2009) finding, who found that majority of consumers in Accra (Greater Accra Region), Kumasi (Ashanti Region), Tamale (Northern Region) and Techiman (Brong-Ahafo Region) were between 30 and 65 years of age, and this group of consumers constituted 77 percent of the sample used in that study.

On the educational level of consumers, it was realized in this study that 84 percent of them have had some level of formal education (from primary school through to the tertiary level). Out of those who had formal education, 68 percent of them have had up to the Senior High School (SHS) level. Again, Aidoo (2009) reported that majority (40%) of consumers in Accra, Kumasi, Tamale and Techiman had either no formal education or attained only basic formal education, whereas 31.6 percent of them have attained secondary or pre-university education and 28.3 percent at the tertiary levels. This also indicates that most of them have attained some level of formal education.

Table 3 also shows that more than half of the respondents were married, indicating that most households in the study areas consume bush yam as part of their meals. This study also reports a mean year of consumption to be 17.2±12 years, demonstrating that most people in the study areas have been consuming bush yam for some years now. This means that they are knowledgeable when it comes to bush yam, and that the right people were selected for this study.

Table 3: *Bush Yam Consumers' Demographic Characteristics*

Variables	**Western-N Region**		**Eastern Region**		**Central Region**	
	Freq	%	Freq	%	Freq	%
Sex						
Male	54	37.0	57	52.3	22	18.5
Female	92	63.0	52	47.7	97	81.5
Age						
Mean = 34.9, SD = 12.1,	**Mini = 15, Max = 70**					
20 & below	16	10.1	15	12.0	3	2.5
21-30	39	26.7	36	28.8	70	58.8
31-40	39	26.7	39	31.2	27	22.7
41-50	28	19.2	18	14.4	12	10.1
51-60	15	10.3	6	4.8	9	7.6
61 through 70	6	4.1	8	6.4	-	-
Educational Level						
No formal education	25	17.1	18	14.4	17	14.3
Primary school	1	.7	2	1.6	-	-
JHS/middle school	76	52.1	48	38.4	22	18.5
SHS	25	17.1	29	23.2	23	19.3
Tertiary	19	13.0	28	22.4	57	47.9
Marital Status						
Single	47	32.2	47	37.6	56	47.1
Married	99	67.8	77	61.6	55	46.2
Widow/widower	-	-	1	.8	8	6.7
Years of consumption						
Mean = 17.2, SD = 11.5,	**Iini = 1, Max. = 50**					
Mean	16.0		19.1		16.6	
Minimum	5		2		1	

Maximum	50	50	40
Standard deviation	11.7	11.9	10.7
Mode	10	20	20
Median	12	18	18

n

n = 390

Discussion of Results

Consumers Ranking of Bush Yam Attributes Importance

This paper used Kendall's coefficient of concordance to rank the attributes of bush yam. Bush yam consumers rated how important the attributes are to their choice of a particular bush yam profile. The researchers assigned scores to the ratings of the responses, where 1= most important preferred attributes, and 6 being least important preferred attribute. Table 4 presents the descriptive statistics of the bush yam attributes included in the choice experiment as well as the rankings of these attributes by the consumers. It is worth mentioning that respondents were asked to rank the bush yam attributes using the scores (1-6).

The result shows that taste was rated to be the most important attribute consumers consider when making the decision to choose a particular profile of bush yam they prefer and so it was ranked first. This is consistent when it comes to making a rational decision about the quality of a food stuff, and it is not surprising that the respondents considered taste to be paramount among the other attributes, most importantly, when the yam in question is tagged not to have a good taste by most Ghanaians. This was followed by the yam's ability to store for long (storability). This was actually expected, since it is believed by most people that the yam has short shelf-life, and we expected that storability would be one of the most important attributes consumers would look out for when buying bush yam. Again, the size of the tubers, cookability and colour change took the third, fourth and the fifth positions, respectively, in terms of the rankings. Price, which was one of the variables included in the experiment, is rated least, which means that all the

consumers would not want to consider the price of the yam before purchasing. This also suggests that once consumers are satisfied with the qualities of the bush yam, they will go ahead and buy without considering how much it costs.

The result of the Kendall's W test statistics, as indicated in Table 4, shows that an agreement exists among consumers on the ranking of bush yam attributes at 1% alpha level with 5 degrees of freedom. However, Kendall's coefficient of concordance (W) of 0.375 indicates a moderate degree of unanimity among consumers, which could be attributed to different geographical areas of the study areas. In order words, bush yam consumers in the study areas agreed on the rankings of the attributes that affect their preference but at moderate degree.

Table 4: *Descriptive Statistics of the Attributes Included in the Choice Experiment*

ATTRIBUTES	**N**	**MEAN**	**STD. DEVIATION**	**MEAN RANK**
Price	2988	5.07	1.525	6th
Taste	2988	1.60	1.216	1st
Size	2988	3.37	1.519	3rd
Storability	2988	3.24	1.120	2nd
Cookability	2988	3.60	1.302	4th
Colour Change	2988	4.11	1.364	5th
Test Statistics				
N	2988			
Kendall's W	.375			
Chi-Square	5601.278			
Df	5			
Asymp. Sig.	.000			

Consumers' Bush Yam Attributes Preferences

This part presents the results of the econometric modelling estimations of consumers' choice behaviour and bush yam attributes preferences. A total of 299

complete choice experiment interviews were carried out, yielding panel data of 2990 complete choice sets. Table 5 presents the results of the maximum likelihood estimates for consumers' preferences for bush yam attributes from conditional logit estimates for the pooled sample and the subsamples. As can be seen from the results (Table 5), most of the regressors in the whole sample are statistically significant, which suggests that the attributes selected for the choice experiment survey were generally what consumers would consider to be among the most important factors when buying bush yam. This stands to suggest that the attributes selection in the design of the choice experiments are appropriate to meet consumers' preference as was also the case of the study of Okoffo et al (2016). The results (Table 5) from the whole population show that all the choice specific attributes are significant except for the *Cookability* attribute that showed insignificant but positive coefficient. This shows that they are important factors in the choice of bush yam and that any of the significant attributes increases the probability of selecting bush yam with those attributes as also implied in the interpretation of the findings of Mohanty *et al* (2019).

The coefficients of *Purchased Price* and *Storability* are, of course, negative, and significant as expected. This means that consumers prefer lower prices for the attributes and they will not select bush yam with higher price. The consumers also want bush yam that can be stored for a long time and, therefore, their negative utilities, for those two attributes are not surprising. Noteworthy, however, the price or affordability is the most important consideration when shopping (Ndungu, 2013), hence bush yam needs to be perceived as affordable in order to increase consumption by consumers.

The result also shows that *PurchasedPrice* is negatively significant at 1% alpha level in the pooled sample, but negatively insignificant at 1% alpha level across the subsamples. *Taste* attribute is also positive and statistically significant at 1% alpha level in the pooled sample but positively insignificant at 1% alpha level across the subsamples. *TuberSize* and *Storability* attributes of bush yam are statistically significant at 1% alpha level in both the pooled sample and the subsamples, which means that all consumers who participated in the study pay attention to the tuber size and storage ability of bush yam when making a choice. Whereas *cookability* attribute is positive and not statistically significant in the pooled sample and Central Region sub-sample, it is positive and statistically significant in the Western North and Eastern Regions sub-samples at 1% alpha level, indicating that consumers in the Western North and Eastern Regions are very much interested in the ability of bush yam to cook well.

Table 5: *Maximum Likelihood Estimates from Choice Experiment Data for Consumers Using Conditional Logit*

Attributes	Coefficients	Std Errors	Sig.
Estimates from Pooled Data			
PurchasedPrice	-.271	.041	.000***
Taste	.206	.039	.000***
TuberSize	.480	.034	.000***
Storability	-.170	.024	.000***
Cookability	.007	.034	.831
ColourChange	.363	.036	.000***
Estimates from Western Region -.066			
PurchasedPrice		.071	.355
Taste	.116	.065	.076*
TuberSize	.574	.058	.000***
Storability	-.289	.044	.000***
Cookability	.797	.077	.000***
Colour Change	.375	.058	.000***
Estimates from Eastern Region			
PurchasedPrice	-.083	.082	.312
Taste	.046	.066	.481
TuberSize	.326	.063	.000***
Storability	-.199	.048	.000***
Cookability	.392	.074	.000***
ColourChange	.130	.066	.051*
Estimates from Central Region			
PurchasedPrice	-.324	.138	.019**
Taste	.057	.110	.600
TuberSize	.312	.082	.000***
Storability	-.292	.062	.000***
Cookability	.151	.088	.088*
ColourChange	.091	.092	.324
Omnibus test of model coefficients			
Pooled Data			
		.000	

Chi-square	508.920	
-2log Likelihood	42650.104	
WesternNorth Region		
Chi-square	167.687	.000
-2log Likelihood	13024.630	
Eastern Region Chi-square	54.148	.000
-2log Likelihood	9192.274	
Central Region Chi-square	39.241	.000
-2log Likelihood	3816.101	

***significant at 1%, **significant at 5%, *significant at 10%

Hypotheses testing

To compare if parameter estimates of the pooled model for consumers are shared across the three different study areas or regions, separate conditional logit models have been calculated to obtain estimates for each study area. The hypotheses tested were:

a. H_0: $\beta_{Pooled\ sample} = \beta_{Western\ Region}$ and H_A: $\beta_{joint\ sample} \neq \beta_{Western\ Region}$
b. H_0: $\beta_{Pooled\ sample} = \beta_{Eastern\ Region}$ and H_A: $\beta_{joint\ sample} \neq \beta_{Eastern\ Region}$
c. H_0: $\beta_{Pooled\ sample} = \beta_{Central\ Region}$ and H_A: $\beta_{joint\ sample} \neq \beta_{Central\ Region}$

The null hypotheses that state the parameter estimates of all the models from the pooled sample and the sub-samples are equal were tested against the alternative hypotheses that they were not equal. This has been done by checking if the loglikelihood function from the conditional logit estimation for the different subsamples is significantly larger than the pooled sample log-likelihood function. The results from hypotheses tests are as shown below.

$L_{Pooled\ sample}$ = 42650.104 and $L_{Western\ Region}$ = 13024.630

$L_{Pooled\ sample}$ = 42650.104 and $L_{Eastern\ Region}$ = 9192.274

$L_{Pooled\ sample}$ = 42650.104 and $L_{Central\ Region}$ = 3816.101

The null hypotheses a, b and c were rejected since results from hypothesis test were statistically different and, consequently, should not be put together.

Attributes consumers consider important when making choice

From the results in the estimates in Table 5, the top three attributes' consumers consider very important in making a decision to choose bush yam were the size, colour change and the taste. Consumers consider size of bush yam as an important attribute in taking a decision. This is followed by whether or not the colour of the tuber flesh changes after cutting or peeling, and then, thirdly, whether the bush yam has a sweet taste, tasteless or bitter.

Influence of consumers' demographic characteristics on their choice of attributes

In this study, we interacted numerous demographic variables with the attribute levels to assess their influence on attribute preferences, using conditional logit models. The results were reported after the interaction terms were tested by removing the insignificant interaction terms as revealed by their p-values one after the other and then re-estimating the model over and over again until only the significant ones remained. This means that, out of the 31 possible interactions, only those interactions that were significant at 10% level are reported. The results are, therefore, presented in Table 6.

The results in Table 6 revealed that age, education, marital status, and years of consumption affect consumers' choices and preferences for bush yam attributes at 1% significance level. The results indicate that when the socio-demographic characteristics are included, *Cookability*, which was not significant, is now statistically positively significant (this shows that most of the positive utility derived from *Cookability* attributes of bush yam is explained by the interaction terms between this attribute and the demographic characteristics). However, *Purchased Price* and *Colour Change* attributes are now statistically insignificant while *Taste*, *Tuber Size*, and *Storability* remained statistically significant. This shows that the inclusion of socio-economic characteristics of decision makers is one way of explicitly accounting for observed preference heterogeneity, as explained by specific observable characteristics of consumers in the model (Fungo et al, 2016; Zulu, 2019; Fungo et al, 2018). The interaction between *Educ* (education) and *Taste* was statistically and positively significant but negatively significant with *Cookability*. This means that consumers with higher educational levels are likely to choose bush yam which cooks well and has good or sweet taste. This finding is consistent with that of Asante, Osei-Asare, and Kuwornu (2016).

Furthermore, the interaction effect between *Yrs_Consum* (number of years of consumption) and *Size* and *Cookability* produced a negative significance at 1% level, indicating that consumers who have consumed yam for so long are more

likely to consider size of the yam tuber and the colour change when peeled or cut in their preferences for bush yam. The interaction between *Age* and *Colour Change* is also positive and significant, indicating that older consumers prefer bush yam with no colour change after peeling. Also, the interaction between *Marital Status* and *Size* is positive and significant, which means that consumers' marital statuses affect their choice of bush yam in terms of size. This may be due to the fact that people who are married with children would choose big size tubers for satisfaction.

Test of hypothesis: Here, the null hypothesis that states the regression parameters for the restricted and the unrestricted models (for consumers) are equal was rejected under a log-likelihood ratio test. The test statistics was 24554.458, which is larger than 300.234, the critical value of chi-square distribution at 12 degrees of freedom and 1% significance level. This implies that the conditional logit model with interactions which allows taste variations fits the data better than the conditional logit model without interactions that assumes fixed taste parameters.

Table 6: *Conditional Logit Estimates for Bush Yam Attributes with Consumers' Demographic Factors*

Variables	**Coefficient**	**Standard Error**	**Sig.**
PurchasedPrice	-.072	.050	.148
Taste	-.425	.086	.000***
TuberSize	.381	.088	.000***
Storability	-.273	.029	.000***
Cookability	.940	.093	.000***
ColourChange	.121	.081	.134
Educ*Taste	.180	.029	.000***
MaritalStatus*TuberSize	.154	.052	.003***
TuberSize*Yrs_Consum	-.009	.003	.000***
Cookability*Educ	-.152	.029	.000***
Age*ColourChange	.010	.002	.000***
ColourChange*Yrs_Consu	-.011	.003	.000***
Omnibus test of model coefficients			
Chi-square	300.234	.000	
-2 Log Likelihood	30372.875		

***significant at 1%, **significant at 5%, *significant at 10%.

Consumers' Willingness to Pay (WTP) for Bush Yam Attributes

The marginal attribute prices from the conditional logit model have been derived, using individual conditional constrained parameter estimates and are presented in Table 7. The estimates are validated, using the survey data and current market prices. The result in Table 7 indicates that for the pooled sample, consumers were willing to pay GH₵0.76 more for bush yam *taste* attribute in order to obtain an improvement in the taste of bush yam. Again, the consumers are willing to pay GH₵1.77 more for an increase in size of bush yam tubers, GH₵0.63 more for an increase in the period of storage (*Storability* attribute), GH₵0.03 more for an improvement in *Cookability* attribute and GH₵1.34 more for an improvement in the *Colour Change* attribute. These values indicate that consumers value size and colour change more than the other attributes.

The WTP results from the three regions of study show that consumers from Western Region are willing to pay more than their counterparts in the other regions. Moreover, while the consumers in the Western and Eastern Regions value *Cookability* attribute more than other attributes, those from the Central Region value *Size* attribute more than other attributes. It can be realized that WTP value from Western Region are very high, indicating the importance consumers place on the attributes of bush yam.

The results prove that consumers do not look for a single attribute of the bush yam when making their selection decisions but also other more important, but non-tradable attributes, like *Colour Change,* and thus forcing them to make difficult trade-offs. Several studies have been conducted to examine how consumers evaluate different product attributes in numerous food products, including yam. For instance, Bech-Larsem, Grunert and Poulsen (2001) indicated that health, nutrition, taste, price, quality, colour, storability, cookability and convenience, among other attributes, are some of the criteria consumers use to determine which product (yam) is more attractive. Blaylock, Smallwood, Kassel, Variyam and Aldrich (1999) also stated that consumers face many trade-offs in their food choices, for example, between nutrition and price, as well as nutrition and convenience. The findings from this study also support the study by Bonilla (2010), who found that United State consumers were willing to make trade-offs to obtain packaging and labelling attributes when choosing 100% fruit juices.

Table 7: *Consumers' Willingness to Pay (WTP) Estimates*

	WTP (GH₵)			
Attributes	Pooled Dat	Western Nor	Eastern	Central
Taste	0.76	1.76	0.55	0.18
Size	1.77	8.70	3.93	0.96
Storability	0.63	4.38	2.40	0.90
Cookability	0.03	12.08	4.72	0.47
Colour Change	1.34	5.68	1.57	0.28

NB: US$1.00 = GH₵4.40 at the time data was collected

Conclusion

Our examination of consumers' preferences for bush yam attributes, using discrete choice model (conditional logit) revealed that cultivar attributes, such as *tuber size*, *colour change* and *taste,* were their most preferred attributes of bush yam. It was also concluded that consumers have strong preferences for *tuber size*, no *colour change* and *taste* more than the other attributes of bush yam. The age, educational level, marital status, and years of consumption affected consumers' preferences for bush yam attributes. The estimated willingness to pay amounts revealed that consumers were willing to pay more for an improvement in *tuber size*, the *colour change* and the *taste* attributes of bush yam. Consumers at this point cannot accept bush yam with bad taste and unpleasant colour change after cutting or peeling. This has an important implication for breeding of bush yam varieties and for subsequent commercialization.

The policy implication of the findings in this paper is in the area of breeding priority setting. The results show that consumers attach greater importance to certain bush yam attributes. Therefore, for any breeding programme, given that consumers' preferences for cultivar attributes determine, to a large extent, their choice of bush yam, breeders should satisfy the demands of the consumers of bush yam. The National Agricultural Research Systems (NARS), which mainly deals with crop breeding programmes in Ghana, should, therefore, prioritize these attributes in their direct or supportive breeding programmes in the future to satisfy consumers' taste for bush yam.

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We the authors of this paper hereby declare that there are no competing interests in this publication.

References

Abong, G. O., Ndanyi, V. C. M., Kaaya, A., Shibairo, S. I., Okoth, M. W., & Lamuka, P. O. (2016). A review of production, post-harvest handling and marketing of sweetpotatoes in Kenya and Uganda.

Acheampong, P. P., Nimo-Wiredu, A., Amengor, N. E., Nsiah-Frimpong, B., Haleegoah, J., Adu-Appiah, A., & Adogoba, D. (2017). Root and Tuber Crops Technologies Adoption and Impact Study in Ghana: The Case of Improved Cassava Technologies. *West Africa Agricultural Productivity Programme, Crops Research Institute and Savannah Agricultural Research Institute, Accra*.

Aidoo, R. (2009). *An analysis of yam consumption patterns in Ghanaian urban communities*. Unpublished doctoral dissertation. Department of Agricultural Economics, Agribusiness and Extension, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi Ghana.

Asante, S. B., Osei-Asare, Y. B., & Kuwornu, J. K. (2016). Smallholder maize farmers' food consumption expenditures in Ghana: The mediating role of commercialization. *AGRIS on-line Papers in Economics and Informatics*, *8*(665-2016-45097), 13-27.

Anokye, M., Tetteh, J. P., and Otoo, E. (2014). Morphological characterization of some water yam (*Dioscorea alata* L.) germplasm in Ghana. *Journal of Agricultural Science and Technology*, B, 4, 518-532.

Bakulumpagi, A. (2018). *Use of underutilized Elite Banana Cultivars in the production of Composite Tomato Ketchup* (Doctoral dissertation).

Bateman, I. J., Carson, R. T., Day, B., Hanemann, W. M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., and Swanson, S. (2003). *Guidelines for the Use of Stated Preference Techniques for the Valuation of Preferences for Non-Market Goods*. Edward Elgar, Cheltenham.

Bech-Larsen, T., Grunert, K. G., and Poulsen, J. B. (2001). *The Acceptance of Functional Foods in Denmark, Finland, and the United States*. MAPP Working Paper No. 73. MAPP, Aarhus, Denmark.

Blaylock, J., Smallwood, D., Kassel, K., Variyam, J., and Aldrich, L. (1999). Economics, Food Choices, and Nutrition. *Food Policy*, 24, 269–86.

Bonilla, T. (2010). Analysis of consumer preferences toward 100% fruit juice packages and labels. A Master of Science thesis submitted to the Department of Agricultural Economics and Agribusiness, Louisiana State University and Agricultural and Mechanical College, Costa Rica.

Brillouet, J.-M., Treche, S., and Sealy, L. (1981). Alterations in cell wall constituents of yams *Dioscorea dumetorum* and *Dioscorea rotundata* with maturation and storage conditions in relation to post-harvest hardening of *D. dumetorum* yam tubers. *Journal of Food Science* 46, 1954-1965.

da Silva Dias, J. C. (2014). Guiding strategies for breeding vegetable cultivars. *Agricultural Sciences*, *5*(1), 9.

Fungo, R., Muyonga, J. H., Kabahenda, M., Okia, C. A., & Snook, L. (2016). Factors influencing consumption of nutrient rich forest foods in rural Cameroon. *Appetite*, *97*, 176-184.

Fungo, R., Tieguhong, J. C., Muyonga, J. H., Odjo, S., Tchingsabe, O., & Tchatat, M. (2018). Perceived nutrition benefits and sociodemographic factors affecting consumption of forest foods in eastern and southern Cameroon. *African Crop Science Journal*, *26*(2), 203217.

Ghana Statistical Service (2008). Ghana Living Standards Survey Round 5 (GLSS5); GSS, Accra, Ghana.

Goron, T. L., & Raizada, M. N. (2015). Genetic diversity and genomic resources available for the small millet crops to accelerate a New Green Revolution. *Frontiers in plant science*, *6*, 157.

Hensher, D. A., Rose, J. M., and Greene, W. H. (2005). *Applied Choice Analysis: A Primer*. Cambridge: Cambridge University Press.

Idang, G. E. (2015). African culture and values. *Phronimon*, *16*(2), 97-111.

Lancaster, K. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, *74*(2):132-157.

Lancsar, E., and Louviere, J. (2008). Conducting discrete choice experiments to inform healthcare decision making: a user's guide. *Pharmacoeconomics*, 26(8), 661–677.

Louviere, J. J., Hensher, D. A., Swait, J. D., & Adamowicz, W. L. (2000). *Stated Choice Methods: Analysis and Applications.* Cambridge, UK: Cambridge University Press.

Luce, R. D. (1959). *Individual Choice Behaviour: A Theoretical Analysis*. Wiley, New York.

McFadden, D. (1986). The Choice Theory Approach to Market Research.

Marketing Science, 5(6), 275-297.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behaviour. In P. Zarembka (ed.) *Frontiers in Econometrics.* NY: Academic Press.

McFadden, D., Train, K., and Tye, W. B. (1976). An Application of Diagnostic Tests for the Independence from Irrelevant Alternatives Property of the Multinomial Logit Model. *Transportation Research Record*, 637, 39–45.

Marschak, J. (1960). Binary-Choice Constraints and Random Utility Indicators, in K. Arrow (Ed) *Stanford Symposium* on *Mathematical Methods in the Social Sciences*. Stanford University Press, Stanford.

Mensah, C. (2005). *Response of 'Pona' and 'Asana' cultivars of white yam, Dioscorea rotundata (Poir) to the minisett technique of yam propagation*. M.Phil. Thesis, Department of Crop Science, University of Cape Coast, Ghana.

Mayes, S., Massawe, F. J., Alderson, P. G., Roberts J. A., Azam-Ali, S. N., and Hermann, M. (2012). The potential for underutilized crops to improve security of food production. *Journal of Experimental Botany*, 63, 10751079.

Mohanty, S. K., Balcombe, K., Bennett, R., Nocella, G., & Fraser, I. (2019). Attribute Specific Impacts of Stated Non-Attendance in Choice Experiments. *Journal of Agricultural Economics*, *70*(3), 686-704.

Nakashima, D. & Roue, M. (2012). Indigenous Knowledge, Peoples and Sustainable Practice, *Social and Economic Dimensions of Global Environmental Change*, 5, pp 314–324

Ndungu, S. K. (2013). Consumer Survey of Attitudes and Preferences Towards Organic Products in East Africa A report presented to International Federation of Organic Agriculture Movements pp 21.

Obidiegwu, J. E., & Akpabio, E. M. (2017). The geography of yam cultivation in southern Nigeria: Exploring its social meanings and cultural functions. *Journal of Ethnic Foods*, *4*(1), 28-35.

Okoffo, E. D., Denkyirah, E. K., Adu, D. T., & Fosu-Mensah, B. Y. (2016). A double-hurdle model estimation of cocoa farmers' willingness to pay for crop insurance in Ghana. *SpringerPlus*, *5*(1), 1-19.

Ouma, E. A. (2007). *Economic Valuation of Phenotypic Cattle Trait Preferences in Trypanosomiasis Prevalent Production Systems of Eastern Africa: Implications for Sustainable Cattle Breeding Programs.* PhD Thesis, Christian-Albrechts University of Kiel, Germany.

Pearmain, D., Swanson, J., Kroes, E., and Bradley, M. (1991). *Stated preference techniques: a guide to practice* (2nd ed.). Steer Davies Gleave and Hague Consulting Group.

Sato, H. (2006). A brief report on a large mountain-top community of *Dioscorea praehensilis* in the tropical rainforest of south-eastern Cameroon. *African Study Monographs, Supplement*. 33, 21-28.

Shiferaw, B., Smale, M., Braun, H. J., Duveiller, E., Reynolds, M., & Muricho, G. (2013). Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security. *Food Security*, *5*(3), 291-317.

Train, K. (2003). *Discrete Choice Methods with Simulation* (1st ed.). Cambridge University Press, UK.

Treche, S., and Guion, P. (1979). Etude des potentialities nutritionals de queues tubercles tropic au Cameroun. *Agronomy Tropical* 34, 127-131.

Thurstone, L. (1927). A Law of Comparative Judgement. *Psychological Review*, 34, 273-286.

Yasuoka, H. (2009). Concentrated distribution of wild yam patches: Historical ecology and the subsistence of African rainforest hunter-gatherers. *Human Ecology*, *37*(5), 577-587.

Zulu, M. (2019). *Consumer preferences for common dry beans in Lusaka, Zambia* (Doctoral dissertation, The University of Zambia).