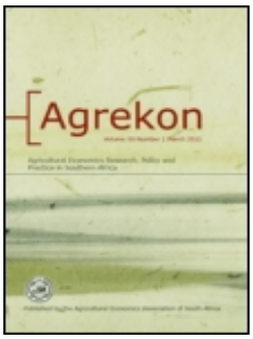

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FARMERS' CHOICE AMONG RECENTLY DEVELOPED HYBRID BANANA VARIETIES IN UGANDA: A MULTINOMIAL LOGIT ANALYSIS

K. Akankwasa* **, G.F. Ortmann*, E. Wale* and W.K. Tushemereirwe**

ABSTRACT

This paper analyses the effect of farmer characteristics, variety attributes and agro-ecological conditions on farmers' banana variety choice decisions in Uganda. A Multinomial Logit (MNL) model was used to estimate the determinants of variety choice. The results show that M9 was the most preferred hybrid variety, followed by M2 and M14. However, many of the respondents (39.4%) chose Mbwazirume, a local variety, as their most preferred variety. Good taste, large bunch size, soft food and good flavour were the most desirable attributes, while longer maturity period was a notable undesirable attribute. Results from the MNL analysis suggest that small land size, taste and regional location were negatively associated with variety choice, while perceptions that hybrid bananas could reduce food insecurity and tolerance to pests and diseases were positively associated with probabilities of variety choice. Probabilities of choosing hybrids for food security increase in favour of M2 (by 6.13%) and M9 (27.60%), and decrease by 23.05% for M2, 6.89% for M14 and 9.36% for M9 due to taste relative to Mbwazirume. Farmers' involvement in varietal improvement and development programmes is vital for meeting their preferences. Future breeding efforts should consider attributes such as bunch size, good taste, soft food and agronomic characteristics. Farmers with large land sizes should be targeted for on-farm promotional activities to increase the potential adoption and impact of the hybrids. After the hybrids are popularized and used by farmers, there will be a need for an impact study to evaluate their acceptability in terms of household food security and income.

Keywords: Banana (Matooke) hybrids, Farmers' choice, Uganda, Multinomial logit

JEL classification number: Q160

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1. INTRODUCTION

Research has demonstrated that farmer involvement in varietal selection promotes varietal development, dissemination and sustainability (Halewood *et al.*, 2007). Professional plant breeders have in most cases experienced considerable difficulty in developing viable modern varieties, partly because of an incomplete understanding of why farmers choose the varieties they grow (Morris and Bellon, 2004; Lacy *et al.*, 2006). As a result, many farmers do not have the real choice of varieties appropriate for their growing environments. According to Kitch *et al.* (1998), utilizing local farmer knowledge as an additional screening tool in the selection process is critical for successful participatory breeding. Farmer participation in the breeding of crop varieties is regarded by some as necessary to help ensure acceptance and eventual adoption (Franzel *et al.*, 1995; Sperling *et al.*, 1993). Understanding the production problems and varietal preferences of the local farmers in various agro-ecological and social economic contexts is important to the selection of varieties that will ensure long-term adoption by farmers (Mekbib, 1997). Consideration of farmers' variety preferences and choice in variety selection by adjusting the breeders' criteria will achieve better adoption rates (Sperling *et al.*, 1993; Misiko *et al.*, 2008). This will contribute greatly to hybrid banana varieties being retained in the cropping system at farm level as farmers will choose and adopt varieties that bear characteristics they prefer. This will also serve as an input to future variety development and diffusion.

Agriculture in Uganda is dominated by smallholder subsistence farmers who occupy the majority of land and meet their consumption requirements largely from own production (Salami *et al.*, 2010). Over 75 per cent of the total agricultural outputs are produced by smallholder farmers with farm sizes of about 2.5ha on average, producing mainly for home consumption and using traditional technologies. Bananas in Uganda occupy the largest cultivated area among staple food crops with more than 75% of all farmers growing bananas (Zake *et al.*, 2000). Bananas are primarily grown as a subsistence food crop, with marketable surplus sold in local markets. Most of the banana production takes place on small subsistence farms of less than 0.5ha using farming methods with low levels of external inputs (Gold *et al.*, 1998). Banana farmers in Uganda plant different varieties, taking into consideration both production and consumption attributes. Each variety contributes a unique composition and level of these attributes (Edmeades *et al.*, 2008).

Bananas are grown across diverse agro-ecological environments and socio-economic conditions and they represent an important source of income and food security for resource-poor farmers (Karamura *et al.*, 1998). Banana is consumed as a staple food for more than a half of the Ugandan population (Bagamba *et al.*, 1998). In spite of banana's importance, the banana farmer is currently facing

major challenges due to soil exhaustion, pests and diseases (such as weevils, nematodes, black sigatoka) and socio-economic constraints (such as high costs of production and stiff competition for labour with other enterprises) (Bagamba *et al.*, 1998). In response, NARO's National Banana Research Programme (NBRP), in collaboration with the International Institute of Tropical Agriculture (IITA), initiated a banana breeding programme in 1994. The programme has so far developed new banana hybrids, including M2, M9, M14, and M17. These have been under evaluation since 2008 in different agro-ecological regions of Uganda, with Mbwazirume as a local check (control). This is the first study focusing on the choice of the hybrids by the farming community.

The paper analyses the effects of farmer characteristics, variety attributes and agro-ecological conditions on banana variety choice in Uganda, with the application of a multinomial logit model. According to Smale *et al.* (2001), variety choice can be viewed as a process by which a farmer assembles various bundles of traits to satisfy consumption preferences, meet specific production conditions, or fulfil marketing requirements. The choice of a hybrid banana variety may differ depending upon the concerns of the farmers, which are likely to be defined by agro-ecological location, the physical characteristics of the farmers' plots and hybrid banana attributes. In this study, we quantify which hybrid bananas farmers are likely to choose and how dependent this choice is on agro-ecological and farmer characteristics.

The rest of the paper is organized as follows. The theoretical framework is presented in the next section. Section 3 present the empirical model while sections 4 and 5 present the study area, the data and variables considered in the empirical analysis. Section 6 presents and discusses the empirical results. The paper concludes in section 7 with a summary of the results and policy implications.

2. THE CHOICE OF HYBRID BANANA VARIETIES: A CONCEPTUAL FRAMEWORK

Modelling farmers' choice is considered under the general framework of consumer demand theory (Lancaster, 1966; Rosen, 1974), which suggests that consumers derive utility not from a good but from the characteristics embedded in a good. Variety choice is driven by farmers' demand for a number of variety traits (Smale *et al.*, 2001). The paper follows arguments from previous literature that farmers choose varieties based on the bundles of observable characteristics that each variety embodies and produces (Smale *et al.*, 1998; Edmeades and Smale, 2006; Wale and Yalew, 2007; Kikulwe *et al.*, 2011). In this study, we assume that an individual farmer faces a choice among alternative hybrid banana varieties. The individual farmer is assumed to consider the full set of offered alternative hybrid bananas in a choice situation and has to choose the alternative that maximizes

utility (Hensher *et al.*, 2005). New hybrid banana varieties have observable and unique attributes that make them different from one another; for example, plant vigour, size of bunch, finger size and shape, tolerance to pests and diseases, and colour of food (visual appearances). The unobservable attributes such as taste and flavour make the hybrid bananas different compared with the local check. A farmer's decision to choose a variety is made by comparing both the observable and unobservable attributes of all the banana varieties (Gracia and deMagistris, 2008). Consider a farmer's choice of a variety, and assume that utility depends on the choice made from a set (C), that is the choice set that includes all the possible variety alternatives. Thus, the farmer is assumed to have a utility:

$$U_{ij} = Q(Z_j, S_i) + \varepsilon(Z_j, S_i) \quad (1)$$

Where for any farmer i, a given level of utility will be associated with any alternative variety j. The utility derived from any alternative variety depends on the attributes (Z) of the variety and other socio-economic and agro-ecological factors affecting farmers' decisions.

Choices made among alternatives will be a function of the probability that the utility associated with a particular option (j) is higher than that associated with other alternatives. The statistical model of the probability (Pij) that alternative j is chosen by individual i is given by

$$P_{ij} = \text{Prob}(\text{Uij} > Uia; \quad a = 1,2,3,\ldots,j; a \neq j) \quad (2)$$

Thus, if the ith farmer selects variety type j, then Uij is the highest utility obtainable from among the j possible choices.

3. THE EMPIRICAL MODEL

In this paper, the farmer's choice from among the hybrid banana varieties was estimated within the multinomial logit framework (McFadden, 1974). The MNL model is applied to analyse the factors that affect the choice of hybrid banana varieties (M2, M9, M14) and Mbwazirume. The MNL model has been applied widely in earlier studies (Goktolga *et al.*, 2006; Wale and Yalew, 2007; Dragos and Dragos, 2009). The MNL is a suitable model because it allows the analysis of decisions across more than two categories of hybrid banana varieties (Wooldridge, 2002; Deressa *et al.*, 2009). The response variable includes four distinct unordered alternatives: M2, M9, M14 and Mbwazirume. Hence, we specify an MNL model (discrete choice method) as follows (Greene, 2003):

$$\text{Prob}(Y_i = j) = \frac{e^{xi\beta j}}{\sum_{k=1}^{4} e^{xi\beta k}} \quad \text{with} \quad j = 1,2,3,4 \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where Y_i is the dependent variable representing the hybrid banana varieties chosen by the farmer and takes the values of 1, 2 or 3 if the farmer chooses a hybrid variety M2, M9 or M14. Variety Mbwazirume is used as the reference category. X_i represents a vector of explanatory variables that include socio-economic characteristics, varietal attributes, and market and agro-ecological factors that affect farmers' variety choice. β_j represents the coefficients to be estimated. The results of the MNL model are interpreted in terms of the odds ratios, that is, the ratios of the probability of choosing one outcome category over the reference category.

These ratios are defined as

$$l_n\left[\frac{P_{ij}}{P_{ik}}\right] = X_i(\beta_j - \beta_k) = X_i\beta_j \; if \; k = 1 \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

A positive parameter indicates that the relative probability of choosing a hybrid banana variety over a local variety increases relative to the probability of choosing a local variety over a hybrid banana variety.

While other statistical options such as a discriminant function analysis could be used to analyse the choice of the variety among alternative banana varieties, a decision has been made to retain the MNL results because they are relatively easy to interpret in line with the purpose of this study, unlike the discriminant analysis that does. Compared to the MNL model, a discriminant analysis describes the differences in groups, predicts membership on the basis of response variable measures but does not estimate the marginal effects that present the actual magnitude of change or probabilities (Rencher, 2002). Moreover, the discriminant function assumes linear relationships between the response variable and the explanatory variables which are restrictive. However, discriminant function estimates were made using the same data set and only one of the functions was statistically significant (P<.0000) (Appendix 1), suggesting that the MNL results explain the data set better. Since only the first function is significant, it shows that it is the only function that has substantial discriminating power in differentiating the hybrid banana varieties. The discriminant function results do not have any new value-adding insights. Besides, the focus in this study was to measure the impact of each independent variable on the choice of each variety relative to the local variety. For all these reasons, interpretations, conclusions and policy implications are drawn based on the MNL results.

4. STUDY AREA AND DATA

The study was conducted in four regions of Uganda (Mid-Western, Central, Western and Eastern) representing six major Agro-ecological Zones: Lake Albert Crescent area, Lake Victoria Crescent, Western Highlands, Southern Highlands, South East and Eastern Agro-ecologic Zones (Wortmann. and Eledu, 1999). These are the regions where the National Banana Research Programme (NBRP) of the National Agricultural Research Organization (NARO) is evaluating the new hybrid banana varieties. While selecting the above regions and agro-ecological zones of the project operation, the programme considered high disease/pest susceptibility as a major factor. This is mainly because the major objective of hybrid banana development was to produce banana varieties resistant to Black Sigatoka, which has negatively affected banana production in these major areas. Consequently, new varieties (M2, M9, M14, M17) and Mbwazirume were introduced to farmers' fields. Mbwazirume was included so that farmers can have a complete choice and make fully informed decisions by comparing the old variety with the new varieties. These varieties are being evaluated under farmer-managed conditions across all the above Agro-Ecologic Zones in four regions of Uganda.

The analysis is based on primary data collected from a sample of 149 participating farmers (host farmers of the demonstration plots) and 305 non-participating farmers (neighbours with no demonstration plots) across all six Agro-Ecologic Zones. The data were collected from May 2010 to April 2011. A structured and pre-tested questionnaire was used as an instrument to collect the data. During the data collection, the questionnaire was administered by the principal investigator with the assistance of research assistants who were first trained. Primary data were collected on socio-economic characteristics of sampled farmers, farmer perceptions of banana hybrid attributes and institutional factors (like access to credit and extension services). Data were also collected on the likely impact of the hybrid banana varieties on food security and household income. Respondents were asked to rate the hybrid banana variety characteristics according to their level of importance in variety choice. The rating for each of the characteristics was based on a five-point Likert scale, namely (5) Strongly Agree, (4) Agree, (3) Disagree, (2) Strongly Disagree, (1) Don't Know. Farmers were asked to choose the most desirable hybrid banana varieties and the reasons for their choice using the above ratings. They were also asked to list the desirable and undesirable attributes for each variety for each of the hybrid banana varieties with respect to a local variety.

5. DATA DESCRIPTION

The dependent variable in the empirical estimation was the choice of banana variety option from the set of varieties. We use "varietal choice" to mean farmers'

stated preferences among the hybrid banana varieties and Mbwazirume being evaluated on farm. Previous studies on variety choice (Edmeads, 2007; Edmeades and Smale, 2006) were based on area share allocated to a variety and the number of plants to represent the demand for a variety. In the present study, we are considering farmers' variety choice from the set of newly developed hybrid "Matooke" banana varieties (M2, M9, M14), with Mbwazirume as a local check. The variety choice data were collected from the banana garden directly from farmers at the same time while observing each banana variety in the garden. This strategy allowed us to obtain farmers' true preferences about the banana varieties. Moreover, in the banana garden, the survey gave participants an opportunity to inspect the actual banana variety they were being asked to consider due to the presence of all the variety alternatives.

The choice of the explanatory variables is based on theory, data availability and previous literature (Deressa *et al.*, 2009; Bellon and Hellin, 2011). The explanatory variables and the hypotheses of how each explanatory variable influences variety choice is presented below.

Age is one of the potential factors affecting farmer's choice of varieties as an indicator for decision-making in variety choice (Bellon and Hellin, 2011). It is also an indicator of traditional preferences, farming experience and local knowledge, which can be expected to be related positively to the cultivation of local variety and negatively to hybrids (Bellon and Hellin, 2011).The effect of farmers' age (AGE) could be positive or negative depending on the farmer's position in the life cycle (Zavale *et al.*, 2005). Younger household heads may be more willing to try out new varieties, while older household heads may be less likely to try new crops or varieties (Adesina and Baidu-Forson, 1995).

The effect of the gender composition of the household on variety choice is difficult to predict. This variable is measured as a dummy. The effect may be related to the type of farming system or access to resources such as credit or extension (CIMMYT, 1993). Female-headed households are hypothesized to have limited access to productive resources (land and credit) and are less likely to have access to new information than male-headed households (Doss and Moriis, 2001); consequently, their access to improved technologies is negatively affected.

Family size was another variable considered. There is no agreement in the adoption literature regarding the direction of influence of this variable (Ajewole, 2010). A larger family size could be an indicator of food consumption requirement. Also, many members in a household imply labour availability that is frequently associated with the choice and adoption of a new technology. In this case, the variable was predicted to be positively related to the demand for hybrid banana varieties as banana production is labour-intensive and is a dominant food crop in Uganda.

Farmer access to extension agents is expected to influence variety choice among the available banana alternatives. According to various researchers (Doss, 2003; Sall *et al.*, 2000; Wubeneh and Sanders, 2006), extension is regarded as one of the most important sources of information. It is hypothesized that contact with extension agents measured as a dummy variable is positively related to variety choice by exposing farmers to new information. According to Feder *et al.* (1985), more exposure to information through various extension agents reduces subjective uncertainty about the technology.

Availability of credit eases the cash constraints and allows farmers to buy purchased inputs such as fertilizers, improved planting materials and other inputs. Access to credit was measured as a dummy variable and is expected to influence variety choice among the hybrid banana varieties. Studies on adoption of agricultural technologies indicate that farm size has positive effects on adoption (Bradshaw *et al.*, 2004). Land size (a proxy for farm size) is expected to have a positive effect on the choice of hybrid banana varieties. Larger farm areas can be allocated among varieties, the most preferred variety taking a larger share (Janaiah and Hossain, 2003). Farm size can be positively related to adoption because larger farmers can experiment with new technologies on a portion of land without worrying about endangering the family's food security (Wubeneh and Sanders, 2006.)

A household wealth index is also included and expected to have a positive effect on variety choice. Data were collected on household asset ownership (values of radio sets, bicycle, chairs, tables, car, mobile phones, television sets, and sofa sets) and livestock ownership. The values of all these assets were estimated in current Ugandan Shillings. The PCA method through factor analysis was used to construct an overall household wealth index (Filmer and Pritchett, 2001).

In this study, farmers' perceptions about the hybrid banana variety attributes were measured as a dummy: 1 = if a farmer perceives a variety to have more desirable attributes and 0 otherwise, relative to the local variety. Consumption and production attributes are variety specific (Edmeades *et al.*, 2005). Therefore, better performance in relation to these attributes is positively associated with variety choice decisions. According to Kshirsagar *et al.* (2002), farmers assess a new technology such as an improved variety in terms of a range of attribute requirements. Most bananas produced in Uganda are for home consumption (about 65%) with a smaller portion being sold to urban consumers (Smale and Tushemereirwe, 2007). Therefore, better taste and large bunch sizes give a specific variety more chances of being selected.

We include farmers' perceptions of the role of hybrid bananas in food security, measured as a binary variable (Yes = 1; No = 0), to examine farmers' perceptions about the role of the new hybrid banana varieties to reduce food insecurity

problems among the farming communities. The banana crop is regarded as an essential crop for food security in Uganda as it is an all-year crop with all stages of the crop cycle occurring at any one time of the year (Eledu *et al.*, 2004). Banana varieties perceived to possess important desirable attributes that are effective in food security (like short maturity period, large bunch sizes, provision of volumes of food after cooking, and good resistance to drought stress, diseases and pests) are preferred (Gold *et al.*, 2002), and more likely to be chosen and stay longer with the farming communities.

A regional dummy variable was included to measure the effect of regional location as a determinant of variety choice to capture the cultural and physical environment in which farmers make their decisions. The likelihood of a variety being chosen increases with the better physical environment of the area with farmers having a higher preference for a variety that is relevant to the agro-climatic conditions and the farming systems in their locations. The agro-ecological zones are based on differences in farming systems, weather and climatic, altitude and major vegetation cover (Wortmann and Eledu, 1999). Moreover, the differences in farming conditions (plot slope, soil fertility, diseases and pest severity) across regions tend to increase differences in variety choice (Benin *et al.*, 2004). In Uganda, the Eastern and Central regions of the country are located in the lowland areas where banana production has been severely affected by pests and diseases in the past 20 years (Kikulwe *et al.*, 2011). The Western region is the main banana producing region located in the highlands of the country and it is characterized by low incidences of pests and diseases (Nelson *et al.*, 2006). Most banana varieties are susceptible to certain severe diseases such as black sigatoka, but some varieties are far more sensitive than others.

Farmer perceptions of the hybrid banana plot characteristics (soil and slope) were measured as ordered variables (1 = Fertile, 2 = Medium, 3 = Low; 1 = Steep, 2 = Gentle, and 3 = Flat) to control for soil differences across agro-ecological regions. The choice of a hybrid banana variety is affected by soil conditions although the direction of the effect is difficult to predict *a priori*.

Other variables included are: average walking time from home to the dry weather road (hours) and the nearest market, and education level of the respondent (Deressa *et al.*, 2009; Isgin *et al.*, 2008). It is hypothesized that these factors are positively related to variety choice decision.

6. EMPIRICAL RESULTS AND DISCUSSIONS

6.1. Descriptive results

According to the survey results, the average household size was 6.5 members – above 5, the mean household size in Uganda (Ubos, 2009/2010) – of which

children constitute an average of 3.6 members. The results show that respondents had completed, on average, 8.6 years in school, above the primary level of education in Uganda (Table 1). The survey results also show that 50.4% of the respondents were male. The mean age of the household head was 47.13 years. About 76.9% of the respondents reported farming as their main activity and, on average, households had 8.9 acres of land. When asked whether they believed the hybrid banana varieties could reduce food insecurity, 92.5% of the respondents agreed. The results further revealed that 29% of the respondents had access to credit (Table 1). On average, respondents had been visited by extension workers 2.5 times in a period of two years. In terms of market accessibility, the average walking time to the nearest market was 43 minutes, while it took 53.5 minutes to walk to the nearest tarmac road.

Table 1: Descriptive statistics of sampled households, Uganda, 2010/11 (n = 454)

Variable	Variable description	Mean (SD)	Expected sign
Reduc	Years of schooling of the respondent	8.63 (3.91)	+
Fhsize	Total number of household members	6.54 (3.23)	+
HHAGE	Respondent age (years)	47.13 (14.30)	+/ -
Walking to road	Average walking time from home to the tarmac road (minutes)	53.48 (96.05)	+
Walking to market	Average walking time from house to the nearest market (minutes)	43.01 (56.66)	+/ -
Labour force	Active household members between the age group 15 and 64 years in the household	3.04 (1.73)	+
Tlarea	Total land operated (acres)	8.91 (10.60)	+
Iwealth	An index derived from factor analysis of the total values in Ush for household assets and livestock	.0014729 (1.00)	+
In percentage (%)			
Gender	Dummy (1 if household head is male; 0 otherwise)	50.44	+/ -
Taste	Binary (1 if the preference for taste attribute is important; 0 otherwise)	47.80	+
Diseases	Binary (1 if farmer perceives variety indicates a good resistance to pests and diseases; 0 otherwise)	62.56	+
Drought	Binary (1 if farmer perceives varieties are tolerant to drought; 0 otherwise)	31.50	+

Good bunch	Binary (1 if farmer perceives varieties produce good bunch size; 0 otherwise)	62.33	+
Maturity	Binary (1 if farmer perceives varieties take a short time to mature; 0 otherwise)	36.56	+
Hbrfood	Farmers' perception about the role of hybrid banana to food security (Yes = 1; No = 0)	92.51	+
DCentral	Binary (1 if farmer is located in Central region; 0 otherwise)	21.81	+ / -
Dwest	Binary (1 if farmer is located in Western region; 0 otherwise)	23.79	+/ -
Dmidw	Binary (1 if farmer is located in Mid-western region; 0 otherwise)	22.03	+/ -
Deast	Binary (1 if farmer is located in Eastern region; 0 otherwise)	32.38	+/ -
Sought credit	Binary (1 if a farmer has access to credit; 0 otherwise)	29.07	+
Extension	Binary (1 if a farmer was visited by extension agents in two years; 0 other-wise)	54.41	+
Farming	Binary (1 if farming is the major economic activity for the respondent; 0 otherwise)	76.87	+
Hybrid banana Plot slope	An ordered variable representing slope 1 = Steep; 2 = Gentle; 3 = Flat	12.68 83.94 3.38	+/ -
SoilFertily	An ordered variable representing soil fertility 1 = High; 2 = Medium; 3 = Low	30.97 63.07 5.97	+/ -

Source: Survey data (May 2010–April 2011)

The descriptive results indicate that the majority of farmers' plots (83.9%) are gently sloped, 12.7% had steep plots, while 3.4% were flat. In terms of soil fertility, most farmers (63.1%) perceived their soils to be medium, 31% high and 6% low in fertility.

6.2. Desirable and undesirable attributes of the banana hybrids: farmers' perceptions

Farmers were asked to indicate the most desirable and undesirable attributes of the banana hybrids. The results of tables 2 and 3 show the most frequently mentioned desirable and undesirable attributes of all the hybrid banana varieties. Good taste, large bunch size, soft food and good flavour were the most frequent desirable attributes that farmers reported (Table 2).

Table 2: Farmer desirable attributes for banana hybrids (percent of respondents), Uganda, 2010/11 (n =454)

	M2		M9		M14		Mbwazirume	
Attributes	Freq	%	Freq	%	Freq	%	Freq	%
Good Taste	45	29.6	29	14.7	12	12.5	60	31.6
Big bunch	40	26.3	76	38.4	33	34.4	21	11.1
Big fingers	-	-	10	5.1	10	10.4	7	3.7
High yielding	-	-	11	5.6	9	9.4	9	4.7
Early maturity	18	11.8	12	6.1	7	7.3	14	7.4
Tolerance to pests and disease	12	7.9	3	1.5	8	8.3	4	2.1
Tolerance to drought	-	-	12	6.1	4	4.2	6	3.2
Good performance in poor soils	9	5.9	4	2.0	2	2.1	-	-
Suitable for market	12	7.9	5	2.5	-	-	11	5.8
Soft food	4	2.6	19	9.7	5	5.2	28	14.7
Good flavour	6	4.0	5	2.5	6	6.3	19	10.0
Good colour	-	-	7	3.5	-	-	5	2.6
Good height	4	2.6	-	-	-	-	6	3.2
Longer storage	2	1.3	2	1.0	-	-	-	-
Total	152	100.0	198	100.0	96	100.0	190	100.0

Table 3: Farmer undesirable attributes for hybrid banana varieties (percent of respondents), Uganda, 2010/11 (n =454)

	M2		M9		M14		Mbwazirume	
Attributes	Freq	%	Freq	%	Freq	%	Freq	%
Not easy to sell	7	11.7	-	-	-	-	-	-
Small fingers	8	13.3	13	20	12	44.4	3	6.5
Hard food	12	20.0	9	13.9	7	25.9	1	2.2
Poor taste	14	23.3	13	20	5	18.5	1	2.2
Delays to mature	11	18.3	10	15.4	-	-	4	8.7
Requires a lot of management	-	-	6	9.2	-	-	-	-
Not resistant to disease	4	6.7	3	4.6	-	-	21	45.7
Not tolerant to drought	-	-	6	9.2	-	-	2	4.4
Not tolerant to wind	2	3.3	5	7.7			2	4.4
Small bunches	2	3.3	-		3	11.1	12	26.1
Total	60	100.0	65	100	27	100	46	100

Note: Taste is the stimulation of the receptors on the tongue for sweet, sour, salty, and bitter flavours while flavour is the quality in a food that imparts a particular taste in the palate.

Many of the respondents preferred Hybrid M2 because of its relatively good taste among all attributes compared with Mbwazirume (Table 2); this also applies to bunch size, early maturity period, tolerance to diseases and suitability for the market. Many respondents (38.4%) choose to grow hybrid M9 because of its relatively large bunch size, good taste, soft food and good flavour compared with Mbwazirume. Notable desirable attributes for hybrid M14 are its bunch size, good taste and soft food and flavour. While investigating the variety selection in Uganda, Gold *et al*. (2002) also found out that bunch size was ranked as the most important selection criterion of Musa cultivars. Despite the desirable attributes associated with the hybrid banana varieties, some farmers also mentioned that the hybrid bananas have some undesirable attributes (Table 3). For instance, respondents suggest that variety M2, which is hard when cooked, takes long to mature, and also is not easy to sell. The results also show that hybrid M9 is associated with poor taste and small fingers, and takes long to mature, while hybrid M14 is associated with small fingers, hard food and poor taste (Table 3). Despite Mbwazirume's good desirable features in other traits, the results show that the farmers perceived it as not being tolerant to pests and diseases and it produces small bunches.

6.3. Farmer perceptions of the hybrid banana attribute

For this study, farmers were asked to choose their most preferred variety among those under evaluation. There were four variety options or response probabilities (Figure 1). Results showed that many farmers selected reference variety Mbwazirume (39.0%) as their first choice. Among the hybrids, M9 was the most preferred variety (27.3%), followed by M2 (21.8%) and M14 (11.9%) (Figure 1). M17 was excluded in the analysis because it was never chosen. Farmers suggest that compared to Mbwazirume, M17 has a disadvantage of small fingers, relatively poor cooking qualities and takes long to mature.

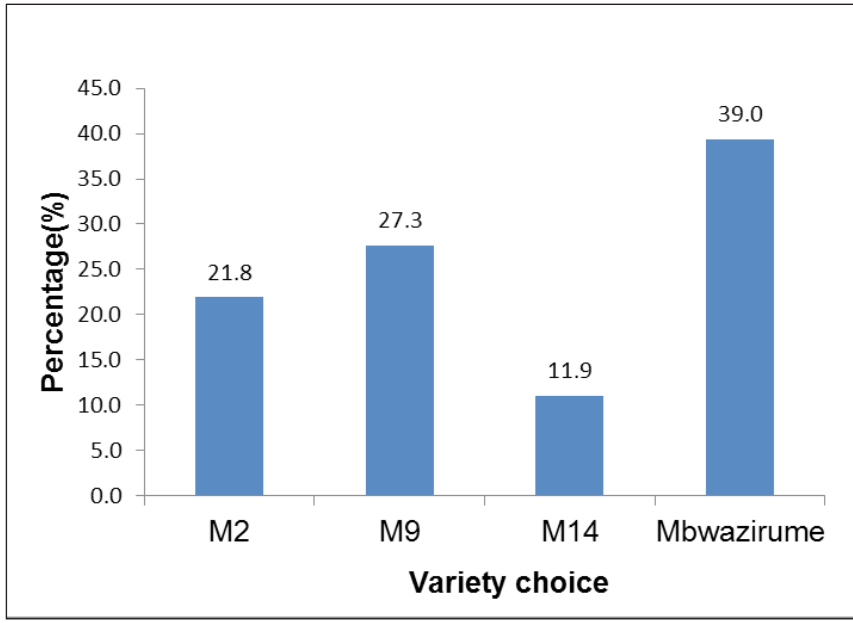

Figure 1: Farmer choice of hybrid bananas, Uganda 2010/11 (n =454)

Farmers were probed about their perceptions towards each of the hybrids in regard to preferences and choice made. Results show that farmers in all agro-ecological zones of Uganda have concerns regarding the hybrid banana varieties they would choose (Table 4). Judging by the percentage of responses related to a particular attribute as a measure of its relative importance, all the hybrid banana varieties were perceived to be better than the local variety with respect to agronomic characteristics, and pest and disease tolerance attributes, but inferior with respect to consumption characteristics compared with the reference variety. Specifically, farmers strongly agreed that hybrid M9 has a high adaptation to drought, poor

soils and wind, and is stable in terms of yield compared with the rest of the hybrids and a local check. This explains why farmers preferred hybrid M9 as the best variety among the hybrid varieties despite its lower preference compared to the local variety (Table 4). Moreover, farmers strongly agreed that all the hybrids were better than a local check in terms of tolerance to pests and diseases such as black sigatoka, weevils and nematodes (Table 4). Mbwazirume is believed to be inferior in terms of bunch size compared with M9 and M2 but is better in terms of taste.

Table 4: Farmer perceptions of hybrid variety attributes in all agro-ecological regions of Uganda, 2010/11 (n=149)

Variety attributes	(%) M2		(%) M9		(%) M14		(%) Mbwazirume	
	Agree		Agree		Agree		Agree	Disagree
High adaptation to drought	82.86	17.14	88.30	11.70	77.56	22.44	67.03	32.97
High adaptation to poor soils	75.31	24.69	78.99	21.01	67.53	32.47	58.06	41.94
High adaptation to wind	76.35	23.65	80.58	19.42	74.03	25.97	70.07	29.93
Stable in terms of Yield	81.36	18.64	84.44	15.56	74.34	25.66	75.46	24.54
Preferred to plant on own fields	63.52	36.48	64.79	35.21	56.38	43.62	66.79	33.21
Needs more labour	64.41	35.59	67.65	32.35	69.48	30.52	64.94	35.06
Usually requires higher rate of fertilizer application	39.13	60.87	41.35	58.65	39.33	60.67	48.47	51.53
Variety matures early	65.68	34.32	70.91	29.09	55.63	44.37	79.26	20.74
Resistance to black sigatoka	82.74	17.26	87.45	12.55	82.78	17.22	57.25	42.75
Resistance to weevils	74.45	25.55	77.82	22.18	72.00	28.00	58.02	41.98
Resistance to nematodes	75.00	25.00	78.03	21.97	75.00	25.00	58.94	41.06
Longer storage life after harvest	70.14	29.86	70.27	29.73	59.71	40.29	59.46	40.54
Suitability to Matooke local food	61.21	38.79	67.29	32.71	62.42	37.58	84.85	15.15

Good bunch size	85.36	14.64	92.45	7.55	73.15	26.85	81.95	18.05
Good finger size	83.40	16.60	90.91	9.09	60.67	39.33	87.50	12.50
Good skin colour	85.53	14.47	88.36	11.64	73.33	26.67	91.58	8.42
Good inside colour when cooked	71.86	28.14	77.57	22.43	64.19	35.81	90.71	9.29
Good texture	72.73	27.27	78.23	21.77	64.43	35.57	88.15	11.85
Good taste	70.39	29.61	74.54	25.46	59.06	40.94	91.35	8.65

Note: Farmer perceptions were captured using a five-point Likert scale:

(5) Strongly Agree; (4) Agree; (3) Disagree; (2) Strongly Disagree; (1) Don't Know.

The results show that many of the farmers have a preference for the hybrid M9 due to its good bunch size, good finger size and longer storage capability after harvest compared with the rest of the hybrid banana varieties (Tables 4). Banana consumers in Uganda in most cases consider bunch characteristics when buying. This gives hybrid M9 an advantage of being widely considered a variety to be produced for the market. In terms of the consumption qualities, many of the farmers regarded M9 to be better than the rest of the hybrids and close to the local variety. Considering supplementary input requirements, the majority of respondents disagreed that the hybrid banana varieties require higher rates of fertilizer application (Table 4). This result suggests that one would expect the majority of the resource poor farmers in Uganda, who lack the ability to purchase adequate amounts of fertilizers, to plant more of these hybrid-banana varieties when they are less input-intensive.

6.4. The determinants of variety choice: multinomial results

The parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent (response) variable (Table 5). Moreover, the estimates do not represent actual magnitude of change or probabilities. Thus, the marginal effects from the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, are reported and discussed (Table 6). Estimated coefficients for all the hybrid banana varieties are compared with Mbwazirume, a reference variety as the base category.

Table 5: Parameter estimates of the Multinomial Logit model explaining farmer choice and preferences for each hybrid banana variety, Uganda, 2010/11

Variables	M2	M9	M14
	Estimate(P level)	Estimate(P level)	Estimate(P level)
REduc	-0.014(0.79)	0.037(0.36)	0.093(0.11)
FHsize	-0.013(0.86)	0.034(0.60)	0.018(0.82)
HHAGE	0.007(0.64)	-0.0001(0.99)	0.019(0.18)
Gender	-0.606(0.17)	-0.375(0.32)	-0.414(0.36)
Labourforce	0.068(0.60)	0.079(0.42)	-0.110(0.44)
Tlarea	-0.026(0.08)*	-0.030(0.06)*	-0.015(0.47)
Hbrfood	1.142(0.07)*	2.677(0.01)**	0.808(0.21)
Taste	-2.417(0.00)***	-1.188(0.00)***	-1.834(0.00)***
Disease	0.064(0.87)	0.172(0.61)	0.014(0.97)
Good bunch	-0.470(0.26)	-0.177(0.62)	-1.111(0.01)**
Maturity	0.539(0.18)	0.039(0.91)	0.634(0.16)
Dcentral	-1.809(0.01)**	-0.012(0.98)	-0.237(0.71)
Dwest	-0.085(0.88)	-0.077(0.89)	-0.347(0.63)
Deast	-0.445(0.41)	0.026(0.96)	0.393(0.45)
IWealth	-0.670(0.06)*	-0.212(0.21)	-0.172(0.26)
Sought credit	0.158(0.72)	0.165(0.65)	-0.862(0.10)*
Extension	-0.466(0.27)	0.280(0.39)	-0.042(0.93)
Walking to road	0.003(0.05)*	0.001(0.56)	0.003(0.13)
Walking to market	-0.005(0.18)	-0.001(0.69)	-0.003(0.34)
Farming	0.758(0.11)	0.297(0.44)	0.529(0.32)
Plot slope	0.285(0.54)	0.488(0.22)	0.451(0.45)
SoilFertily	-0.345(0.32)	-0.283(0.34)	0.145(0.71)
Constant	0.314(0.84)	-3.310(0.07)*	-2.676(0.13)
Number of obs	305		
pseudolikelihood	-321.748		
Wald chi2	148.16		
Prob > chi2	0.0000		
Pseudo R2	0.176		

Notes: ***, **, * = significant at 1%, 5%, and 10% probability levels, respectively

Table 6: Marginal effects from the Multinomial Logit model explaining farmer choice and preferences for each hybrid banana variety, Uganda, 2010/11

Variables	M2	M9	M14
	Marginal effect (P level)	Marginal effect (P level)	Marginal effect (P level)
REduc	-0.005(0.42)	0.005(0.46)	0.008(0.10)
FHsize	-0.003(0.69)	0.007(0.57)	0.001(0.89)
HHAGE	0.001(0.73)	-0.001(0.69)	0.002(014)
Gender	-0.057(0.31)	-0.036(0.61)	-0.018(0.65)
Labourforce	0.007(0.63)	0.016(0.37)	-0.014(0.28)
Tlarea	-0.002(0.28)	-0.005(0.12)	0.000(0.92)
Hbrfood	0.061(0.24)	0.276(0.00)**	0.019(0.69)
Taste	-0.231(0.00)***	-0.069(0.22)	-0.0936(0.01)**
Disease	0.001(0.98)	0.031(0.60)	-0.005(0.91)
Good bunch	-0.033(0.48)	0.019(0.76)	-0.1008(0.03)**
Maturity	0.057(0.25)	-0.033(0.59)	0.053(0.23)
Dcentral	-0.162(0.00)***	0.057(0.55)	-0.002(0.97)
Dwest	-0.003(0.97)	-0.003(0.98)	-0.027(0.60)
Deast	-0.059(0.28)	0.010(0.91)	0.045(0.37)
IWealth	-0.072(0.08)*	-0.011(0.74)	0.000(1.00)
Sought credit	0.025(0.63)	0.048(0.47)	-0.077(0.03)**
Extension	-0.070(0.17)	0.074(0.19)	-0.004(0.92)
Walking to road	0.0003(0.06)**	0.000(0.91)	0.000(0.21)
Walking to market	-0.001(0.22)	0.000(0.91)	0.000(0.48)
Farming	0.067(0.12)	0.019(0.78)	0.029(0.48)
Plot slope	0.009(0.86)	0.073(0.33)	0.024(0.66)
SoilFertily	-0.034(0.39)	-0.047(0.39)	0.027(0.40)

Notes: ***, **, * = significant at 1%, 5%, and 10% probability levels, respectively

The Chi-square test results indicate that the likelihood ratio statistics are highly statistically significant ($p<0.000$) suggesting that the MNL model has strong explanatory power. The model was tested for multicollinearity using the variance inflation factors (VIF). The VIFs for all variables were less than 10, which indicates that multicollinearity was not a problem.

The estimated coefficient for total land size (Tlarea) is negative and significant for the probability of farmer' choice of variety M2 and M9 (Table 5), implying that farmers with small pieces of land are less likely to choose all new hybrids relative to Mbwazirume with a significant effect to M2 and M9. The marginal effects suggest that a unit reduction in the size of land in acres is likely to decrease the farmers' likelihood of choice for Hybrid M2 and M9 by 0.18% and 0.45%,

respectively, relative to Mbwazirume (Table 6). The reason could be that farmers with small pieces of land tend to concentrate on the variety they are relatively certain to get some harvest in terms of food security and are less likely to choose the hybrid banana varieties. According to Wubeneh and Sanders (2006), farm size can be positively related to adoption because larger farmers can experiment with new technologies on a portion of land without worrying about endangering family food security.

The estimated coefficient for taste is negative and statistically significant for all the hybrid banana varieties. These results suggest that farmers are less likely to choose all the hybrid banana varieties over Mbwazirume for food taste. The marginal effects of the taste variable indicate that the probabilities of selecting hybrid banana varieties decreases by 23.05% for M2, 6.89% for M14 and 9.36% for M9, relative to Mbwazirume. This suggests that farmers consider the hybrid bananas as inferior to the local variety in terms of taste. One of the explanations could be that farmers prefer Mbwazirume because it may have other desirable attributes such as soft food, good flavour and colour when cooked (Table 4). In a similar study of rice, Kshirsag *et al.* (2002) found that farmers indicated preference for retaining traditional varieties of rice for domestic consumption compared with the improved varieties.

The respondent farmers' perceptions about the role of hybrid banana to food security (Hbrfood) were positive for all hybrids and statistically significant for varieties M2 and M9 (Table 5). Similarly, the marginal effects suggest that the probabilities of choosing hybrid banana varieties for food security reasons increase in favour of M2 (6.13%) and M9 (27.60%) (Table 6). This could be due to the desirable attributes farmers associated with these hybrid bananas like large bunch size, tolerance to pests and diseases, and relatively good taste (Tables 2 and 4). According to Gold *et al.* (2002), farmers are more likely to select a variety with attributes that are considered important for provision of food security in subsistence production.

Farmer's perceptions of the resistance of hybrid varieties to pests and diseases, distance to the nearest market, education, importance of farming as a source of income to the household and plot slope showed positive relationships with variety choice as expected, but the estimated coefficients were not significant. None of the variables reflecting physical resources (for example, labour and family size), with the exception of accessibility to credit, was statistically significant. This is perhaps not surprising given that hybrid banana planting materials (suckers) can be relatively easily accessed through farmer to farmer exchange systems (Tushemereirwe *et al.*, 2006). In many parts of the country, banana planting materials circulate among farmers and communities without necessarily involving the exchange of money.

A respondent being in the Central region (Dcentral) is negatively associated with the choice of all the hybrid banana varieties with a significant effect on M2 relative to Mbwazirume. Being in the Central region of Uganda decreases the likelihood of choosing hybrid M2 by 16.15% (Table 6).

7. CONCLUSIONS AND POLICY IMPLICATIONS

Despite the importance of bananas in Uganda, the crop is facing major threats from soil exhaustion, pests and diseases (such as weevils, nematodes, black sigatoka) and socio-economic constraints (such as high costs of managing the crop and competition for labour with other enterprises). This prompted NARO's National Banana Research Programme to run a banana breeding programme that developed new hybrids (M2, M9, M14 and M17), which have been under evaluation since 2008 in different agro-ecological regions of Uganda, with Mbwazirume as a local check (control). This is the first study focusing on the choice of the hybrids by the farming community. Even though a discriminant analysis was also undertaken, interpretations and conclusions are made based on the MNL results mainly due to three reasons: restrictive linearity assumption of the discriminant model, the non-significance of the two discriminant functions out of the three and similar nature of the MNL and discriminant model results.The empirical results suggest that among the hybrids, M9 was the most preferred variety followed by M2 and M14. However, many of the respondents (39.4%) chose Mbwazirume (a local variety) as their most preferred variety. The results of the study highlight the importance farmers attach to banana attributes: good taste, large bunch size, soft food and good flavour were the most desirable attributes that farmers considered on the hybrid banana varieties, particularly for M9 and M14. Moreover, all the hybrid banana varieties were perceived to be better than the local variety with respect to agronomic characteristics and pests and disease tolerance attributes, but inferior with respect to consumption characteristics. The study further revealed that total land size, taste and regional location, particularly in Central region, were negatively associated with hybrid choice while farmers' perception that hybrid bananas could reduce food insecurity were positively associated with probabilities of hybrid choice.

The results of this paper have implications for the banana crop improvement programme underway in Uganda. Farmers being the ultimate consumers of the invention of the agricultural research, such as a new hybrid banana variety, their knowledge of the production environment, and variety and attribute preferences are critically important in influencing, not only the decision for the variety choice, but also the level of adoption. Hence, policy makers could prioritise farmers' involvement in varietal improvement and development programmes so as to address their concerns and preferences. The preference for hybrid M9 among the

hybrids is a reflection of the desirable attributes associated with this variety. The implication for banana breeders could be that breeding efforts should consider attributes such as bunch size, good taste, soft food, agronomic characteristics, and pest and disease tolerance while developing new varieties. The M9 variety could be promoted further on a wider scale for more farmers to benefit. The perception that new hybrid banana varieties could improve food security is a reflection of the production environment that farmers are facing, for which hybrid banana varieties could make a significant contribution, especially when widely disseminated. While disseminating the hybrid banana varieties, farmers with relatively large land sizes should be targeted for on-farm promotional activities to easily up-scale the potential adoption and impact of the hybrid technologies. There is a need to monitor the adoption and dis-adoption of these hybrids. After the hybrids are popularized and used by farmers, there will be a need for an impact study to evaluate their acceptability in terms of household food security and income.

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APPENDIX 1.

DISCRIMINANT FUNCTION ANALYSIS

The discriminant analysis is meant to determine if the hybrid banana varieties differed significantly on the independent variables. In this study, the discriminant analysis generated one statistically (P<.0000) significant function. This accounted for 74.87% of the explained between-group variance and has a canonical correlation of 0.52. Function 2 accounts for 14% of the explained between-group variance and has a canonical correlation of 0.25 and function 3 accounts for 11% of the explained between-group variance and has a canonical correlation of 0.23. With respect to function 1, Taste, Drought, and Central region are important and have a negative impact in variety choice for the new hybrid banana varieties. This is reflected in their higher loadings of above -20. Three variables have relatively high loadings on function 2, namely Hbrfood, Extension, and FHsize with loadings of 0.5819, 0.3928 and 0.2607, respectively; they are positively important in allocation of respondents in this group. With respect to function 3, respondent education and farmer's location in the Eastern region would negatively be important while Labourforce, sought credit and Good bunch are positively important.

Table A1. The structured matrix of canonical loadings of the independent variables on the canonical discriminant analysis of the hybrid banana varieties, Uganda, 2010/11

Variables	Structured matrix		
	Function 1	Function 2	Function 3
REduc	0.0206	0.1026	-0.3913*
FHsize	0.0818	0.2607*	0.0631
HHAGE	0.0502	-0.1011	-0.1851
Gender	-0.0956	-0.0073	-0.0125
Labourforce	0.0384	0.3016	0.2331*
Tlarea	-0.1208	-0.2090	0.0401
Hbrfood	0.1206	0.5819*	0.0468
Taste	-0.6982*	-0.1413	-0.0541
Disease	-0.0574	0.1113	-0.0642
Drought	-0.3351*	0.2022	0.1615
Good bunch	-0.2264	0.0760	0.2090*
Maturity	0.1514	-0.1020	-0.0111
Dcentral	-0.2777*	0.2326	-0.1945
Dwest	0.0948	-0.1450	0.4190
Deast	0.1023	0.0528	-0.3397*

IWealth	-0.1419	-0.0983	-0.1180
Sought credit	-0.1013	0.1534	0.2920*
Extension	-0.1225	0.3928*	-0.3014
Walking to road	0.1088	-0.0695	-0.2393
Walking to market	-0.0722	0.0974	-0.1120
Farming	0.0564	0.0606	-0.0628
Plot slope	0.0803	0.0709	-0.1241
SoilFertily	-0.0384	-0.1446	-0.2526
Canonical correlation	0.5197	0.2548	0.2278
P Value	0.0000	0.8328	0.7982
Variance accounted for (%)	0.7487	0.1405	0.1108

Table A2. The standardised canonical discriminant function coefficients of the hybrid banana varieties, Uganda, 2010/11

Variables	Canonical discriminant variate		
	Function 1	Function 2	Function 3
REduc	0.0490	0.1654	-0.4810
FHsize	-0.0380	0.2032	-0.1421
HHAGE	0.1339	-0.1450	-0.2099
Gender	-0.1390	-0.1295	-0.0398
Labourforce	0.0813	0.1769	0.3658
tlarea	-0.1429	-0.3862	-0.0423
Hbrfood	0.1733	0.6289	-0.0032
Taste	-0.7628	-0.1396	-0.0707
Disease	-0.0045	0.1419	-0.0447
Drought	-0.4251	0.1812	0.1586
Good bunch	-0.1876	0.1303	0.3015
Maturity	0.1951	-0.1416	-0.0107
dcentral	-0.3553	0.3539	-0.4421
dwest	-0.0253	-0.0004	0.1356
deast	-0.0612	0.0874	-0.4276
IWealth	-0.1725	-0.1054	-0.1238
Sought credit	-0.0510	0.2220	0.4210
Extension	-0.1407	0.3434	-0.2223
Walking to road	0.2177	-0.1189	-0.1811
Walking to market	-0.1457	0.0499	-0.0137
Farming	0.0564	0.0606	-0.0628
Plot slope	0.0803	0.0709	-0.1241

SoilFertily	-0.0384	-0.1446	-0.2526
Canonical correlation	0.5197	0.2548	0.2278
P Value	0.0000	0.8328	0.7982
Variance accounted for,%	0.7487	0.1405	0.1108