International Scholars Journals

African Journal of Agricultural Marketing ISSN 2375-1061 Vol. 7 (1), pp. 001-012, January, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Relative importance of common bean attributes and variety demand in the drought areas of Kenya

Enid Katungi[1]*, Louise Sperling[2], David Karanja[3], Andrew Farrow[1] and Steeve Beebe[4]

[1]Centro Internacional de Agricultura Tropical (CIAT) National Agriculture Research laboratories, Kawanda, P. O. Box 6247, Kampala, Uganda.
[2]Centro Internacional de Agricultura Tropical (CIAT-AFRICA), Arusha, Tanzania.
[3]Kenya Agricultural Research Institute (KARI), P. O. Box 340, Machakos, Kenya.
[4]Centro Internacional de Agricultura Tropical (CIAT) Cali, Colombia.

Accepted 05 September 2018

The analysis assessed the relative importance of production and consumption attributes to different wealth groups of households and tested the effect of attribute preference and that of other factors on common bean variety demand in the drought areas of Eastern Kenya. Variety demand was conceptualized within the agricultural household framework and attributes were incorporated into the model according to the Lancaster (1966) consumer theory. Empirical analysis was based on primary data collected from two districts of Eastern Kenya using the stated preference and revealed preference methods. A factor analysis was used to cluster a set of common bean variety attributes that are highly preferred by households into those related to consumption flavour and yield related characteristics. The effect of consumption and production attributes and those of other factors were estimated through applying ordinary least squares regression. The study findings reveal that varietal adaptation to environmental stresses should also strive to reduce the cooking time as well as enhance the keeping quality and grain colour for better benefits to the poor but trade-offs are feasible. Prioritizing the improvement of production attributes as a short term goal seems an efficient strategy when multi-attribute based breeding is a long process.

Key words: Common bean, relative importance of variety attributes, variety demand, drought areas, Eastern Kenya.

INTRODUCTION

Common bean (*Phaseolus vulgaris L.) is* an important source of protein for many households in Kenya, but its production has not kept pace with demand. In 2007, production was about 417,000 metric tons while demand was estimated at 500,000 metric ton (FAOSTAT, 2010). The supply deficit is attributed to the severity of biophysical stresses (such as climatic variability, insect pests and diseases; declined soil fertility) that maintain productivity at less than 25% of potential yield (Odendo et al., 2004; Beebe, Personal Communication).

The National Agricultural Research Institute of Kenya in partnership with Centro Internacional de Agricultura Tropical (CIAT) has been conducting researches to produce common bean germplasm that is well adapted to the environment. These efforts are still continuing and new approaches, such as marker selection, are being exploited to meet the farmers' needs. While these advances in plant breeding have made it possible to develop crop varieties with multiple attributes to overcome a range of biotic and abiotic constraints without compromising the desirable qualities, the process of multi-attribute based breeding approach can be often complex, take long to complete and provide no guarantee that an ideal variety will be found (Bellon, 1996). Therefore, it is important for breeders to understand the important variety attributes that drive planting decisions in order for them to set breeding priorities.

The objective of this study was to assess the relative importance of common bean attributes to different groups of farmers and their contribution to variety demand. Sperling et al. (1993) found that common bean variety

*Corresponding author. E-mail: e.katungi@cgiar.org. Fax: +256(0)414_567635.

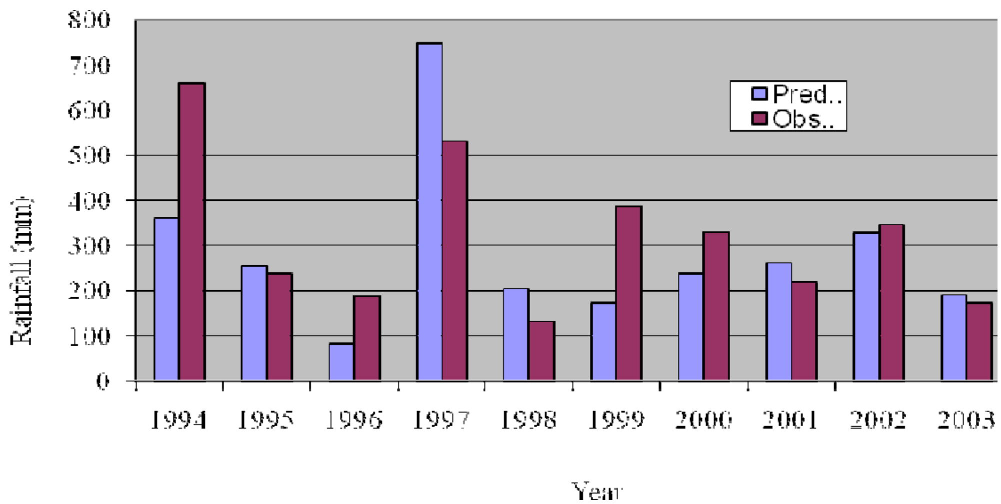

Figure 1. Predicted and observed amounts of rainfall (September-November), 1994 to 2003. Source: Katumani Meteorological Station.

choice varies among farmers within a given location according to their production conditions, objectives and preferences. Their research influenced the integration of participatory variety selection into the breeding process. However, the information from the participatory variety selection regarding the specific consumption and production attributes that influence the choice of common bean varieties has not been able to provide precise weights among a string of desired characteristics. Little is known regarding the connection between land allocation to common bean varieties (that is, variety demand) and relative importance of variety attributes (such as consumption or risk reducing characteristics). The paper assesses the relative importance of different common bean variety attributes to different groups of households and tests their effect and that of other factors on the variety demand.

MATERIALS AND METHODS

Study area and data sources

The study was carried out in Mwala and Kitui districts of Eastern Kenya, one of the major bean-producing regions in the country. Mwala and Kitui districts are neighbouring towns and are located about 50 to 150 km from Nairobi City, on a national road connecting Nairobi and Mombasa towns with favourable conditions for the marketing of agricultural produce. The areas are elevated between 1000 to 1500 masl. Highlands above 1500masl exist but are rarely used for agriculture because they are either arid or unsuitable for animal power technology. The soil types in Eastern Kenya are predominantly sandy and murram with patches of black cotton soils (vertisols) in poorly drained areas (Mwita Rukandema et al., 1981).

The area receives a total rainfall of about 800 to 1000 mm per year but the records at Katumani Meteorogical Station of Kenya Agriculture Research Institute (KARI) indicate that rainfall has generally been lower than 800 mm in the last ten years (Figure 1). Rainfall variability has also been acute, resulting in famine and repeated deliveries of food and seed aid (Sperling, 2002). Common bean is a short season crop that contributes significantly to food and nutrition in the study area. It is managed mainly for subsistence requirements but surpluses can be sold in the market.

The data used in this study were collected for tropical legumes project of CIAT/ICRISAT/IITA implemented in 2007 to 2010 in South Asia and Sub-Saharan Africa[1]. Mwala and Kitui Districts were chosen purposively for the baseline studies on common bean because the two districts experience high probability of rainfall failure (about 60%), and have high levels of poverty for which the project was designed. Geo-referenced maps were used to guide in the selection of districts.

Conceptual framework and model specification

The theory of agricultural household (Singh et al., 1986; de Janvry et al., 1991; Sadoulet and de Janvry, 1995) was used to derive variables used in the econometric analysis. Variety consumption attributes were incorporated into the utility function according to the consumer theory of Lancaster (1966) also used by others (Edmeades 2003, Wale and Mburu, 2005). In the consumer theory of Lancaster (1966), the utility derived from the consumption of a good is specified as a function of the intrinsic attributes supplied by the good rather than the good itself. The specification of intrinsic properties of a variety as arguments of a utility function and application of an agricultural household model allows for the inclusion of variety consumption attributes in the econometric estimation of the variety demand.

Following the two theories, the agricultural household is assumed to maximize utility derived from the intrinsic consumption attributes of common bean embodied in vector (ϕ_c), the purchased good (G)

[1] The goal of the project is to enhance the productivity of legumes (i.e common bean, pigeon pea, chick pea, ground nuts, cow pea, and soya bean) for improved livelihoods of the poor households in drought prone area. It is implemented jointly by International centre for Tropical agriculture (CIAT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Research and International Institute of Tropical Agriculture (IITA) and in collaboration with NARS in participating countries of East and Southern Africa and Asia with funding from the Bill and Melinda Gates foundation.

and home time (h). The household chooses the amount of common bean to consume from different varieties it produces (V), the purchased good and home time subject to income (W), production technology (Q), and time endowment (T). Utility is maximized given the household preferences, which, in turn, depend on the socioeconomic characteristics of the household (Φ_{HH})and market conditions (Φ_M). The theoretical model can be expressed as:

$$MaxU\,(\,x(\phi^{c}),\,G,\,h\mid \Phi_{HH},\,\Phi_{M}\,)$$
$$q = f\,(v(\phi^{p}),\,l \mid \Phi_{F},\,\Phi_{M},\,A)$$
$$T - l - h = 0$$
$$\sum_{i=1}^{k} v_i = 1$$
$$x_i \geq 0,\, q_i,\, v_i \geq 0$$

The total amount of common bean consumed (x) can be distinguished according to the intrinsic and extrinsic attributes of common bean varieties such as taste, cooking time, grain size and colour (ϕ^c) they possess. The amount consumed of each variety can vary across households but the levels of intrinsic properties each possesses are fixed from the perspective of the household.

Full income in a single decision making period is composed of the net farm earnings (profits) from crop production and income that is exogenous to the season's crop such as stocks carried over, remittances, pension and other transfers from the previous season. For goods that are not traded, the prices that govern the choices of the household are endogenous to the household, determined by internal supply and demand for the good, expressing the household's valuation of the good. Shadow prices are affected by the costs of transacting in the markets influenced by market and household characteristics (de Janvry et al., 1991).

The production technology constraint establishes the output-input technical relationships and the production margins. Common bean in the study area is produced by combining labour and seed of specific varieties on land that is fixed in a single cropping season. The choice and allocation of the common bean area to a specific variety is influenced by the decision maker's perception of the variety agronomic attributes such as maturity period, drought resistance, yield, tolerance on poor soils or growth habits, expressed in vector, $v(\phi^p)$. The demand for variety specific agronomic attributes emanates from the need for farmers to maximize returns from production as well as stabilize income from common bean. The land constraint circumscribes the land area allocated to common bean, which is fixed to one for every household. The household can choose to allocate all common bean area to one variety or simultaneously plant multiple varieties if certain attributes are unique to a particular variety. Varieties planted can vary across households and a variety specific corner solution is possible. The vector Φ_F denotes farm characteristics. The time constraint captures the total time available to production and home activities.

The vector of market conditions (Φ_M) captures the role of market imperfections in variety demand. Particular households can choose to be self sufficient in common bean variety and/or its seed if faced with wide price bands (Sadoulet and deJanvy, 1995).

Common bean markets in Kenya are characterized by high price fluctuations with the price of varieties those are well adapted to the fluctuations with the price of varieties those are well adapted to the communities more likely to increase by two fold at planting time.

Common bean is bulky and markets for grain and seed are located far away from the farming communities, with implications of high transport costs. Households differ in their abilities to overcome transport costs even when located in the same geographical area. Majority of the households produce seed on-farm and separate it from grain harvest. The family is the main source of labour used in common bean production. Thus, for many households, production decisions are likely to be influenced by the endogenous shadow prices rather than the exogenous market prices.

Kuhn-Tucker conditions are used to derive optimal demand of varieties. Given that the conditions are met, the following reduced form equation defines the optimal share of common bean area allocated to variety i .

$$v^{*}_{i} = v(\phi^{c},\phi^{p},\,p_{a},p_{g},I,\Phi_{HH},\Phi_{F},\Phi_{M}\,) \qquad (2)$$

Equation 2 is the basis of the econometric estimation. The share of common bean area allocated to variety i is derived as a function of variety consumption and production attributes (ϕ^c,ϕ^p) , the socio-demographic characteristics of the household (Φ_{HH}) and characteristics of the farm (Φ_F) and market characteristics (p_a, p_g, Φ_M) .

The impact of consumption and production attributes will depend on distribution of these attributes in the varieties selected for analysis. A positive relationship is hypothesized for varieties with respective high supply of the attribute. For example, varieties with high supply of consumption attributes will be highly demanded by those households who demonstrate high preferences for consumption attribute while low supply of such attributes will result in low demand for the variety. The same relationship is expected for the production attributes.

Household characteristics such as household composition and assets are expected to influence crop variety production decisions through their effect on consumption demand and risk preferences. High dependency ratio is associated with the vulnerability of the household and this may increase the risk of starvation and hence favour demand for crop varieties that are risk reducing. Dependants in form of children may also have special consumption requirements, which could stimulate demand for varieties that meet special consumption needs. Household wealth enhances the household's ability and willingness to take risks that could favour the demand of the risk increasing varieties.

Farm characteristics include the scale of operation and diversity of soil types on the farm. The effect of scale on variety demand cannot be determined *a priori*. Larger scale of operation, defined as the total area under common bean in a given season, enhances the household' ability to bear the risk of failure. Scale of operation also reflects the importance of the crop in meeting the household' livelihood requirements. Research elsewhere suggests that farmers with a high degree of soil heterogeneity tend to match the crop varieties with soil types (Bellon and Taylor, 1993). By so doing, the area share allocated to each variety might be reduced.

Market failures are household specific depending on shadow prices (de Janvry et al., 1991). In the study area, markets may fail due to high transport costs or risk aversion. In an environment where price risks are high, households who commercialize are risk neutral and are expected to demand market varieties. In Eastern Kenya, donkeys are highly used in transportation of agricultural goods to and/or from the market and households in possession of this asset are expected to take less time to the market and can travel there more frequently. This can easily influence the household' ability to depend on the market and hence choice and demand of specific varieties.

Data collection and measurement of empirical variables

Data on socioeconomic household characteristics (education dependency ratio, exogenous income and household wealth assets), farm characteristics (scale of operation, soil types) market conditions (production orientation, market value of donkeys) and land allocation of varieties was collected from randomly selected households between June and August, 2008. A total of 120 households randomly selected from three villages with a moderate to high potential for common bean production in each district were interviewed as part of the baseline survey. Morphological characteristics such as seed colour and size were used to distinguish varieties grown by farmers with the help of seed samples. Data on consumption and production attributes important to the household were collected in April 2010 as part of project monitoring. Due to limited budget, only 60 households randomly selected from the original baseline sample were interviewed for tracking varietal diffusion.

The data on common bean area share allocated to the selected varieties (that is, the variety demand) was determined in two steps. In the first step, all varieties grown in the study area were solicited from respondents and the popularity of each in terms of percentage of households growing the variety determined. About 15 varieties of different seed sizes and colour were identified in the sampled villages (Table 1) with an average of 2 varieties per farm. These varieties were landraces and the improved varieties released in 1980s. Although many varieties are grown in the study area, only two were popular among the selected households. These were GLPx92 (grown by 87% of the households) and GLP2 large red mottled (grown by 72% of the households) (Table 1). Other varieties were grown by less than 40% of the households. Based on this, the two popular varieties, GLPx92 and GLP2 large red mottled, were selected for the econometric analysis.

In the second step, area allocated to each of the selected variety was determined. Given the multiple varieties grown and the intercropping system, determining common bean area occupied by a single variety was not straight forward. Farmers were able to recall the amount of seed for each variety that was planted during the cropping season of 2008/2007 and their usual seeding rate. The amount of variety seed and the seeding rate were then used to compute the area under each variety selected for the analysis. The descriptive statistics are presented in Table 2.

Farmers were presented with a predetermined list of common bean attributes (cooking time, keeping quality, flatulence, grain size and grain colour, drought tolerance, early maturing, pest resistance, tolerance to poor soils and growth habit) derived from the previous participatory variety selection studies (Sperling et al., 1996). Each farmer was asked to rate each attribute on a three point scale (3= very important and 1= not important) according to his/her preference. A higher score reflects high preference and vice versa. The 10 variety attributes were subjected to a factor analysis procedure using principal components method to analyze correlation between them and determine whether they could be represented by a smaller number of components[2]. Based on the criterion of an Eigenvalue greater than unity, the 10 variety attributes were grouped into two independent attributes according to two unobserved factors interpreted as: consumption flavour and yield related characteristics[3].

[2] The attribute preferences tend to be collated and including all them would induce multicollinearity a well as the degrees of freedom.

[3] The results of the factor analysis are summarized in appendix A. The 2 factors explain 100% of total variance in the stated preferences for traits.

Factor one, explained about 56% of the variance in the 10 selected attributes subjected to factor analysis. Consumption attributes (high keeping quality, less flatulence and less cooking time) loaded heavily on this index and the index was interpreted as consumption flavour. Drought tolerance, early maturing, pest resistance and tolerance to poor soils were highly correlated with factor two interpreted as yield related characteristics. The two underlying latent factors were recovered from the data using the scoring after factor analysis command in Stata 8.0 and included in the analysis as explanatory variables (Table 2).

Variables representing individual and household characteristics (education, household wealth, dependency ratio, exogenous income), farm characteristics (scale of operation and soil type heterogeneity index) and market conditions (production orientation and value of donkey) were computed based on primary data gathered through interview of individual households. For each plot, the soil type and plot area were recorded. Then, soil type diversity was represented by the Shannon index (D_i^S) computed as:

$$D_i^S = -\sum_i S_{ij}/A_i \; In \; S_{ij}/A_i$$

$$D^S \geq 0 \tag{3}$$

S_{ij} is the total area occupied by soil type j on farm i . A_i is the total cropped area on farm i . The Shannon index has a lower limit of zero when only one soil type exists on the farm. The list of utilized variables, their definition and descriptive statistics is presented in Table 2.

Data analysis

The importance for common bean attributes and distribution of attributes in the popular varieties found in the study area were analyzed using descriptive statistics based on the average ratings. The Kruskal Wallis one-way analysis of variance by ranks (a nonparametric statistical procedure) was used to test for differences among the ratings and determine whether or not each rating for an attribute was statistically equal among the three livelihood groups. The criteria used to classify households into livelihood groups are summarized in Table 3. A paired sample t-test was used to compare attribute supply by the two popular varieties chosen for the analysis.

The effect of the attributes ratings and other factors on area share occupied by variety i was determined using econometric analysis. The choice of the econometric estimation method was dictated by the nature of the data on the dependent variables. The area shares allocated to GLPx92 and GLP2 large red mottled differ across households but were observed for almost all households in the data set used in the analysis and censored for very few households (2 for GLPx92 and 8 for GLP2 large red mottled). These observations were too few to allow calculation of the total effect of the explanatory variables on the explained variable from a tobit model. For this reason, the Ordinary Least Squares (OLS) regression model was preferred over a tobit regression for the estimation of area shares allocated to GLPx92 and GLP2 large red mottled.

Denote $V_i{}^*$ the optimal demand of variety i expressed as a function of all the variables hypothesized (*Z*) to explain variation in the area share occupied by the variety i , cast on the right hand side of Equation 2, and the random component (ε_i):

$$y_i^* = \beta' Z + \varepsilon_i \qquad \varepsilon_i \mid Z \sim N(0,1) \tag{4}$$

Table 1. Varieties grown, their morphological characteristics, local names, incidences and the year of release.

Variety, local name(s)	Researcher classification/ Morphological characteristics	Year of release/origin	Household share (%)
Nyayo or Maina	GLP2 large red mottled	Early 1980s	71.5
Amini	GLP2 Very large red mottled		4.9
Rosecoco	GLP2 medium purple mottled	Early 1980s	13.8
Nyayo short, saitoti or short maina	GLP2 medium red mottled		17.9
Kakunzu	Local Purple stripes on cream		8.9
Mwezimoja	GLP1127or GLP1004 Medium purple or grey speckled	Early 1980s land race)	7.3
Katumbuka, Mwitemania, Katinga or Maddu	GLPX92 Medium Pinto	Early 1980s land race)	87.0
Wairimu, Katune or Kamusina	GLP585 Small red haricot	Early 1980s	12.2
Kitui	GLp24 Large dark red kidney	Pre-released 1993	14.6
Kitui small;	GLP24 Small dark red kidney	-	-
Kayellow, Kathika, or Ka-green	KatB1 Medium yellow/green round shaped	Pre-released 1985	34.6
Ikoso, Ngoloso or Itulenge	Local Black with white stripes		15.5
Kamwithiokya	Local Black		

Source: Kenyan seed company in Spilsbury et al. (2004) updated with survey data.

β is a vector of parameters to be estimated while ε_i is a vector of random component assumed to be randomly distributed with zero mean and constant variance IN $(0,\sigma^2)$.

There is a possibility that one household grows both GLPx92 and GLP2 large red mottled. This implies that the factors that influence demand of one variety are also likely to influence demand for the other. This is likely to induce correlation between the unobserved heterogeneity in the two variety demand equations. However, according to Greene (2000, p. 616) there is no gain in statistical efficiency from estimating the two equations jointly when the set of explanatory variables is identical in both equations (Greene, 2000, p. 616). Based on this, each variety demand equation was treated separately.

RESULTS

Assessing the relative importance of common bean attributes to farmers

Generally, farmers prefer many common bean attributes. Four production attributes and one consumption attribute were rated important with an average rating of more than 2.5 on a three point scale (Table 4). This reflects the wide range of production constraints faced by the households in the drought areas of Kenya and the importance of varietal adaptation. The Kruskal Wallis one-way analysis of variance by ranks indicates no variation in the relative importance for all the production attributes across household categories defined by livelihood groups. This means that these production attributes are preferred equally across households in the study area because production constraints affect them in the same way. Similarly, the relative importance for high keeping quality and grain colour does not show significant variation across household categories, which implies that preferences for these attributes do not depend on the household socioeconomic background.

However, ratings for a less cooking time variety, grain size and low flatulence, also consumption attributes, vary across household categories, with the households in the middle stratum attaching relatively less importance on less cooking time as compared to those in the top and bottom strata. Households in the top stratum also expressed high preference for low flatulence and grain size than the poorer households.

Distribution of the important attributes in the varieties grown

Farmers were asked to rate each variety according to the selected production and consumption attributes. Results summarized in Table 5 shows that varieties differ in their supply of attributes preferred by households. GLPx92, the most popular variety is rated above average (3.7 on a 5 point scale) for drought tolerance, yield and tolerance to poor soils. On the other hand, the

Table 2. Definition of empirical variables included in the analysis, hypothesized effects and the summary of the descriptive statistics.

Variable	Definition	Expected effect	Mean	SD
Dependent variable				
GLPx92	Share of common bean allocated to GLPx92 variety during the 2008/2007 cropping year		0.250	0.217
GLP2 large red mottled	Share of common bean allocated to GLP2 large red mottled variety during the 2008/2007 cropping year		0.186	0.142
Attribute				
Consumption flavour	An index derived from factor analysis of attributes where consumption attributes loaded heavily	+/-	0.114	0.723
Production related	An index derived from factor analysis of attributes where production attributes loaded heavily	+/-	0.319	*0.585*
Household characteristics				
Education	Years of schooling, household head	+	7.70	3.66
Dependency ratio	Proportion of household members below 15 years and above 64 years of age	+/-	0.538	0.406
Household wealth	Total value in (K.sh) of consumer durables (i.e. bicycle, radio) and livestock	+	62567.3	22911.3
Exogenous income	A dummy capturing whether a household receives remittances, credit, or non farm/labour income	+/-	0.277	0.452
Farm characteristics				
Scale of production	Total area (ha) allocated to common bean in a year	+/-	0.147	0.180
Diversity of farm soil types	A Shannon index of soil types on the farm cropped area	-	1.350	0.610
Market access				
Value of donkey	Total value in (K.Sh.) of the donkey if sold at the time of survey	+	1255.3	2900.3
Production orientation	Dummy(=1) if the farmer 's primary objective of producing common bean is for sale and 0 otherwise	+/-	0.468	0.504

Table 3. Criteria used for categorizing households in wealthy strata.

Sources of livelihood	Wealth category
Crops, any type of livestock and/ off farm employment	Top
Crops and small Livestock	Medium
Crops and local chicken only	Bottom

Table 4. Average rating of importance of common bean attributes by household wealthy category in Eastern Kenya, 2008.

Variety attribute	Top=11	Med=15	Bottom=21	Total	P-value
Drought tolerance	2.82 (0.60)	3.00 (0.00)	2.90 (0.30)	2.92 (0.35)	0.877
Early maturing	2.82 (0.60)	3.00 (0.00)	2.81 (0.60)	2.88 (0.49)	0.876
Pest resistance	2.64 (0.81)	2.60 (0.74)	2.71 (0.72)	2.67 (0.72)	0.871
Tolerance to poor soils	2.64 (0.67)	2.53 (0.74)	2.62 (0.74)	2.60 (0.71)	0.917
Growth habit (upright)	2.18 (0.98)	2.87 (0.52)	2.29 (0.92)	2.48 (0.85)	0.160
Less cooking time	2.45 (0.82)	1.80 (0.94)	2.71 (0.64)	2.38 (0.87)	0.029**
High keeping quality	2.40 (0.97)	2.87 (0.52)	2.76 (0.62)	2.72 (0.68)	0.599
Low flatulence	1.91 (0.94)	1.33 (0.72)	2.19 (0.87)	1.88 (0.91)	0.033**
Grain size	2.36 (0.92)	1.33 (0.72)	1.86 (0.91)	1.83 (0.93)	0.039**
Grain colour	2.09 (1.04)	1.80 (0.94)	2.20 (1.01)	2.06 (0.99)	0.561

**, * denote 5% and 10% levels of significance, respectively.

variety is rated inferior in all the consumption attributes. The rating for GLP2 large red mottled was in the reverse order. It is rated above average for consumption attributes, but below average for production attributes. A paired sample t-test further revealed that these varieties significantly differ in their supply of the selected attributes as perceived by farmers. GLPx92 outperforms GLP2 large red mottled in all production attributes but evaluated inferior to GLP2 large red mottled in terms of consumption attributes (Table 5).

Effect of attributes and other factors on variety demand

An OLS regression was used to estimate the marginal proportion of common bean area allocation to GLPx92 and GLP2 large red mottled for each explanatory variable and the respective elasticities. Missing data across the variables reduced the usable sample to 40 observations in analyzing the predicted effects. The results summarized in Table 6 show that the two models were significant

Table 5. Evaluation of popular common bean variety in different preference criteria and paired samples t-test results between the varieties.

Attribute	Average rating of relative performance of variety (5 point scale)		GLPx92-GLP2 large red mottled	
	GLPx92	GLP2 large red mottled	Mean score difference	P-value
Drought tolerance	4.575	2.855	1.725	0
Early maturing	0	0	0	
Pest resistance	0	0	0	
Tolerance to poor soils	3.89	2.2	1.69	0
Cooking time	2.265	3.9	-1.635	0
Low flatulence	2.25	3.815	-1.57	0
Keeping quality	2.34	3.565	-1.225	0
Seed size	2.69	4.155	-1.465	0
Seed colour	2.29	4.15	-1.855	0

at less than 1% with a respective R^2 of 0.48 and 0.51, which implies a good fit for a cross sectional data. Test for multicollinearity using the variable, inflation factor, also shows that all variables had a VIF of less than 2.5, suggestive of stable results.

A joint test of the hypothesis that consumption attributes and other household demographic factors do not matter in land allocations to varieties was rejected, providing support to the agricultural household mode l used to derive variables for the econometric estimation. As expected, a high index of the rating of production attributes had a positive and significant effect on the area share allocated to GLPx92, which is generally evaluated superior to other varieties in production attributes. The index had a negative and significant impact on the area share allocated to GLP2. The GLP2 large red mottled was rated below average for the supply of almost all production attributes.

The analysis of elasticity revealed that farmers in the drought parts of Kenya are more responsive to production attributes than they are to consumption attributes. Results indicate that 1% increase in the index for the production attributes increases the area share of GLPx92 by 0.35% and reduces that of GLP2 large red mottled by 0.24% (Table 5). On the other hand, a similar increase in preference index for consumption attributes reduces area share for GLPx92 by 0.06% and increases that of GLP2 large red mottled by 0.07%.

The concept of the marginal rate of substitution was also applied to assess the farmers' valuation of consumption attributes in terms of production attributes so as to draw implications for possibility of trade-offs. Results show a marginal rate of substitution of consumption attributes for production attributes of 0.42 for GLPx92 and 0.67 for GLP2, further demonstrating the high valuation for production attributes as compared to consumption attributes. This result implies that at the current level of utility, farmers are only willing to give up less than one unit of utility from production attributes for gains in one unit of utility from consumption attributes.

Among the household characteristics included in the analysis, education and household wealth were only significant. Education had a positive effect on the area share allocated to GLPx92 and a negative effect on GLP2 large red mottled. This result could be interpreted that educated people tend to allocate their land designated for common bean to varieties that perform relatively well in terms of yield and use the market to access varieties they prefer but do relatively poorly on their farm.

Farm characteristics represented by the scale of operation and the heterogeneity in farm soil types are also important determinants of variety demand. Scale of operation was positively related with the area share allocated to both varieties but the effect was only statistically significant for GLP2. The positive and significant effect of scale on the area share occupied by GLP2 implies that farmers with access to land tend to compensate for low yield from GLP2 with area expansion.

Variables included as proxies for market conditions show the expected signs. Households with commercial production orientation tend to allocate a bigger proportion of their common bean land to GLP2 (market variety), and less to GLPx92, a risk reducing variety but with inferior consumption attributes. The value of donkeys, shows a positive relationship with the area share

Table 6. Results of the estimation of the ordinary least squares regression of the effect of variety attributes and other factors on the area share allocated to GLPx92 and GLP2 large red mottled.

Variable	GLP2 large red mottled			GLPx92		
	Coefficient	Elasticity	t-value	Coefficient	Elasticity	t-value
Index of consumption attribute	0.089 (0.040)	0.071 (0.033)	2.22**	-0.099 (0.057)	-0.061 (0.036)	-1.72*
Index of production attributes	-0.132 (0.073)	-0.249 (0.139)	-1.82*	0.237 (0.104)	0.347 (0.156)	2.29**
Dependency ratio	0.006 (0.055)	0.018 (0.162)	0.11	-0.039 (0.078)	-0.089 (0.179)	-0.5
Education	-0.022 (0.009)	-0.899 (0.402)	-2.29**	0.023 (0.013)	0.755 (0.441)	1.74*
Production orientation	0.098 (0.050)	0.245 (0.128)	1.95*	-0.169 (0.072)	-0.327 (0.143)	-2.36**
Soil diversity	-0.001 (0.042)	-0.005 (0.295)	-0.02	-0.141 (0.060)	-0.765 (0.337)	-2.34**
Scale of operation	3.3E-01 (1.4E-01)	0.274 (0.119)	2.37**	-0.071 (0.198)	-0.046 (0.128)	-0.36
Value of donkey	2.0E-05 (8.9E-06)	0.094 (0.044)	2.2**	-5.1E-06 (1.3E-05)		-0.4
Household wealth	1.4E-07 (1.8E-07)	0.048 (0.061)	0.79	-2.0E-07 (2.5E-07)		-0.78
Exogenous income	-2.3E-02 (6.1E-02)		-0.38	0.039 (0.087)		0.45
Constant	2.6E-01 (9.8E-02)		2.64***	0.301 (0.139)		2.16**
Observations	38			38		
F(10, 27)	2.88			2.46		
Prob > F	0.014			0.0308		
R^2	0.5161			0.4766		
Adj. R^2	0.3369			0.2827		
Root MSE	0.11748			0.16744		

allocated to GLP2 (a market variety), but the magnitude is too small to matter.

DISCUSSION

This paper highlights important variety attributes, their supply by varieties grown, their effect and that of other factors on the variety demand in drought parts of Kenya. Although the sample was taken from Eastern Kenya, results have implications for other areas with similar socioeconomic and agro-ecological conditions. Consistent with the findings of the previous research (Sperling et al., 1993), a high number of variety attributes is preferred. This preference is largely derived from the high incidences and severity of biophysical stresses and socioeconomic problems faced by farmers in the study area (Katungi et al., 2010). All farmers attach high importance to all production attributes analyzed in this paper, while they significantly differ in their stated preferences for cooking time, low flatulence and grain size. To wealthier households, low flatulence and large grain size are very important while the medium and the poorer households do not mind any size. On the other hand, poorer households prefer a bean variety with less cooking time because these households lack the required resources to support the extended cooking time. This is a key result and has not been reported from other preference studies on common bean.

The study findings indicate that stated consumption and production preferences significantly explain the revealed land allocations to two popular varieties grown in Eastern Kenya. This is consistent with the agricultural household model that was used in this study. Edmeades (2003) also applied an agricultural household model to study variety choice among banana producers in Uganda and obtained similar results. The variety attributes have coefficients of larger magnitudes, implying that variety preferences are the important determinants of land allocation to a common bean variety, underscoring the importance of clear understanding of farmers' preferences.

The study has elaborated that households attach high importance on production and consumption attributes, implying that genetic improvement that incorporates both desirable production and consumption traits would enhance the welfare of these people, especially the poorer households. Therefore, breeding effort should target producing varieties with superior production attributes that are compatible with farmers' consumption preferences. Results further revealed that farmers in drought areas are more responsive to production attributes and value them highly compared to consumption attributes. This implies that introduction of varieties with superior production attributes than is currently supplied by the popular varieties will be widely adopted even when their consumption attributes are the same as that of the existing varieties or reduced slightly.

The study has also demonstrated that in addition to variety attributes, education of the production decision maker, farm size, diversity of soils on the farm and production orientation significantly explain variation in the extent of variety planting across households. Study results indicate that the area share allocated to a risk increasing variety (GLP2 red mottled) increases with farm size because larger farmers have the ability to diffuse risk through better access to credit (Feder, 1980; Feder et al., 1985; Knight et al., 2003). Controlling for farm size and other factors, education seems to reduce land allocation to the risk increasing variety. Although education has been demonstrated to act through its positive effect on information (Schultz, 1975), we do not expect this mechanism to be important in land allocation to the two varieties considered in this study since these varieties have been grown for long in the community and almost every farmer is considered to have information about them. Instead, the result implies that as drought in Kenya increasingly becomes more important (Sperling, 2002) and bean markets increasingly rely on imports, better educated decision makers choose to allocate more land to varieties less vulnerable to drought while they depend on the markets for varieties considered more vulnerable to drought as a way of enhancing productivity of their resource. Several empirical studies reviewed by Feder et al. (1985) have confirmed the positive effect of education on allocative efficiency in agriculture, particularly, under changing environment.

Results also show that area allocation to each variety reduces with increase in soil type heterogeneity on the farm which is consistent with the findings in literature that farmers match their crop varieties with soil types (Bellon and Taylor, 1993) and this could result in each variety occupying a small portion of the land. Furthermore, farmers with commercial production orientation tend to trade-off expected yield with high marketability. The implication is that as markets develop and market attributes become more important, area under common bean cultivation may shift to more marketable varieties even in drought prone areas. This could further reduce common bean productivity.

Conclusions

The study findings have important implications for breeding, as well as variety dissemination. For breeding, the study findings support the conclusion that varietal adaptation to environmental stresses that also strive to reduce the cooking time, enhance the keeping quality and grain colour will greatly benefit the poor. However, when multi-attribute breeding is not feasible or is long term, prioritizing the improvement of production attributes as a short term goal seems an efficient strategy. Trade-off between desirable production attributes and marketability need to account for exogenous factors that are important in variety planting decisions but subject to change. For example, the study findings point to a possibility of a future shift in land to well adapted varieties as farm sizes become smaller due to increases in population pressures and household access to markets in neighbouring countries with a comparative advantage in the production of market varieties improves. In the long term, there is need for breeding strategy that simultaneously enhances the production, as well as marketability of varieties even in drought prone areas.

Study findings also imply that during variety dissemination, information related with less tangible variety attributes such as cooking time and keeping quality should be packaged and disseminated alongside varieties to facilitate adoption decision making process and faster diffusion of varieties.

ACKNOWLEDGEMENTS

This study was done as part of a project funded by Bill and Melinda Gates Foundation. The good collaboration of the International Centre for Tropical Agriculture (CIAT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Institute of Tropical Agriculture (IITA) and KARI contributed greatly to the success of this project. The Kenya Agriculture Research Institute in Katumani greatly facilitated data collection and the initial analysis of the study.

REFERENCES

Bellon M, Taylor J (1993). "Folk" soil taxonomy and the partial adoption of new seed varieties. Econ. Dev. Cult. Change, 41: 763-786

Bellon MR (1996). The dynamics of crop intra-specific diversity: A conceptual framework at the farmer level. Econ. Bot., 50: 26-39.

de Janvry A, Fafchamps M, Sadoulet E (1991). Peasant household behaviour with missing markets: Some paradoxes explained. Econ. J., 101: 1400-1417.

Edmeades S (2003). Variety choice and attribute trade-offs within the framework of agricultural household models: The case of bananas in Uganda. A PhD Dissertation, North Carolina State University.

FAOSTAT (2010). Food and Agriculture Organization at www.fao.org.

Feder G (1980). Farm size, risk aversion and the adoption of new technology under uncertainty". Oxford Economic Papers, 32 (2): 263-283.

Feder G, Just RE, Zilberman D (1985). Adoption of agricultural innovations in developing countries: A survey. Econ. De. Cult. Change, 33: 255-298.

Greene W (2000). Econometric analysis. Fourth Edition, Prentice Hall, Upper Saddle River, New Jersey.

Katungi E, Farrow A, Mutuoki T, Gebeyehu S, Karanja D, Alamayehu F, Sperling L, Beebe S, Rubyogo JC, Buruchara R (2010). Improving Common Bean productivity. An Analysis of socio-economic factors in Ethiopia and Eastern Kenya. CIAT Working document #217.

Knight J, Weir S, Woldehanna T (2003). The role of education in facilitating risk-taking and innovation in agriculture. J. Dev. Stud., 39(6): 1-22.

Lancaster KJ (1966). A new approach to consumer theory. J. Polit. Econ., 74: 132-157.

Mwita R J, Mavua K, Audi PO (1981). The farming system of lowland Machakos district, Kenya. Report of farm survey results from Mwala location. Technical report No.1

Odendo M, David S, Kalyebara R (2004). The Key role of beans in poverty alleviation: Lessons from the Impact of Improved bean varieties in Western Kenya, Occasional publications Series, No.43.

Sadoulet E, de Janvry A (1995). Quantitative development policy analysis. The John Hopkins University Press, Baltimore and London.

Schultz T (1975). The value of the ability to deal with disequilibria. J. Econ. Lit., 13 (3): 827-846.

Singh I, Squire L, Strauss J (Eds) (1986). Agricultural household models. Extension, applications and policy. The Johns Hopkins University Press Baltimore, Maryland 21211, USA.

Sperling L (2002). Emergency seed aid in Kenya: some case study insights on lessons learned during the 1990's disasters, 26(4): 283-287.

Sperling L, Loevinsohn M, Ntabomvura B (1993). Rethinking the farmer's role in plant breeding: local bean experts and on-station selection in Rwanda. Expl. Agric., 29: 509-519

Sperling L, Scheidegger UC, Buruchara R (1996). Designing seed systems with small farmers: principles derived from bean research in the Great Lakes Region of Africa. Agricultural Administration (Research and Extension) Network Paper, No. 60. London: Overseas Development Institute.

Wale E, Mburu J (2006). An attribute-based index of coffee diversity and implications for on-farm conservation in Ethiopia. In Smale, M. (Ed.) valuing crop biodiversity. On-farm genetic resources and economic change, CAB International Publishing, 48-62.

APPENDIX

Table 1. Scores after factor analysis of variety attributes.

Attribute	Scoring coefficient		
	Consumption flavor	Yield related characteristic	Proportion of variation explained
Consumption			0.568
Less cooking time	0.10	0.02	
High keeping quality	0.41	0.09	
Less gas	0.28	0.03	
Grain size	-0.12	0.04	
Grain colour	-0.04	0.03	
Production attribute			0.471
Drought tolerant	0.05	0.39	
Early maturing	-0.05	0.23	
Pest resistance	0.28	0.22	
Tolerate poor soils	-0.05	0.20	
Growth habits (upward)	0.13	0.07	