African Journal of Rural Development, Vol. 7 (3): July-September 2022: pp. 399-411. ISSN 2415-2838

Household income determinants of crop sales: The case of Common Bean production and marketing in selected bean corridors in Kenya

J. KAVOI,[1]* S. WAMBUA[2], A. GICHANGI[1], M.MUTUA[4], E. BIRACHI[3], C. CHEGE[3] and D. KARANJA[4]

[1]Socio-Economics and Policy Development Programme, KALRO-Katumani Research
[2]Business Development Sub-Unit, KALRO Headquarters
[3]International Centre for Tropical Agriculture (CIAT), Nairobi Office, Kenya
[4]Grain Legumes Research Programme, KALRO-Katumani Research Centre
Corresponding Author: jmkavoi@yahoo.com; Justus.kavoi@kalro.org; j.kavoi59@gmail.com

ABSTRACT

Beans (*Phaseolus vulgaris* L.) are mainly consumed without much processing although value addition through precooking leads to many benefits. Challenges in common bean production have been attributed to increasing severity of production constraints, amongst them erratic and poorly distributed rainfall patterns, and degraded natural resources – especially declining soil fertility. This study sought to characterise common bean producers, determinants of smallholder farmers' income from crop sales, bean marketing challenges and potential opportunities that can be explored for increased adoption and production of common beans along selected bean production corridors in Kenya. Data were collected from 440 respondents selected using a multi-stage random sampling procedure. Study findings show that labour distribution across bean production activities were predominantly carried out by male and female household members. Up to 50% of the respondents reported crop farming as their main source of household income. Smallholder farmers with secondary and above level of education stood to significantly gained more from crop sales relative to those with either primary or no education at all (p=0.04). Use of certified bean seeds coupled with allocation of large portion of owned land for bean production positively contributed to household income from crop sales (p=0.07; p=0.028, respectively). Challenges associated with bean marketing were unreliable and unorganized bean market; low bean grain prices; poor transport to sell farm produce and procure farm inputs; and market price instability emanating from market intermediaries. Value addition of beans at industrial level can enhance both household income and nutrition.

Keywords: Certified bean seed, crop sales, education level, household income, Kenya

RÉSUMÉ

Les haricots (*Phaseolus vulgaris* L.) sont principalement consommés sans beaucoup de transformation, bien que la valeur ajoutée par la précuisson présente de nombreux avantages. Les défis de la production de haricots communs ont été attribués à l'aggravation des contraintes de production, parmi lesquelles des motifs de pluie erratiques et mal répartis, et des ressources naturelles dégradées, en particulier la baisse de la fertilité du sol. Cette étude visait à caractériser les producteurs de haricots communs, les déterminants du revenu des petits exploitants provenant des ventes de cultures, les défis de la commercialisation des haricots et les opportunités potentielles qui peuvent être explorées pour augmenter l'adoption et la production de haricots communs le long de

Cite as: Kavoi, J.,Wambua, S., Gichangi, A., Mutua, M., Birachi, E., Chege, C. and Karanja, D. 2022. Household income determinants of crop sales: The case of Common Bean production and marketing in selected bean corridors in Kenya. *African Journal of Rural Development* 7 (3): 399-411.

certains couloirs de production de haricots au Kenya. Les données ont été collectées auprès de 440 répondants sélectionnés selon une procédure d'échantillonnage aléatoire à plusieurs étapes. Les résultats de l'étude montrent que la répartition du travail dans les activités de production de haricots était principalement effectuée par des membres masculins et féminins du ménage. Jusqu'à 50 % des répondants ont déclaré que l'agriculture était leur principale source de revenu. Les petits exploitants ayant un niveau d'éducation secondaire et supérieur ont été significativement plus avantagés financièrement par les ventes de cultures par rapport à ceux ayant une éducation primaire ou aucune éducation du tout (p=0,04). L'utilisation de semences de haricots certifiées associée à l'allocation d'une grande partie des terres possédées à la production de haricots contribuait positivement au revenu des ménages provenant des ventes de cultures (p=0,07 ; p=0,028, respectivement). Les défis associés à la commercialisation des haricots étaient un marché de haricots peu fiable et désorganisé ; des prix du grain de haricot bas ; un transport insuffisant pour vendre les produits agricoles et acheter des intrants agricoles ; et l'instabilité des prix sur le marché résultant des intermédiaires. La valeur ajoutée des haricots au niveau industriel peut améliorer à la fois le revenu des ménages et la nutrition.

Mots-clés : Semence de haricot certifiée, défis, ventes de cultures, niveau d'éducation, revenu des ménages, Kenya

INTRODUCTION

Globally, common bean (*Phaseolus vulgaris* L.) is the most important food legume for direct human consumption and was introduced in Africa before the 16th century (Katungi *et al.,* 2010; Bukenya-Ziraba *et al.,* 2012). The crop occupies more than 3.5 million hectares in Sub-Saharan Africa (SSA), accounting for about 25% of the global production. Its genetic diversity has sustained livelihoods for more than 100 million people in SSA, with important economic and socio-political dimensions (Kiwuka *et al.,* 2012). In the Eastern Africa region, common beans provide a ready source of plant protein with a per capita consumption of 50 to 60 kg year^{-1}. This is considerably higher than in Latin America where per capita consumption is 4 and 17 kg year^{-1} in Colombia and Brazil, respectively (Katungi *et al.,* 2010). Njeru (2013) noted that food production in SSA has faced unprecedented challenge of producing sufficient and healthy food for the surging human population. Furthermore, severe and prolonged droughts have affected much of East Africa resulting in for example devastating impacts on Kenya's pastoral areas (Boon and Semakula, 2010).

Although small-scale farmers are prone to food insecurity, they feed more than 80% of the world's population and are located in the developing world (Herren *et al.,* 2012). Moreover, many communities in SSA region depend largely on agriculture. Thus, development of resilient and affordable agricultural systems is vital (Njeru, 2013). In the SSA region, relatively slow expansion in the cultivated area is due to scarcity of arable land mass and rapid population growth (Sibiko, 2012). In addition, natural resources degradation is a serious problem resulting from efforts to increase land productivity and improve food security in the densely populated highlands of eastern and southern Africa (Yirga *et al.,* 2014). Bean research for improved bean production, which combines breeding and improved agronomic practices, began in the 1960s (Katungi *et al.,* 2010). Due to their high nutrients content and commercial potential, common beans hold great promise for fighting hunger, increasing income and improving soil fertility (Katungi *et al.,*2010; Beebe *et al.,* 2013). Traditionally, beans are a smallholder farmer crop, often grown in complex farming systems in association with or rotation with maize, sorghum, cowpeas and other crops

(Beebe *et al.,* 2013). Common bean presents a potential pathway for improving rural livelihoods through production and marketing (Birachi *et al.,* 2011). However, in recent years, common bean production trend has not kept pace with the annual population growth rate due to a number of biotic, abiotic and socioeconomic constraints (Katungi *et al.,* 2009).

Majority of farmers in Kenya are smallholders who own less than two hectares of land (Altieri *et al.,* 2012). Such land sizes are likely to be further reduced due to land fragmentation and unregulated urban centres' expansion leading to reduced farm productivity. Additionally, agricultural extension has been the means of information delivery to farmers. This goes alongside dissemination of new technologies for increased production in food and animal products (Chemining'wa *et al.,* 2014). However, declining Government budgets combined with waning donor interest has led to significant cuts in public extension services (Ministry of Agriculture, 2012). Limited access (in terms of availability and affordability) to improved technologies, for instance, certified bean seeds among other technologies coupled with poor extension services further lower farm productivity among smallholder farmers (Chemining'wa *et al.,* 2014). Moreover, smallholder farmer's household income is arguably a function of crop and livestock sales as well as the individual farmer's access to improved technologies. This poses a major challenge especially when the farmer has to share the available household income between several household pressing needs such as health, education and food, among others. As such, increasing common bean production in Kenya continues to be challenge. Hence a study to determine the factors that contribute to the amount of household income generated from crop sales was deemed necessary, since this would establish the quantities of farm inputs the farmer would be able to purchase. To better understand the challenges this study was undertaken to also explore emerging opportunities for enhancing agricultural productivity and economic development among farmers in bean production corridors in Kenya.

MATERIALS AND METHODS

The study was carried out in Bomet, Homa-Bay, Machakos and Narok Counties, Kenya where common bean production enterprise is practised. Additionally, infrastructure such as roads, electricity and markets, among others, in the four counties differ in size and level of development. Calculating a sample size is usually a trade-off between the ideal and the feasible (SMART, 2012). In the four study Counties, over 10,000 households comprising small (less than 2 hectares), medium (2-5 hectares) and large farm (above 5 hectares) (Altieri *et al.,* 2012) sizes grew and marketed common beans (Ministry of Agriculture, 2012). From a total target population of 10,000 and above, sample size determination follows recommended statistical formulae (Green, 2000) for arriving at desired sample size using predetermined confidence levels (Equation 1). A sampling frame was established and a sample drawn using multi-stage sampling procedure based on administrative boundaries at different levels until individual sampling unit level was selected for inclusion in the study as recommended by Thompson *et al*. (2011) and Garson (2012). The sample size was determined, as:

$$n = \frac{Z^2 p q}{d^2} \qquad (1)$$

Where
n = the desired sample size
Z = the standard deviation set using a desired confidence levels (e.g. at 95% confidence intervals Z is 1.96),
P = the proportion of the target estimated to have a particular characteristic for example the target population has 60 % of the households living under the poverty line,
q = 1-P, and,
d = the degree of accuracy desired in this case was 95%,

In this study therefore, n was determined as follows:

$$n = \frac{1.96^2 \times 0.60 \times (1-0.60)}{0.05^2} = 369$$

With the assistance of local public extension officers and local administrators, names of households in selected villages were listed to help select the respective desired sample sizes. To draw the desired sample size, sampling standard procedures were adopted (SMART, 2012). To cater for attrition cases across the four study sites, 20% of the calculated total sample size was adopted. This gave a total sample size of 443, rounded up to 440 respondents randomly drawn from the selected study sites. The 440 respondents were proportionately spread across the study sites, thus, 70 respondents (Bomet), 238 respondents (Homa-Bay), 61 (Machakos), and 71 (Narok) (Equation 2).

$$i = \frac{N_1}{N_2}(n) \qquad (2)$$

Where
i = Proportion of the sample in particular village
N_1 = the total number of households in a particular village
N_2 = the total population
n i = the total sample size calculated on the basis of the target population.

Data collection and analysis. Data were collected in two waves using computer assisted personal interviews (CAPI) on Tablets: The first wave involved data collection on gender related issues in common bean production. In the second wave, data on farm level bean production were collected from the same farmers where data on gender related issues were collected. Qualitative data were coded and transformed into quantitative data for analysis. Descriptive statistics (frequencies, percentages, and means) and linear regression model were used to analyse data using the statistical package for social sciences software. The unit of analysis was the individual household. Natural log of income was used to normalize the dependent variable (household income from crop sales) before applying the regression model.

RESULTS AND DISCUSSIONS

Demographic characteristics of smallholder common bean producers. The study respondents comprised 143 men (33%) and 297 women (67%), spread out in the study sites. Additionally, gender composition of the household head differed across the study sites. There was a higher percentage (32%) of women-headed households in Homa-Bay County compared to Machakos County (8%). Results further indicated that 74% and 87% respondents were from men-headed households in Bomet and Narok Counties, respectively.

Age of the respondents ranged from 21 to 92 years, with the lowest mean age of about 41 years in Narok County and highest mean age of 58 years in Machakos County. With regard to household income, study findings showed that, household income from crop sales is a function of several independent variables. These include demographic characteristics of the respondents (education level, sex of the respondents, number of household members) and well as cropped land, amount of seed bought and supplier of bean seed. Education level of household heads indicated that 64% had either no education or at least primary education. Only 9% of the respondents had attained tertiary education (Table 1).

Education plays an important role in decisionmaking on technology adoption (Quisumbing and Pandolfelli, 2009). Thus, low education level among the smallholder bean-producing farmers is likely to negatively affect adoption of improved technologies including improved bean varieties for increased household income from crops in the study region. The study further sought to relate the factors contributing to the level of household income from marketed crop produce. Correlation equations were used to establish such factors. Price, land size

(area of production - county), education level, household head gender, cropped area and gender of the respondent had impact on the level of household income obtained from crop sales. Results from normalised linear regression model showed that those with secondary and above education significantly gained more relative to those with either primary of no education at all (p=0.001 and p=0.005 for secondary and tertiary education respectively) (Table 2).

Table 1. Education level of household head

Variable	Min	Max	Mean	Std. Dev
Gender of household head: Male			29%	
Female			71%	
Education level of household: At least primary			64%	
At least secondary			27%	
At least tertiary			9%	
Household members aged 15-65 year	0.00	8.00	3.16	1.67
Quantity of bean seed bought	0.00	280.00	13.74	28.31
Price of bean seed per Kg (KES)	35.00	430.00	101.00	36.88
Proportion of owned land under beans (Ha)	0.01	30.00	1.34	2.018

n=335

Table 2. Effects of selected production factors on household income from crop sales

	Standardized Coefficients[a]			
Model	Std. Error	Beta	t-Value	p-Value
Dummy for female respondent=1; 0 otherwise	0.129	-0.021	-0.419	0.676
Dummy for respondent with above primary up to secondary education=1;0 otherwise	0.132	0.167	3.287	0.001
Dummy for respondent with tertiary education=1;0 Otherwise	0.204	0.146	2.8839	0.005
Number of household members aged 15-65 years	0.034	0.038	0.762	0.446
Supplier of input Bean seed for beans last season	0.029	-0.067	-1.377	0.170
Quantity of input Bean seed bought	0.003	0.157	2.352	0.019
Price of input Bean seed per unit	0.000	-0.072	-0.969	0.333
Area (Acres) of land under beans	0.046	0.309	3.565	0.000

[a]Dependent Variable: Natural log of income

With regard to household labour distribution and use, a cross-tabulation analysis across the data collection sites showed that male and female household members predominantly carried out certain bean production activities. A case in point is threshing and winnowing of beans. A greater percentage of female respondents were involved in bean threshing compared to their male counterparts (Table 3). Thus, promotion of technologies that reduce post harvest labour are likely to be adopted for enhanced improved bean production, household income and improved nutritional status.

Female farmers were the main actors – doing most of harvesting, transporting harvested bean crop, threshing, harvesting and storage (Table 4).

Table 3. Marital status of household heads

Name of County	% Marital status of household head				Total
	Married	Single	Widowed	Separated	
Bomet	88.4	1.4	10.1	0.0	100.0
Homa-Bay	76.4	0.0	23.1	0.5	100.0
Machakos	91.7	1.7	6.7	0.0	100.0
Narok	86.8	7.4	5.9	0.0	100.0

Table 4. Main actor in bean production activity cross tabulation

Activity	Average percent of household main actor in different bean production activities across the four Counties							
	Husband	Wife	Son	Daughter	Parent (In-law)	Brother/ Sister	Son/ daughter in-law	Hired worker
Site selection	74.3	19.3	0.4	0.2	0.7	0.0	0.0	1.8
Bush clearing	65.0	19.0	1.0	0.5	0.3	0.3	0.5	9.6
Land opening	60.6	22.0	0.7	0.5	0.2	0.2	0.0	10.6
Final land ploughing	59.6	22.2	0.9	0.6	0.4	0.6	0.2	10.5
Planting	37.0	44.5	0.5	0.5	0.4	0.0	0.0	7.7
Weeding	31.8	46.1	0.4	0.2	0.4	0.0	0.0	11.5
Spraying (Pests and Diseases)	53.7	27.3	3.1	0.9	0.0	0.3	0.0	8.6
Fertilizer application	51.5	31.8	1.7	0.3	0.0	0.0	0.0	7.9
Bean harvesting	29.4	50.8	0.6	0.2	0.4	0.0	0.0	7.9
Transporting beans from field	28.8	47.9	1.5	0.8	0.4	0.0	0.2	7.8
Threshing beans	25.4	50.8	1.3	0.9	0.2	0.0	0.0	9.6
Winnowing beans	20.2	65.3	0.2	0.2	0.5	0.0	0.2	5.5
Sorting beans	19.0	65.0	0.5	0.3	0.5	0.0	0.8	5.9
Post-harvest and storage	41.9	48.8	1.0	0.5	0.5	0.0	0.0	1.8

Continuous dependency on family labour subjects farmers to problems of seasonal peaks in labour demand. Since the household wife does most of the bean weeding, priority and competition between different crops led to poor technical efficiency on the part of the women folk in the study areas. Consequently, late common bean weeding occurred once or even haphazardly leading to reduced bean yield (Ronner and Giller, 2012). This could partly be attributed to reduced labour availability as individual household male members migrate to urban centres in search of jobs.

Household income sources differed across study sites with 50%, 44%, 42.6% and 37% of the respondents mentioning crop farming as their main source of income in Homa-Bay, Narok, Bomet and Machakos respectively (Table 5). The four Counties fall under different agroecological zones with different agricultural production potential. Thus, the differences in household income from crops are partly explained by the differences in agricultural production potential across the four Counties.

Further analyses were conducted to establish if there were differences in farm enterprises' contribution to household income from sales of crops and livestock. Results showed that households relied on both crop and livestock enterprises – a possible mitigation against the unpredictable vagaries of nature. In Bomet County, mean annual income from crops sales was KShs.70,281 compared to a mean of KShs.103,003 from livestock sales. However, in Homa-Bay County, the mean annual earnings from crop sales were higher than mean annual earnings from livestock, i.e., KShs.30,978 and 20,737, respectively.

Challenges facing bean producing smallholder farmers in the study areas. The importance of common bean in providing a ready source of protein cannot be overemphasized. However, during the study, it was observed that the growth in common bean productivity has been slow due to several challenges facing farmers in the study areas. These included continuous use of own bean seed (seed recycling) – due to poor access to certified bean seed at the local level; distorted and or unorganized bean marketing systems along the bean value chain; poorly distributed and erratic rainfall especially in the semi-arid areas; and pests and diseases. Furthermore, rainfall unpredictability outdoes the other constraints in common bean production in Kenya as it accounts for over 50 % of yield loss.

Table 5. Sources of household income in the study sites

Source of Income	Percent Respondents			
	Bomet	Homa-Bay	Machakos	Narok
Crop farming	42.6	50.1	37.1	44.1
Livestock rearing	40.7	19.4	30.1	31.1
Salaried employment	2.	6.5	8.4	11.8
Casual jobs	4.3	6.0	7.0	0.6
Business/ Trade	9.3	16.5	11.2	11.2
Remittances	0.0	1.6	3.5	0.0
Pension	0.0	0.0	2.8	0.0
Property rental	0.6	0.0	0.0	1.2
Total	100.0	100.0	100.0	100.0

Study findings on poorly distributed and erratic rainfall agreed with earlier study findings by Katungi *et al*. (2010) who noted that drought is by far the most important common bean production constraint, with a probability of occurrence estimated at 38% in Ethiopia and 60% in Eastern Kenya. Study findings showed several challenges associated with marketing of beans. Top on the list was low market prices where 168 respondents (38%) said it was a major challenge. Other price associated challenges mincluded market intermediaries (brokers) (9%), unreliable transport (9%) and market instability (8%). Further probing on bean marketing challenges showed that respondents trekked long distances to the market for both farm inputs and farm produce. Distances (in Kilometres) to nearest suppliers of farm inputs varied across the different types of input suppliers as well as across the Counties. In Narok County, the average distance to the nearest Agro-Vet dealer was 16 km while the same in Homa-Bay County was 4.06 km (Table 6).

Poor access to farm inputs including new improved varieties remains a major challenge to smallholder farmers. Access (in terms of availability and affordability) of certified bean seed and accompanying farm inputs for enhanced common bean production. Price of certified (packaged) bean seed was reported as the most important factor limiting access to new improved bean varieties. Moreover, lack of right information on availability and how to use new bean varieties adversely affects efforts by farmers to increase acreage and production of common bean grain. Respondents committed minimal financial resources to purchase a variety of farm inputs associated with bean production. The state of vulnerability, i.e., the poor households' susceptibility to external stresses and shocks depicted high production risks on the farm. Thus, the need to package farm inputs such as seed, fertilizer, herbicides, pesticides in a variety of sizes to realize affordability among the smallholder farmers in bean production corridors in Kenya.

Opportunities for increasing common bean production and marketing. Results and other information obtained in the study areas pointed to a number of opportunities which can be explored for increased common bean production in the four Counties. These included:

Table 6. Average distances (km) to input suppliers across the study sites

Type of input supplier	County			
	Bomet	Homa-Bay	Machakos	Narok
Farm-made	2.76	1.56	19.64	7.74
Agro-Vet Dealer	5.47	4.06	10.63	16.04
Research Organizations	3.67	N/A	17.50	10.00
Seed Companies	1.50	N/A	12.00	3.33
Retail Markets	4.55	1.38	0.30	7.66
Other Farmers	4.55	1.38	030	7.66
Retailer/Market	N/A	3.38	7.89	20.00
Non-Governmental Organizations	N/A	2.21	N/A	10.00
National Cereals and Produce Board	11.50	N/A	N/A	10.00

Availability of improved bean varieties in the market (Agro-Vet Dealers). Improved bean varieties present potential opportunity in that they mature fast, are drought tolerant, rich in micronutrients, low or no flatulent and high yielding. In areas where agro-vet dealers stocked improved bean varieties in different size packs, respondents indicated increased sales of the same.

Value added bean. Value-addition of beans at industrial level can enhance both household income and nutrition. Urban and peri-urban consumption of beans and bean products has the potential to enhance marketing of beans for increased household income and improved health status.

Organised bean production and marketingthrough community production and marketing system. Prior to the introduction and implementation of the Cultivate Africa's Future (CultiAF) project, especially in semi-arid lower Eastern Kenya, a public-private development initiative to promote and commercialize Gadam sorghum grain had been implemented using existing farmer self help groups. Lessons learnt by the then Kenya Agricultural Research Institute (KARI), currently one of the four institutes that formed the Kenya Agricultural and Livestock Research organization (KALRO), Smart Logistics (Private company) and Ministry of Agriculture who implemented Gadam sorghum initiative were used to mobilize, train and establish a similar public-private-partnership platform named Community Production and Marketing System (COPMAS). This platform enables the farming community to collectively grow, aggregate and sell their farm produce. This gives the farmers collective price bargaining power and limited exploitation by intermediaries in the bean value chain. Thus, the platform has great potential to enhance promotion, production and marketing of improved bean varieties that have been introduced to participating farmers for improved household income, food security and
nutrition.

Demographic and economic factors influencing household income from crop sales. Certified seed is an important farm input and has influence on the yield obtained. However, quantities that smallholder farmers are likely to plant can be dictated by the seed accessibility (defined by availability and affordability). With regard to sources of bean seed in the study area, about 62% of the respondents used own saved bean seed. Varieties grown were both local and improved. About 16.1% and 10.7% of the households obtained bean seed from other farmers and retail markets, respectively. A small percentage (about 1%) of the households bought bean seed from research organizations and seed companies (Table 7).

Table 7. Sources of bean seed

Source	Frequency (n=391)	Percent
Farm-made	241	61.6
Agro-Input Dealer	34	8.7
Research Organizations	2	0.5
Seed Companies	2	0.5
Other Farmers	63	16.1
Retailer/ Market	42	10.7
NGOs	6	1.5
Ministry of Agriculture	1	0.3
Total	391	100.0

Regression Analysis Results. To establish the determinants of household income from crop sales among the common bean growing smallholder farmers, the researchers sought to relate the variables contributing to the level of household income from marketed crop produce. To achieve this, correlation analysis was carried out. Price of bean seed, portion of owned land under bean crop, education level and gender of household head had influence on the level of household income generated from crop sales. Dummy variables on education level, crop sales, and household gender were created and incorporated into the ordinary least squares (OLS) model. The variables were then subjected to a regression model to find out if there were any significance relations or associations between the independent variables and the dependent variable. The OLS model used was presented below:

Y = a+(□X1+□X2+□X3+ Đ1+ Đ2+ Đ3+ Đ4)

Where
Y = Lncrop household income (natural log of income from crop sales)
a = constant
□□= Predictor of average change in Y that is associated with a unit change in X1, X2, X3.
X1 = Quantity of bean seed bought in kg
X2 = Price of bean seed per kg
X3 = Area grown with beans relative to total land owned in Ha
1= Seed type: Use improved bean seed=Yes, 0=otherwise
2= Crop sales: Normally sells beans=Yes, 0=otherwise
3= Sex of household head: Female, 0=otherwise
4= Education level: Up to primary education, otherwise attained secondary education or higher

The overall model fit was significant, thus the factors used significantly contributed to the observed income levels from crop sales. Respondents with secondary education and above education significantly gained more relative to those with either primary or no education at all (p=0.04 (Table 8). This study finding agreed with findings in a study by Quisumbing and Pandolfelli (2009), which showed that education plays an important role in decision-making on technology adoption to enhance farm productivity. Such decision could be on type of seed to plant, amount of household income to commit to set aside to purchase farm inputs or the portion of owned land to put under different crop enterprises. Lack of or low education level can partly explain the variation in area allocated for common bean production, use of certified seed and other farm inputs among the farmers in the study sites in Kenya. The proportion of owned land grown with beans significantly influenced household income from bean crop sales (p=0.028). Thus, the more land the farmer puts under improved bean production, the more the household benefits from bean crop sales. As noted in a study by Place *et al*. (2005), with increased household income from bean crop sales, the farmer is more likely to commit more money into purchasing certified bean seeds. This would therefore increase the overall bean crop production and sales from the bean production corridors in study region.

Respondents who planted certified bean seed gained more from bean sales relative to those who planted home or recycled bean seed (p=0.07) (Table 8). This can partly be explained by the fact that improved bean seeds have higher yield potential compared to local bean varieties (Karanja *et al*., 2010) as well as home saved or recycled bean seeds. Improved technologies and innovations are available. However, a knowledge gap exists in that, it may seem not clear why smallholder farmers do not readily adopt them (Wang'ombe *et al*., 2013).

Table 8. Effects of selected production factors on household income from crop sales

	Coef.	p-value	t-statistic	Std. Error
Constant	9.268532		36.79	0.251934
Quantity of bean seed bought (kg)	0.00555	0.000***	5.86	0.000947
Bean seed price in KES/kg	0.001868	0.218	1.24	0.001512
Proportion of owned land under bean	0.019405	0.028**	2.21	0.008792
Used improved bean seed (base is no)	0.236015	0.070*	1.82	0.129654
Household normally sells beans (base is no)	0.545204	0.011**	2.57	0.212284
Sex of household head is female (base is male)	-0.06857	0.630	-0.48	0.142351
Household head attained secondary level of education (base is primary and below)	0.252524	0.040**	2.07	0.122208

*; **; *** Significant at 0.1, 0.05, and 0.01 confidence level, respectively

CONCLUSIONS AND RECOMMENDATIONS

Although different improved bean variety seeds are available in the bean production corridors, their adoption and production remains low. Quantity of certified bean seed bought positively influenced household income. The more the amount of bean seed bought the higher the household income. Long distances to farm input suppliers remain a big challenge for smallholder farmers to readily access and procurement of farm inputs. Promotion and commercialization of bean production through well established public-private-partnership platform such as community production and marketing system has shown great potential for commercializing improved bean varieties. An elaborate initiative need to be undertaken to adequately promote and use adaptable models for enhanced improved household income, food security and nutrition.

ACKNOWLEDGEMENTS

The International Development Research Centre (IDRC)/ Australian Centre for International Agricultural Research (ACIAR) funded the study through the Cultivate Africa Future (CultiAF) project number 1162. Kenya Agricultural and Livestock Research Organization (KALRO) and the International Centre for Tropical Agriculture (CIAT) allowed use of Institution facilities while planning and carrying out the study. Authors equally appreciate data collection enumerators for their dedication and the local extension and administration staff for assistance in data collection.

STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

REFERENCES

Altieri, M. A., Funes-Monzote, F. and Petersen, P. 2012. Agro-ecologically efficientagricultural systems for smallholder farmers: Contributions to food sovereignty. *Agronomy for Sustainable Development* 32 (1): 1–13. http://dx.doi.org/10.1007/s13593-011-0065-6.

Beebe, S., Rao, I., Blair, M. and Acosta-Gallegos, J. 2013. Phenotyping common beans for adaptation to drought. *Frontiers in Physiology, Methods* 4 Article 35: 1-20.

Birachi, E., Ochieng, J., Wozemba, D. Ruraduma, C., Niyuhire, M. and Ochieng, D. 2011. Factors influencing smallholder farmers' bean production and supply to market in Burundi. *African Crop Science Journal* 19 (4): 335 – 342.

Boon, E. and Semakula, H. 2010. Assessing the prospects and challenges of greening agriculture in Africa: A case study of organic agriculture. Paper presented during the 30th annual meeting of the international association for impact assessment, 6-11 April, 2010, International conference centre, Geneva, Switzerland.

Chemining'wa, G., Kitonyo, O. and Nderitu, J. 2014. Status, challenges and marketing opportunities for canning navy bean in Kenya. *African Journal of Food, Agriculture, nutrition and Development* 14 (5): 2072-2087.

Garson, D. 2012. Sampling. Statistical, associates publishing, Blue book series. North Carolina State University, School of Public and International Affairs, United States of America.

Herren, H., Hilbeck, A., Hoffmann, U., Home, R., Levidow, L., Muller, A., Nelson, E., Oehen, B. and Pimbert, M. 2012. Feeding the people: agro-ecology for nourishing the world and transforming the agri-food system. IFOAM Organics International, The Netherlands.

Katungi, E., Farrow, A., Chianu, J., Sperling, L. and Beebe, S. 2009. Common bean in Eastern and Southern Africa: A situation and outlook analysis. *International Centre for Tropical Agriculture* 61: 1-44.

Katungi, E., Farrow, A., Mutuoki, T., Gebeyehu, S., Karanja, D., Alamayehu, F., Sperling, L., Beebe, S., Rubyogo, J. and Buruchara, R. 2010. Improving common bean productivity: An Analysis of socio-economic factors in Ethiopia and Eastern Kenya. Baseline Report Tropical legumes II. Centro Internacional de Agricultura Tropical- CIAT. Cali, Colombia.

Karanja, D., Kavoi, J., Sperling, L., Rubyogo, J. and Ogecha, J. 2010. Promotion of Improved Bean Varieties in Nyanza, Western, and Central Rift Valley Provinces of Kenya. Paper presented during the 12th KARI Biennial Scientific Conference and Exhibition, KARI Headquarters, Kaptagat Road, Nairobi.

Kiwuka, C., Bukenya-Ziraba, R., Namaganda, M. and Mulumba, J. 2012. Assessment of common bean cultivar diversity in selected communities of central Uganda. *African Crop Science Journal* 20 (4): 239 – 249.

Njeru, E. 2013. Crop diversification: A potential strategy to mitigate food insecurity by smallholders in sub-Saharan Africa.

*Journal of Agriculture, Food Systems, and Community Developmen*t 3 (4): 63-69.

Place, F., Adato, M. and Hebinck, P. 2005. Understanding rural poverty and investment in agriculture: An assessment of integrated quantitative and qualitative research in western Kenya. Working paper No. 10,

Centre for International Studies, University of Toronto, Canada.

Quisumbing, A. and Pandolfelli, L. 2009. Promising approaches to address the needs of poor female farmers: Resources, constraints and interventions. *World Development* 38(4): 581-592.

Ronner, E. and Giller, K.E. 2012. Background information on agronomy, farming systems and ongoing projects on grain legumes in Ethiopia, www.N2Africa.org, 33pp.

Sibiko, W. 2012. Determinants of common bean productivity and efficiency: a case of smallholder farmers in Eastern Uganda, MSc Thesis, Egerton University, Kenya.

Standardized Monitoring and Assessment of Relief and Transitions (SMART) Methodology. 2012. Sampling Methods and Sample Size Calculation for the SMART Methodology. Available from: www. nutrisurve y. de/ena/ena. html (accessed 29 May 2016).

Thompson, W., Miller, A., Mortenson, D.and Woodward, A. 2011. Developing effective sampling designs for monitoring natural resources in Alaskan national parks: An example using simulations and vegetation

data. *Biological Conservation* 144: 1270–1277.

Wang'ombe, J. and van Dijk, M. 2013. Low potato yields in Kenya: do conventional input innovations account for the yields disparity? *Agriculture and Food Security* 2 (1): 1-11.

Yirga, M., Waithaka, M., Kyotalimye, M. and Gorfu, B. 2014. Community participatory sustainable land management by-law formulation in the highlands of central Ethiopia. *African Crop Science Journal* 22 (1): 9 – 20.