Vol. 11(12), pp. 272-285, December 2019
DOI: 10.5897/JDAE2019.01075
Article Number: 8061AB462466
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Logistic regression analysis on factors influencing income-poverty among smallholder French bean farmers in Kirinyaga County, Kenya

Noah Kibet*, Job Lagat and Gideon Obare

Department of Agricultural Economics and Agribusiness Management, Faculty of Agriculture, Egerton University, P. O. Box 536-20115, Egerton, Kenya.

Received 24, April, 2019; Accepted 24 October, 2019

The study determined factors affecting income-poverty among French bean farmers in Kirinyaga County, Kenya. Results show that 72.6% of French bean farmers were poor. Relative to the poor households, non-poor had the highest net French bean income per acre (KES. 24,133), total net crop income (KES. 150,608), total net livestock income (KES. 21,674), and off-farm income (KES. 198,070). Aversion to risks (p=0.051 and β=-2.802), household size (p=0.000 and β=-5.032), daily household expenditure per adult equivalent (p=0.001 and β=2.016), net annual household income (p=0.000 and β=7.733), access to credit (p=0.086 and β=1.187), household annual asset value (p=0.051 and β=-0.482) and age of household head (p=0.066 and β=-2.009) statistically and significantly influenced poverty status of French bean farmers. The results suggest that crop insurance, farm diversification and expansion of acreage under Global-GAP certified French bean are necessary strategies for French bean farmers to alleviate household poverty.

Key words: Smallholder farmers, French bean, global-GAP standards, determinants, income-poverty

INTRODUCTION

Poverty indicates household well-being and according to Muyanga et al. (2006), poverty in Kenya is common in rural areas and has been increasing since the late 1980s. Nearly 80% of the total population in Kenya lives in rural areas and derive their livelihood from agriculture. A study by Kenya National Bureau of Statistics (2007) showed that poverty rate rose from 40 to 52.3% between the year 1994 and 1997. In 2007, the rate reduced to 45.9% but according to the International Fund for Agricultural Development (2013), the rate rose again to 53% in 2013. The current national poverty rate is still high at 51.4% while rural poverty level stands at 39.9% (Oxford Poverty and Human Development Initiative, 2017). To eradicate poverty, French bean farmers in Kirinyaga County have been producing Global-GAP certified French beans with an objective of accessing lucrative export markets in Europe, in order to increase household income and thus reduce poverty. Existing studies in Kenya concur that commercial horticultural farming can improve the welfare of farmers (McCulloch and Ota, 2002; Muriithi et al.,

*Corresponding author. E-mail: noahkibet@gmail.com.

2011; Muriithi and Matz, 2014; Chege et al., 2015). This is because most of horticultural crops are high yielding, more profitable relative to cereal crops and are thus able to reduce poverty (McCulloch and Ota, 2002; Kibet et al., 2011; Mwende, 2016) even under situations of high risks (Obare et al., 2003; Kuyiah et al., 2006).

In Central Region where Kirinyaga County is situated, poverty per adult equivalent and household stood at 30.4 and 24.3% respectively in 2007 (Kenya National Bureau of Statistics, 2007). But the latest statistics indicate that poverty rate in Kirinyaga County will increase to 30.1% in future (Oxford Poverty and Human Development Initiative, 2017). However, previous studies conducted in Kirinyaga County show that compliance with the Global-GAP standards improves the households' welfare (Humphrey, 2008; Muriithi, 2008; Asfaw et al., 2009; Asfaw et al., 2010). This raises the question of whether continuous compliance with the Global-GAP standards contributes to poverty alleviation among farmers in the County or there are other factors that drive poverty situations of farmers in the County. Compliance with Global-GAP standards is associated with high costs, risks and at the same time high returns. Risk agricultural technologies in most cases are associated with high returns, which when adopted can increase household incomes and thus poverty reduction. The hypothesis on the increasing poverty in Kirinyaga County is that, since the majority of farmers have been found to be risk-averse worldwide, French bean farmers may have failed to embrace the standards by over-weighing the risks and underestimating returns associated with the standards.

For the Kenyan government to properly address the issue of poverty in rural areas where agriculture is the dominant economic activity, it needs to implement relevant, efficient and effective social protection policies. But to come up with such policies, there is a need to identify and constantly monitor all the relevant drivers of the poverty (Alemayehu et al., 2005). Several studies on the poverty at household level in Kenya have been conducted (Oyugi et al., 2000; Alemayehu et al., 2001, 2005; Nyariki et al., 2002; Republic of Kenya, 2003a; Muyanga et al., 2006; Githinji, 2011; Elhadi et al., 2012; Onyeiwu and Liu, 2013; Machio, 2015). However, none of these studies considered Global-GAP certification and risk attitudes as possible drivers of the poverty in their analysis. Studies on the poverty analysis among French bean farmers in the face of Global-GAP standards are scarce. They include: Asfaw et al. (2009), Muriithi et al. (2011) and Achieng' (2014) among others. These studies are characterized by some limitations: First, Asfaw et al. (2009) and Muriithi et al. (2011) failed to quantify poverty. In their analysis, they determined French bean farmer's poverty status by just comparing certified and non-certified based on their welfare indicators such as consumption levels, asset values and incomes. Secondly, Asfaw et al. (2009) and Muriithi et al. (2011) failed to determine the role risk attitudes in the poverty analysis yet it is a crucial factor as reported elsewhere (Dohmen et al., 2005; Booij and De Kuilen, 2009; Kwesi et al., 2012; Ghartey et al., 2014). Achieng' (2014) quantified poverty and its determinants among French bean farmers in the face of Global-GAP but also failed to consider risk attitudes as one of the crucial drivers of the poverty.

To bridge this knowledge gap and inform further on social protection policies targeting farmers in Kenya, this study went a step ahead and quantified the poverty using the new international poverty line and considered risk attitudes and technology adoption as part of drivers of poverty in the analysis. The information generated is useful in guiding the formulation of social protection policies aimed at the poverty alleviation in Kenya by the government, Non-Governmental Organizations, private sector, and other stakeholders.

METHODS AND MATERIALS

Study area

The study was conducted in Kirinyaga County within Kirinyaga Central, Kirinyaga East, Kirinyaga West, Mwea East and Mwea West Sub-counties (Figure 1) because of the increasing importance of French bean farming and the implementation of Global-GAP standards in the County. The County is located 120 Km North West of Nairobi and has a total population of 153,095 (Economic Survey, 2009). Apart from French beans, rice, maize, and horticulture (onions, tomato, snow peas, avocado, mango and pawpaw) are also commonly grown in the County. French beans are mainly produced under irrigation and rain-fed.

Sample size

Lists containing French beans farmer's certification details were obtained from Kirinyaga County Agricultural Office, farmer groups and exporters of French beans contracting farmers. The lists were then used to generate a sampling frame of 1,943 certified and non-certified farmers. The formula by Krejcie and Morgan (1970) was further used to determine the sample size. Mathematically, the formula is given as:

$$s=\frac{X^2 N\,\mathbf{Pp}(1-\mathbf{Pp})}{d^2(N-1)+X^2\mathbf{Pp}(1-\mathbf{Pp})} \quad (1)$$

where s is the required sample size, χ^2 is the table value of Chi-square for 1 degree of freedom at the desired confidence level (1.96 × 1.96 = 3.84), N is the population size, *Pp* is the proportion of the sample size to population size, d is the degree of the accuracy expressed as a proportion (0.05). Using the formula, the sample size corresponding to N = 1,943 is 322. However, due to the availability of funds, and the need to increase the accuracy of the results, the sample size was increased to 492.

Sampling procedure

The study adopted a multistage sampling procedure in the selection of respondents. Within Kirinyaga County, Kirinyaga Central, Kirinyaga East, Kirinyaga West, Mwea East, and Mwea West Sub-Counties were purposively selected because this is where French

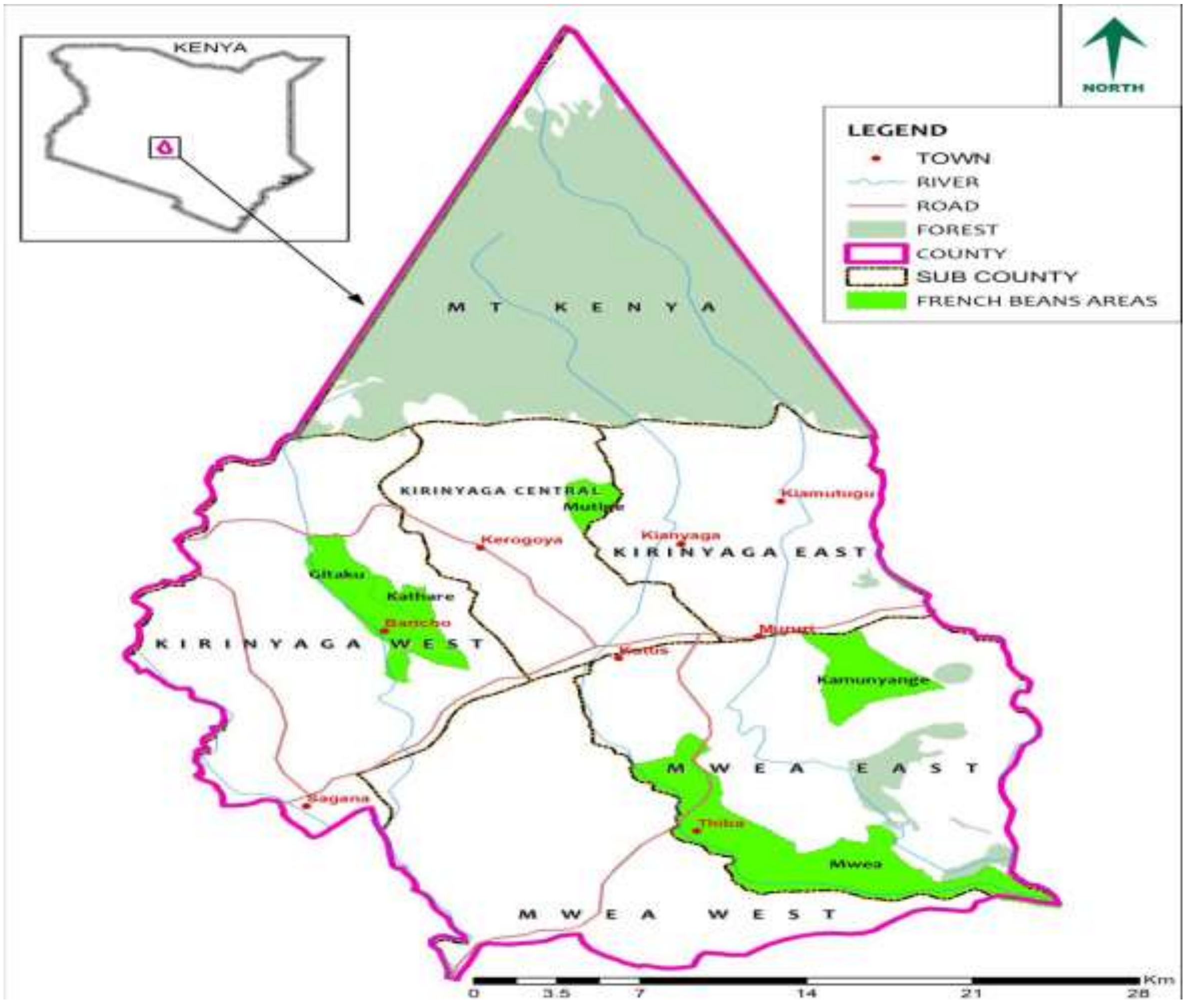

Figure 1. Map showing French beans growing areas in Kirinyaga County.
Source: WRI, DIVA-GIS and ILRI.

beans are mainly produced. Mutige in Kirinyaga Central, Gitaku, and Kathare in Kirinyaga West and Kamunyange and Mwea in Mwea East were randomly selected. French beans farmers in each area were then stratified into two groups: Global-GAP certified and non-certified. Sampling frames for the certified and non-certified French beans farmers were generated with the help of village elders, French beans farmer's group leaders, and County Agricultural Extension officers. The study applied a systematic random sampling procedure to select the certified and non-certified French beans farmers from the sampling frames. Both certified and non-certified French beans farmers were selected proportionately depending on the respective generated sampling frames to give a total sample size of 492 respondents. All five sub-counties were sampled proportionately based on the certification status of the French beans farmers.

Data and data analysis

Single cross-sectional data was used in the study. The data was obtained from the 492 randomly selected respondents using structured and unstructured questionnaires covering 2014 cropping season. Data collected include general household socioeconomic, institutional and psychological characteristics. Psychological characteristics (risk attitudes) were captured using a 5-point Likert scale. Data on total annual household income was captured as the sum of net crop income, net livestock income, and total off-farm income. Total household expenditure comprised of food and non-food items. Total asset values were computed based on respective market prices existed in the year 2014. Non-normal data were log transformed to approach normality. Means with 95% confidence intervals were presented. Differences between certified and non-certified in terms of their socioeconomic, institutional and psychological characteristics were analyzed using a *t*-test for continuous data and Chi-square for categorical data. Statistical analyses were performed using SPSS, STATA and Ms. Excel computer programs.

Theoretical framework

The study was based on the individualistic theory of poverty outlined in Asen (2002). The theory further states that individual characteristics such as low intelligence levels and market factors such as externalities, moral hazard and uncertainty are likely to drive one to poverty. Incomplete information in the presence of shocks/risks makes one prone to poverty.

Table 1. World Health Organization adult equivalent conversion factors.

Age (years)	Males	Females
Under 1	0.33	0.33
1-1.99	0.46	0.46
2-2.99	0.54	0.54
3-4.99	0.62	0.62
5-6.99	0.74	0.70
7-9,99	0.84	0.72
10-11.99	0.88	0.78
12-13.99	0.96	0.84
14-15.99	1.06	0.86
16-17.99	1.14	0.86
18-29.99	1.04	0.80
30-59.99	1.00	0.82
60 and over	0.84	0.74

Source: Muyanga et al. (2007).

Poverty estimation

Poverty estimation involves the determination of income per adult equivalent then compared with the predetermined poverty. There are many ways of determining Adult Equivalent Values (AEV), viz; World Health Organization (WHO) adult equivalent conversion factors (Table 1), Organization for Economic Co-operation and Development (OECD) method, and Harold Watts's approach. WHO approach considers the effect of household gender, age, and size in the determination of adult equivalent values per household. Men are given higher weights than women while children and the old are given lower weights (OECD, 2008, 2011). Relative to Watts' and OECD approaches, WHO approach is multidimensional in the determination of AEVs. It considers not only the economies of scale (household size) but also gender and age issues. In this study, AEVs were determined using the WHO approach. Following Kirimi et al. (2013), household income, household expenditure, and asset values of French beans farmers were computed per annum, monthly and daily. Daily household income and expenditure of each household were then divided by the AEVs from the WHO approach to get daily income and expenditure per adult equivalent. Asset value per adult equivalent was determined by dividing total annual asset value by adult equivalent values generated from the WHO approach.

Determination of the poverty line

The rural income-poverty line of KES 1,562 per month per adult equivalent generated by the Kenya National Bureau of Statistics was last updated in 2006 (Kenya National Bureau of Statistics, 2007). The poverty line has been widely applied in many studies, including Kirimi et al. (2013). The latest survey launched by Kenya National Bureau of Statistics (KNBS) to update the poverty line was launched in 2015, and that was after the collection of household survey data for this study. The first international poverty line was developed by Ravallion et al. (1991) in 1985 and was set at $1.01. The poverty line was later updated to $1.08 per adult equivalent per day by Chien and Ravallion (2001). Ravallion and Shaohua (2009) further updated to $1.25 per adult equivalent per day. Because of the increasing cost of living in developing nations due to inflation, it makes the poverty lines of KES 1,562 and $1.25 less effective. World Bank has been using the poverty line of $1.25 from 2009 to 2014 when Narayan et al. (2015) updated it again to $1.90. This new poverty line is highly recommended for poverty estimations, especially in developing countries. This is because it was partly generated from data collected in African nations (Narayan et al., 2015). Given that Kenya is a developing country and the fact that few studies have applied the new poverty line, it was imperative to embrace it in this study. Certified and non-certified French beans farmers were categorized as poor if their daily income per adult equivalent fall below the poverty line of KES 193.56 (that is, $1.90 at the exchange rate of KES 101.87 per dollar during data collection period) and non-poor if equal or fall above the poverty line.

Analytical technique

French beans farmers' poverty status (PV_i) was captured as binary such that PV_i = 1 indicates not poor while PV_i = 0 indicates otherwise. The factors influencing binary dependent variable can be estimated using binary Logit or Probit model. Binary Logistic model, as outlined in Nyota (2011), was used to determine factors affecting poverty among French beans farmers. The study assumed that the probability of French beans farmer *i* being either poor or non-poor (PV_i) is subject to his/her socioeconomic, institutional, and psychological characteristics (X_i) as indicated in Equation 2.

$$\text{Prob(Not poor} = 1) = X_i \beta_i + e_i \tag{2}$$

An underlying unobserved or latent variable (PV_i*) can be defined to denote the level of poverty and the unobservable variable is related to the characteristics X_i of the farmer. That is assuming there are no ties, then

$$PV_i{*} = X_i \beta_i + \varepsilon_i \tag{3}$$

Where B_i is parameters estimated while ε_i is the error term that captured unobserved variations in French beans farmers' poverty status. Functionally, this is given as:

$$E(PV_i | X_i) = F(\beta' X_i) = \frac{e^{\beta' X_i}}{1 + e^{\beta' X_i}} \tag{4}$$

If the residuals are independent and identically distributed with a

Table 2. Description of variables estimated on observed poverty.

Variable name	Variable label	Variable code	Expected sign
Social characteristics			
Poverty status	PV_i	Dummy (Not poor = 1, Otherwise = 0)	None
Gender of HH	X_1	Dummy (Male = 1, Otherwise = 0)	+/-
Household size	X_2	Number of household members	+/-
Primary education level	X_3	Dummy (Primary = 1, Otherwise = 0)	-
Age of HH	X_4	Years	+/-
Secondary education level	X_5	Dummy (Secondary = 1, Otherwise = 0)	+/-
Psychological factors			
Never like to take risks	X_6	Dummy (Yes = 1, Otherwise = 0	+/-
Always like to take risks	X_7	Dummy (Yes = 1, Otherwise = 0)	
Institutional characteristics			
Global-GAP certification status	X_8	Dummy (Certified = 1, Otherwise = 0)	+
Credit access	X_9	Dummy (Yes = 1, Otherwise = 0)	+
Group membership	X_{10}	Dummy (Yes = 1, Otherwise = 0)	+
Economic characteristics			
Total annual asset value	X_{11}	KES	+
Net annual off-farm income	X_{12}	KES	+
Net annual French beans income per acre	X_{13}	KES	+
Total annual household income	X_{14}	KES	+
Total annual expenditure per adult equivalent	X_{15}	KES	+/-
Total land size owned	X_{16}	ACRES	+

KES means Kenyan Shillings and HH means household head; (+/-) indicates a positive or negative relationship with the dependent variable.

cumulative distribution function given as $F(\varepsilon_i < E) = \exp(-e - E)$ and whose probability density function is $F(\varepsilon_j) = \exp(-\exp(-\varepsilon_{i,j}))$, an analytical solution exists, and the probability of a given choice alternative for the i^{th} French bean is given as:

$$\text{Prob}(\text{Not poor}=1) = \frac{\exp(X'_{ij}\beta_j)}{1+\sum_k \exp(X'_{ik}\beta_j)}, k=i,\ldots,j \tag{5}$$

where Prob(Not poor = 1) denotes the probability of French beans farmer *i* being poor, X_i *is* a vector of the farmer characteristics while β_j are the parameters of the exogenous variables estimated. The parameters were estimated using maximum likelihood (ML) method. Binary logistic regression can yield either the odds ratio or marginal coefficients. Odds ratios mean a unit change in an exogenous variable leads to changes in the probability of French beans farmers not being poor (Prob(Not poor = 1)) by a factor of exp β. On the other hand, marginal coefficients indicate the effect of each exogenous variable on the probability of French beans farmers being poor, *ceteris paribus,* are interpreted as typical beta coefficients in a linear regression model (Nyota, 2011). According to Laduber et al. (2016), the slope of a logistic regression function tells how the log odds ratio in favor of not being poor changes as explanatory variables change. For instance, given that Prob(Not poor = 1) is the probability of not being poor then, (1-Prob(Not poor=1)) represents the probability of being poor. Mathematically this is given as:

$$1-\text{Prob}(\text{Not poor}=1) = 1-\frac{e^{Z_i}}{1+e^{Z_i}} = \frac{e^{-Z_i}}{1+e^{-Z_i}} = \frac{1}{1+e^{Z_i}} \tag{6}$$

Given the equations above, the odds ratio equation is given as:

$$\frac{\text{Prob}(\text{Not poor}=1)}{1-\text{Prob}(\text{Not poor}=1)} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} = e^{Z_i} \tag{7}$$

such that

$$\frac{\text{Prob}(\text{Not poor}=1)}{1-\text{Prob}(\text{Not poor}=1)} ¿¿$$

is the odds ratio in favor of Global-GAP compliance. That is the ratio of the probability that the farmer would comply with Global-GAP standards to the probability that the farmer will not comply with the standards. Factors estimated on the observed poverty are described in Table 2.

Empirically, the model was determined as given in Equation 8:

Table 3. Respondents' characteristics by poverty status.

[1]Poverty status	Frequency	Percent
Poor	357	72.6
Not poor	135	27.4

[1]Poverty status was generated using the international poverty line of $1.90 per day per adult equivalent or KES. 193.56 per day per adult equivalent.

$$\text{Prob}\,(\text{Not poor}=1)=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11}+\beta_{12}X_{12}+\beta_{13}X_{13}+\beta_{14}X_{14}+\beta_{15}X_{15}+\beta_{16}X_{16}+e_i \quad (8)$$

Proper estimation of binary logistic regression depends on certain assumptions. First is the assumption that the dependent variable should be ordinal. Secondly is the linearity assumption, which states that independent variables should have a linear relationship with the dependent variable. Thirdly is the assumption of independent errors, which states that errors should not be correlated. The fourth and last assumption is that there should not be multicollinearity[1].

RESULTS AND DISCUSSION

Level of observed poverty

Results in Table 3 indicate that the majority of French bean farmers, irrespective of Global-GAP certification status, were poor (72.6%). The possible reason is that income from French beans was not sufficient to move the households out of poverty brackets due to low acreage cultivated. Poor farmers cultivated an average of 0.5 acres of French beans while non-poor ones cultivated an average of 0.5 acres as indicated in Table 4.

Descriptive characteristics of the respondents

Socioeconomic and institutional factors were considered in comparing the poor and non-poor groups of farmers. Given the poverty line, both poor and non-poor French beans did not statistically and significantly differ in terms of household size, age, household adult equivalent, total land size owned, distance to the market, years of experience in farming, total annual asset value, annual expenditure on non-food items, number of training attended and the acreage under French beans. On the other hand, the poor and non-poor farmers differed based on costs incurred per acre of French beans, net income per acre of French beans, annual net crop income, annual net livestock income, annual off-farm income, annual total income, annual expenditure on food items, and annual total expenditure per adult equivalent (Table 4).

Relative to the poor, non-poor had the highest net annual French beans income (MD = KES 24,133), French beans production costs (MD = KES 3,562), net crop income (MD = KES 150,608), net livestock income (MD = KES 21,674), incomes from other sources (MD = KES 198,070), total net annual household income (MD = KES 370,352), total annual expenditures (MD = KES 79,726) and expenditure on food items (MD = KES 52,541).

Poverty status of the respondents statistically and significantly varied according to the location (p = 0.020), an education level (p = 0.000) and risk preferences (p = 0.026) of French beans farmers. On the other hand, poverty status did not vary according to Global-GAP certification status, gender, and marital status. The majority of poor farmers are located in Kirinyaga West Sub-County (83.2%) followed by Kirinyaga East Sub-County at 75%. Mwea West Sub-County had the lowest poverty rate at 60%. The majority of those who were poor (88.9%) had no education at all while the majority of those who were non-poor had certificate and diploma (Table 5). Education enables French beans farmer's access to formal employment, which later increases their income and thus reduces poverty. Farmers can also use the knowledge acquired from the education process to improve farming activities such as identification and uptake of high yielding agricultural technologies, which eventually increases farm yields and income and hence poverty reduction.

Finally, among the poor French beans farmers, the majority never like taking risks (87%) and in most cases do not like taking risks (77.6%) while among the non-poor, the majority always liked taking risks (40%). The results show that aversion to risks positively relates to poverty. The findings concur with those of Hulme and Shepherd (2003) who found that risk-averse persons in the face of risks are more likely to be poor because they prefer low risky ventures which are associated with low returns. Mosley and Verschoor (2005) found a very weak link between farmers' risk attitudes and poverty.

Determinants of observed poverty

A binary logistic regression analysis was conducted to determine the factors affecting observed poverty among French beans producers in Kirinyaga County, Kenya (Table 6). The dependent variable (poverty status) was captured as poor = 0 and Not poor = 1 based on the poverty line of KES 193.56 ($1.90 per day per adult equivalent. Hosmer and Lemeshow Test are statistically insignificant (p = 0.281) indicating that the model fits the data well. The model is statistically significant, indicating that the explanatory variables estimated reliably distinguished between the poor and non-poor (Chi-square (χ^2) = 153.314, p = 0.000). Nagelkerke R-square value is 0.626 indicating that 62.6% of the variation to be observed in the poverty situations of the French beans

[1]See (www.restore.ac.uk/srme/www/fac/soc/wie/research-new/srme/modules/mod4/9/index.html).

Table 4. Farmer characteristics by observed poverty category.

Variable	[1]Poverty status: Poor = PV_0 and Not poor = PV_1				
	Poor (N = 357)		Not poor (N = 135)		
	Mean	S.D	Mean	S.D	MD
Household size	3.9 (0.1)	1.4	3.4 (0.1)	1.4	0.5
Age	45.7 (0.7)	12.6	42.6 (1.2)	13.8	3.1
Adult equivalent	3.6 (0.2)	4.5	2.6 (0.1)	1.0	1.1
Years of experience	15.5 (0.6)	10.9	14.6 (1.1)	12.8	0.9
Total land size owned	2.2 (0.2)	4.2	2.2 (0.2)	2.5	0.1
French beans acreage	0.5 (0.0)	0.4	0.5 (0.0)	0.5	-0.0
French beans costs	11045 (610)	11534	14606** (1432)	16633	-3562
Net French beans income	25090 (1542)	29135	49223*** (5851)	67980	-24133
Net crop income	39557 (3254)	61488	190166*** (19772)	229732	-150608
Net livestock income	4086 (1364)	25772	25760*** (6524)	75798	-21674
Off-farm incomes	32804 (2935)	55459	230874*** (26894)	312476	-198070
Annual income	76448 (4377)	82700	446800*** (32927)	382574	-370352
Asset value	1806168 (225963)	4269445	1997603 (189976)	2207316	-191435
Expenditure on food items	89141 (6661)	125863	141683*** (19879)	230968	-52541
Non-food expenditure	87952 (11333)	214134	115137 (17114)	198843	-27185
Total expenditure	177093 (15836)	299218	256820** (31400)	364833	-79726
Number of training	1.1 (0.1)	1.5	1.3 (0.1)	1.7	-0.2
Distance to the market	5.4 (0.3)	4.7	6.2 (0.5)	5.6	-0.8

Figures in parentheses are standard errors. MD means Mean Difference, S.D means Standard Deviation. SD, and MD values were rounded off to two (2) decimal places. [1]Poverty status s was generated using the international poverty line of $1.90 per day per adult equivalent or KES 193.56 per day per adult equivalent. ***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

farmers were explained by the combined effects of all the independent variables in the model specified. Binary logistic regression is based on four crucial assumptions that need to be addressed. First, the dependent variable should be ordinal. In this study, the dependent variable was captured as a binary variable. Secondly is the linearity assumption. Linearity in the binary logistic model assumes that independent variables have a linear relationship with the dependent variable. This assumption can be verified by checking the model fit statistics and pseudo-R-Squared[2].

In this study, the model fit statistics and pseudo R^2 in Table 6 indicate that the model well fits data. Also, binary logistic regression does not need a linear relationship between the dependent and independent variables because it applies a non-linear log transformation to the predicted odds ratio[3]. Thirdly is the assumption of independent errors. The assumption of independent errors states that errors should not be correlated for two observations. That is, data should be drawn from independent samples and not dependent samples such as before and after or matched pairings. In this study, single cross-section data was drawn from an independent sample. The fourth assumption is that there should not be multicollinearity. Binary logistic regression requires that independent variables should not be highly correlated with each other, but to some degree. Correlation analysis is one of the tests that can be used to check the existence of multicollinearity. Pearson's value (r) that is equal to 0.8 or above indicates a serious problem of multicollinearity[4]. In the study, correlation analysis was conducted, and results presented in Appendix A1. The results show that all the Pearson's values (r) are below r =0.8, and hence, multicollinearity was not a problem.

Variables indicating certification status and net income from French beans are statistically insignificant, with a positive relationship with poverty reduction. The results suggest that income earned by the farmers from participating in the production of Global-GAP certified French beans was not sufficient to move households out of poverty brackets. The reason may be due to the low acreage of French beans cultivated. Risk preference variable was coded using a 5-point Likert scale starting from "I never like taking risks" to "always I like taking risks." A response indicating, "I never like taking risks" is statistically significant ($p = 0.051$) with a negative

[2]See www.restore.ac.uk/srme/www/fac/soc/wie/researchnew/srme/modules/mod4/9/index.html.

[3]See www.statisticssolutions.com/wp-content/uploads/wp-post-to-pdf-enhanced-cache/1/assumptions-of-logistic-regression.

[4]See www.restore.ac.uk/srme/www/fac/soc/wie/researchnew/srme/modules/mod4/9/index.html.

Table 5. Respondents' characteristics by observed poverty category.

Variable	Indicator	[1]Poverty status: Poor = PV_0 and Not poor = PV_1		
		Poor (Percent) (N = 357)	**Not poor (Percent) (N = 135)**	**Overall (Percent) (N = 492)**
Sub-Counties	Mwea East	71.1 (192)	28.9 (78)	100 (270)**
	Mwea West	60 (33)	40 (22)	100 (55)**
	Kirinyaga East	75 (18)	25 (6)	100 (24)**
	Kirinyaga Central	66.7 (20)	33.3 (10)	100 (30)**
	Kirinyaga West	83.2 (94)	16.8 (19)	100 (113)**
Certification status	Certified	71.4 (210)	28.6 (84)	100 (294)
	Not certified	74.2 (147)	25.7 (51)	100 (198)
Gender	Female	78 (46)	22 (13)	100 (59)
	Male	71.8 (311)	28.2 (122)	100 (433)
Education level	None	88.9 (8)	11.1 (1)	100 (9)***
	Primary	78.6 (198)	21.4 (54)	100 (252)***
	Secondary	69.1 (134)	30.9 (60)	100 (194)***
	Certificate and Diploma	45.5 (15)	54.5 (18)	100 (33)***
	Degree	50 (2)	50 (2)	100 (4)***
Marital status	Single	68.3 (28)	31.7 (13)	100 (41)
	Married	72.8 (311)	27.2 (116)	100 (427)
	Divorced	77.8 (7)	22.2 (2)	100 (9)
	Widow	73.3 (11)	26.7 (4)	100 (15)
Risk preferences	"I never like to take risks"	87 (20)	13 (3)	100 (23)**
	"In most cases I don't like to take risks"	77.6 (52)	22.4 (15)	100 (67) **
	"I sometimes like to take risks"	74 (94)	26 (33)	100 (127) **
	"In most cases I like to take risks"	74 (134)	26 (47)	100 (181) **
	"I always like to take risks"	59.3 (54)	40.7 (37)	100 (91) **
	No response	100 (3)	0 (0)	100 (3) **

Figures in parentheses are number of observations. [1]Poverty status means poverty status of farmers was generated using the international poverty line of \$1.90 per day per adult equivalent or KES 193.56 per day per adult equivalent. ***p < 0.01, ** p < 0.05, *p < 0.1.

coefficient (β= -2.802). The results suggest that French beans risk-averse farmers are likely to be poor and vice versa. The odds ratio = 0.061 means that, *ceteris paribus*, a farmer who is risk-averse increases his/her log odds of becoming poor by 0.061 times. The findings are in line with those of Moscardi and De Janvry (1977), Dillon and Scandizzo (1978), Binswanger (1980), Antle (1987), Hulme and Shepherd 2003, Dohmen et al. (2005), Booij and De Kuilen (2009), Kwesi et al. (2012), and Ghartey et al. (2014) who found that risk-averse farmers are more likely to be poor.

Household size variable is highly significant (p = 0.000) with a negative coefficient (β = -5.032). The results revealed that an increase in household size increases farmer's chances of becoming poor. The odds ratio value of 0.007 indicates that *ceteris paribus*, an increase in household size by one adult equivalent increases household log odds of becoming poor by 0.007 times. An increase in household size constraints existing incomes. Reduction in income reduces household consumption expenditure and hence an increase in household poverty. Previous studies in Kenya and elsewhere report similar findings. For example, Oyugi et al. (2000), Nyariki et al. (2002), Alemayehu et al. (2005), Geda et al. (2005), Muyanga et al. (2006), Muriithi (2008), Elhadi et al. (2012), Onyeiwu and Liu (2013), Achieng' (2014) and Macho (2015) found that an increase in household size, directly and indirectly, increases household poverty through reduction in income per adult equivalent which eventually impairs standard of living. The findings also concur with those of Swanepoel (2005) and Igbalajobi et al. (2013) who found that large family size with more dependants increase the severity of poverty because it decreases per-capita expenditure. A study by Megersa

Table 6. Determinants of observed poverty among French beans farmers.

Variable	Coefficient	S.E.	Wald	P>Z	Odds Ratio
Certification status	1.095	0.685	2.556	0.110	2.990
Household size	-5.032	1.215	17.149	0.000***	0.007
Total annual household income	7.733	1.514	26.097	0.000***	2282.773
Total annual asset value	-0.482	0.247	3.802	0.051*	0.618
Access to credit	1.187	0.690	2.956	0.086*	3.277
Expenditure per adult equivalent	2.016	0.581	12.025	0.001***	7.509
Net annual French beans income	0.425	0.381	1.246	0.264	1.529
Always like taking risks	-0.447	0.832	0.289	0.591	0.640
Never like taking risks	-2.802	1.436	3.810	0.051*	0.061
Off-farm income	0.431	0.464	0.862	0.353	1.538
Group membership	1.171	0.790	2.200	0.138	3.226
Primary level of education	0.600	1.061	0.320	0.571	1.823
Secondary level of education	-0.999	1.143	0.763	0.382	0.368
Age of household head	-2.009	1.093	3.379	0.066*	0.134
Gender of household head	-1.783	1.417	1.583	0.208	0.168
Total land size owned	-0.108	0.448	0.058	0.810	0.898
Constant	-105.154	21.150	24.719	0.000***	0.000
Omnibus tests:	$p < 0.05$ (0.000)				
Nagelkerke R^2	0.626				
Hosmer and Lemeshow:	$p > 0.05$ (0.281)				

The Dependent variable is poverty status: Poor = PV_0 and Not poor = PV_1. HH means Household, PAE means Per Adult, Equivalent, C.I means Confidence Interval, PV means Poverty Status, S.E means Standard Errors and Poverty status was determined using the poverty line of KES 193.56 ($1.90 per day per adult equivalent at the rate of KES 101.87 per dollar) per day per adult equivalent, ***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

(2015), however, reported contrary findings.

Variable indicating daily household annual expenditure per adult equivalent is statistically significant ($p = 0.001$) with a positive coefficient (β = 2.016). The results suggest that households that spend more are less likely to be poor. The odds ratio = 7.509 means that *ceteris paribus*, an increase in annual expenditure per adult equivalent by KES 1 decreases household log odds of becoming poor by 7.509 times and vice versa. Expenditure is a welfare indicator, such that households, which spend equal to or above the poverty line of KES 2,900 per month per adult equivalent, are regarded as non-poor and vice versa. It is clear in Table 4 that non-poor and poor households statistically and significantly deferred in terms of household expenditure per annum. Poor households spent KES 89,141 per annum relative to non-poor counterparts who spent KES 141,683 within the same period. Similar studies indicate that household's expenditure on aspects such as education increases their chances of access to well-paying jobs, which in turn increases household income and hence reduction in poverty. Expenditure on health and household food increases household member's productivity, which in turn translates to high income and consequently, reduction in household poverty (Kiiru, 2010; Edoumiekumo et al., 2014).

Variable indicating access to credit is statistically significant ($p = 0.086$) with a positive coefficient (β = 1.187). The results revealed that access to credit reduces household poverty among French beans farmers. The odds ratio = 3.277 means that *ceteris paribus*, access to credit reduces household log odds of becoming poor by 3.277 times and vice versa. Credit access provides capital to purchase key inputs of production, which increase yields, income, and savings, and eventually a reduction in household poverty (Igbalajobi et al., 2013). Access to credit also provides income for spending on necessities such as medical, school fees, food, social emergencies, and farm inputs (Muyanga et al., 2006; Owuor et al., 2007). Furthermore, access to credit enables farmers to acquire modern farming techniques and good farm management principles which can improve farm productivity and thus poverty reduction (De Janvry and Sadoulet, 2000; Apata et al., 2010). A study by Machio (2015) found no effect.

Variable denoting household asset value is statistically significant ($p = 0.051$) with a negative coefficient (β = -0.482). The results suggest that as households accumulate more assets, their chances of becoming poor increases. The odds ratio = 0.618 indicates that, *ceteris paribus*, an increase in household asset accumulation by KES 1 increases household log odds of becoming poor by 0.618 times and vice versa. Two types of assets exist: assets that generate income for the households and those that do not. Accumulations of assets that do not generate income do leave households with little or no cash to transact daily household needs, and this may lead to increase in household poverty. In this case, French bean farmers seem to be accumulating assets that do not generate income and hence their high chance of becoming poor. Similar findings are reported in Achieng' (2014) who found that, *ceteris paribus*, an additional high valued asset positively influences severity of poverty by 0.280 times among French bean farmers in Kirinyaga County while contrary findings are reported in studies conducted by Mariara (2002), Muyanga et al. (2006) and Mbakahya and Ndiema (2015) in Kenya. For instance, a study by Mariara (2002) found that asset accumulation is critical in poverty alleviation among pastoralists in Kajiado County, Kenya.

Variable indicating total household annual income is statistically significant (p = 0.000) with a positive coefficient (β = 7.733). The results demonstrate that an increase in household income decreases its chances of becoming poor. The odds ratio = 2282.8 means that the odds ratio in favor of not being poor decreased by a factor of 2282.8 per unit increase in annual household income. The findings concur with those found in Elhadi et al. (2012). The study revealed that income diversification significantly reduces household poverty. Oyugi et al. (2000), Alemayehu et al. (2005), Burke et al. (2007) and Machio (2015) demonstrated that livestock provides milk, meat, and other products which increases household income and subsequently reduces household poverty. Similarly, Geda et al. (2005), Muyanga et al. (2006), Achieng' (2014), and Mwende (2016) found that an increase in income from crop diversification activities significantly reduces household poverty. However, contrary findings are reported in Mwabu et al. (2000) and Machio (2015) who found that dependence on agriculture and cash crops respectively increases the probability of farmers being poor.

Variable indicating the age of household head is statistically significant (p = 0.066) with a negative coefficient (β = -2.009). The results means that an increase in the age of household head increases his/her chance of becoming poor and vice versa. The odds ratio = 0.134 shows that *ceteris paribus*, an increase in the age of household head one year, increases log odds of a household becoming poor by 0.134 times and vice versa. As the age increases, the productivity of household head decreases due to poor health associated with old age. The findings concur with those in Barrientos (2007), Mwanyangala et al. (2010), Harvison et al. (2011), Muleta and Deressa (2014) and Khamaldin et al. (2015). The studies revealed that the aging of the household head tends to increase the household probability of falling into poverty. Contrary results are reported in Akona (2014), who found that an increase in the age of household head significantly reduces household observed poverty. The study argued that as the household head grows older, he/she should accumulate more income that is sufficient to move their households out of poverty. Deressa (2013) concur with Akona (2014) that as the age of the household head increases his/her skills, experience, and assets and thus, the low probability of falling into poverty.

Conclusion

The study determined factors affecting observed poverty among French bean farmers in Kirinyaga County, Kenya. The study found aversion to risks (p = 0.051 and β = -2.802), household size (p = 0.000 and β = -5.032), daily household expenditure per adult equivalent (p = 0.001 and β = 2.016), net annual household income (p = 0.000 and β = 7.733), access to credit (p = 0.086 and β = 1.187), household annual asset value (p = 0.051 and β = -0.482) and the age of household head (p = 0.066 and β = -2.009) as important factors influencing poverty status of French bean farmers.

Policy implications

Since the positive relationship exists between risk taking and poverty reduction in the face of Global-GAP certification, French bean farmers are advised to continue producing and expanding acreage under Global-GAP certified French beans. Risk and loss averse farmers are encouraged to venture into production of Global-GAP certified French beans because it is a profitable venture that can eventually reduce household poverty. French bean farmers should also diversify household income sources in order to increase household income and hence poverty reduction. Both national and County Governments in collaboration with financial institutions (insurance companies and banks) should develop insurance and credit products relevant to farmers producing vegetables for export. This will mitigate aversion to risks and a lack of capital respectively among vegetable farmers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors appreciate DAAD-ICDD for funding research activities along with Kirinyaga County Agricultural Officers, enumerators and French bean farmers for their exceptional efforts during data collection.

REFERENCES

Achieng OR (2014). Impact of Global-GAP Compliance on the Relative Poverty Status of Smallholder Horticultural Farmers in Eastern and

Central Kenya. Department of Agricultural Economics, Faculty of Agriculture University of Nairobi., Nairobi, Kenya. Retrieved from https://www.google.com/?gws_rd=ssl#q=Achieng%E2%80%99+O.+R.+(2014) Accessed February 12, 2015.

Akona JS (2014). Factors Affecting Poverty Levels in Kenya: Case Study Busia County. School of Economics, University of Nairobi. http://erepository.uonbi.ac.ke/bitstream/handle/11295/75012/Akona_Factors%20affecting%20poverty%20levels%20in%20Kenya.pdf?sequence=4&isAllowed=y.Accessed on 6th June, 2018.

Alemayehu G, Niek D, Mwangi SK, Germano M (2005). Determinants of Poverty in Kenya: A Household Level Analysis. Department of Economics, University of Connecticut. https://www.google.com/?gws_rd=ssl#q=Determinants+of+Poverty+in+Kenya:+A+Household+Level+Analysis.+Economics+Working+Papers,+Department+of+Economics,+University+of+Connecticut. Accessed July 15, 2017.

Antle JM (1987). Econometric Estimation of Producers' Risk Attitudes. American Journal of Agricultural Economics 69(3):509-522.

Apata TG, Apata OM, Igbalajobi OA, Awoniyi SMO (2010). Determinants of Rural Poverty in Nigeria: Evidence from Small-holder Farmers in South-Western, Nigeria. Journal of Science and Technology Education Research 1(4):85-91.

Asen R (2002). Visions of Poverty: Welfare Policy and Political Imagination .East Lansing: Michigan State University Press.

Asfaw S, Mithöfer D, Waibel H (2009). Investment in Compliance with Global-GAP Standards: Does it Pay Off for Small-Scale Producers in Kenya? Quarterly Journal of International Agriculture 48(4):337-362.

Asfaw S, Mithöfer D, Waibel H (2010). What Impact are EU Supermarket Standards Having on Developing Countries' Export of High-Value Horticultural Products? Evidence from Kenya. Journal of International Food and Agribusiness Marketing 22(3-4):252-276.

Barrientos A (2007). New Strategies for Old-Age Income Security in Low Income Countries. International Social Security Association. Technical Report 12. http://193.134.194.37/content/download/40640/790535/file/TR-12-2.pdf. Accessed on 10th March, 2016.

Binswanger HP (1980). Attitudes Toward Risk: Experimental Measurement in Rural India. American Journal of Agricultural Economics 62(3):395-407.

Booij AS, de Kuilen G (2009). A Parameter-Free Analysis of The Utility of Money for the General Population under Prospect Theory. Journal of Economic Psychology 30(4):651-666.

Burke WJ, Jayne TS, Freeman HA, Kristjanson P (2007). Factors Associated with Farm Households' Movement Into and Out of Poverty in Kenya: The Rising Importance of Livestock. Michigan State University International Development Working Paper No. 90. http://www.aec.msu.edu/fs2/papers/idp.htm. Accessed July 14, 2016.

Chege JW, Nyikal RA, Mburu J, Muriithi BW (2015). "Impact of Export Horticulture Farming on Per Capita Calorie Intake of Small Holder Farmers in Eastern and Central Provinces in Kenya". International Journal of Food and Agricultural Economics 3(4):65-81.

Chien S, Ravallion M (2001). How Did the World's Poorest Fare in the 1990s? Review of Income and Wealth 47(3):283-300.

De Janvry A, Sudoulet E (2000). Rural Poverty in Latin America Determinants and Exit Plans. Food Policy 25:389-409.

Deressa DF (2013). Assessing Households Vulnerability to Poverty in Rural Oromiya - Ethiopia. Journal of Economics and Sustainable Development 4(8):110-117.

Dillon JL, Scandizzo PL (1978). Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach. American Journal of Agricultural Economics 60(3):425-435.

Dohmen T, Falk A, Huffman DB, Sunde U, Schupp J, Wagner GG (2005). Individual Risk Attitudes: New Evidence from a Large, Representative, Experimentally-Validated Survey (IZA Discussion Papers No. 1730). Retrieved from https://ideas.repec.org/p/iza/izadps/dp1730.html. Accessed August 16, 2017.

Economic Survey (2009). Kenya National Bureau of Statistics. Retrieved July 5, 2017, from https://www.knbs.or.ke/download/economic-survey-2009-3/. Accessed May 21, 2017.

Edoumiekumo SG, Karimo TM, Tombofa SS (2014). Income Poverty in Nigeria: Incidence, Gap, Severity and Correlates. American Journal of Humanities and Social Sciences 2(1):1-9

Elhadi AY, Nyariki DM, Wasonga VO, Ekaya WN (2012). Factors Influencing Transient Poverty among Agro-Pastoralists in Semi-Arid Areas of Kenya. African Crop Science Journal 20(1):113-122.

Geda A, Jong N, Kimenyi M, Mwabu G (2005). Determinants of Poverty in Kenya: A Household Level Analysis. KIPPRA Working Papers no 44, Nairobi: Kenya Institute for Public Policy Research and Analysis.

Ghartey W, Dadzie SKN, Weittey M (2014). Poverty and Risk Attitudes: The Case of Cassava Farmers in Awutu-Senya District of the Central Region of Ghana. Asian Journal of Agricultural Extension, Economics and Sociology 3(2):164-178.

Githinji M (2011). Land, Poverty and Human Development: the Determinants of the Poverty Status of Rural Kenyan Households. Working Paper, University of Massachusetts: Amherst.

Harvison T, Newman R, Judd B (2011). Ageing, the Built Environment and Adaptation to Climate Change. ACCARNSI Discussion Paper, Australia National Climate Change Adaptation Research Facility (NCCARF). http://www.nccarf.edu.au/settlements-infrastructure/sites/www.nccarf.edu.au.settlementsinfrastructure/files/file/ACCARNSI. Accessed on 15th July, 2014.

Hulme D, Shepherd A (2003). Conceptualizing Chronic Poverty. World Development 31(3):403-423.

Humphrey J (2008). Private Standards, Small Farmers and Donor Policy: EUREPGAP in Kenya. Retrieved from http://temp.ids.ac.uk/idspublication/private-standards-small-farmers-and-donor-policy-Eurep-GAP-in-kenya http://www.businessdictionary.com/definition/certification.html. Accessed October, 10, 2017.

Igbalajobi O, Fatuase AI, Ajibefun I (2013). Determinants of Poverty Incidence among Rural Farmers in Ondo State, Nigeria. American Journal of Rural Development 1(5):131-137.

International Fund for Agricultural Development (2013). Investing in Rural People in Kenya. Retrieved from http://www.ifad.org/operations/projects/regions/pf/factsheets/kenya.pdf. Accessed September 05, 2016.

Kenya National Bureau of Statistics (2007). Basic Report on Well Being in Kenya. Ministry of Planning and National Development. Retrieved from https://www.google.com/?gws_rd=ssl#q=Kenya+National+Bureau+of+Statistics+(2007).

Khamaldin M, Sieber S, Maeda C, Tscherning K (2015). Assessing the determinants of poverty and vulnerability of smallholder farmers in a changing climate: the case of Morogoro region, Tanzania. Regional Environmental Change 15:7.

Kibet N, Lagat JK, Obare GA (2011). Identifying Efficient and Profitable Farm Enterprises in Uasin-Gishu County, in Kenya. Asian Journal of Agricultural Sciences 3(5):378-384.

Kiiru JM (2010). Remittances and Poverty in Kenya. Paper Submitted to be Considered for Poster Session "New Faces for African Development" International Conference, Dakar, Senegal June 27-30, 2010.

Kuyiah JW, Obare GA, Herrero M, Waithaka MM (2006). Agriculture, Income Risks and Rural Poverty Dynamics: Strategies of Smallholder Producers in Kenya. Paper Presented during International Association of Agricultural Economists Annual Meeting, Queensland, Australia, August 12-18, 2006.

Kwesi S, Dadzie N, Acquah HD (2012). Attitudes Toward Risk and Coping Responses: The Case of Food Crop Farmers at Agona Duakwa in Agona East District of Ghana. International Journal of Agriculture and Forestry 2(2):29-37.

Laduber W, Dessalegn M, Tilahun D (2016). Logit analysis of factors affecting adoption of improved bread wheat (*Triticum aestivum* L.) variety: The case of Yilmana Densa District, West Gojam, Ethiopia. Journal of Agricultural Extension and Rural Development 8(12):258-268.

Machio PN (2015). Determinants of Rural Poverty in Kenya: The Case of Cash Crop Growing (Master of Science Thesis). University of Nairobi, Kenya.

Mariara JK (2002). Herders Response to Acute Land Pressure and Determinants of Poverty under Changing Property Rights. Some Insights from Kenya. EEE Working Papers Series no 4.

Mbakahya GM, Ndiema AC (2015). Farming Households' Vulnerability and Resilience to Climate Change in Nambale Sub-County of Kenya. International Journal of Science, Environment and Technology 4(6):1608-1617.

Megersa D (2015). Measuring Vulnerability to Poverty: an Empirical Evidence from Ethiopian Rural Household Survey, Degree Thesis No 904. ISSN 1401-4084. Swedish University of Agricultural Sciences, Uppsala. Retrieved from http://stud.epsilon.Slu.Se/7574/

McCulloch N, Ota M (2002). Export Horticulture and Poverty in Kenya. Institute of Development Studies.

Moscardi E, De Janvry A (1977). Attitudes Toward Risk among Peasants: An Econometric Approach. American Journal of Agricultural Economics 59(4):710-716.

Mosley P, Verschoor A (2005). Risk Attitudes and the 'Vicious Circle of Poverty.' The European Journal of Development Research 17(1):59-88.

Muleta AN, Deressa DF (2014). Determinants of Vulnerability to Poverty in Female Headed Households in Rural Ethiopia. Global Journal of Human-Social Science: Economics 14(5):0975-587X.

Muriithi BW (2008). Compliance with Eurep-gap Standards: Determinants, Costs and Implications on Profitability among Smallholder French Beans Exporters in Kirinyaga District, Kenya.https://www.google.com/?gws_rd=ssl#q=MURIITHI+2008. Accessed July 6, 2017.

Muriithi BW, Mburu J, Ngigi M (2011). Constraints and Determinants of Compliance with Eurep-Gap Standards: A Case of Smallholder French bean Exporters in Kirinyaga District, Kenya. Agribusiness 27(2):193-204.

Muriithi BW, Matz JA (2014). Welfare Effects of Vegetable Commercialization: Evidence from Smallholder Producers in Kenya (April 2014). ZEF Discussion Paper on Development Policy No. 189. Available at SSRN: https://ssrn.com/abstract=2424756 or http://dx.doi.org/10.2139/ssrn.2424756

Muyanga M, Ayiekox M, Bundily M (2006). Determinants of Transient and Chronic Poverty. Evidence from Kenya. PMMA Network Sessional Paper.

Muyanga M, Ayieko M, Bundi M (2007). World Health Organization Adult Equivalent Conversion Factors. https://www.google.com/?gws_rd=ssl#q=Muyanga+et+al.+(2006)+World+Health+Organization+adult+equivalent+conversion+factors. Accessed July 6, 2017.

Mwabu G, Masai W, Gesami R, Kirimi J, Ndeng'e G, Kiriti T, Kabubo-Mariara J (2000). Poverty in Kenya: Profile and Determinants. Nairobi: University of Nairobi and Ministry of Finance and Planning. AERC Research Report. : Elsevier. http://erepository.uonbi.ac.ke/handle/11295/45670

Mwanyangala MA, Mayombana C, Urassa H, Charles J, Mahutanga C, Abdullah S, Nathan R (2010). Health Status and Quality of Life among Old Adults in Rural Tanzania. Global Health Action. http://www.globalhealthaction.net/index.php/gha/rt/printerFriendly/2142/6055. Accessed on 12th November, 2014.

Mwende CM (2016). Impact of Small Scale Horticultural Farming on Rural Poverty in Kenya. Department of Economics, University of Nairobi, Kenya. http://erepository.uonbi.ac.ke/bitstream/handle/11295/98968/Mukuma. Accessed on May 11, 2018.

Narayan A, Dabalen AL, Revenga AL, Dikhanov YM, Ferreira FHG, Hamadeh N, Yoshida N (2015). A Global Count of the Extreme Poor in 2012: Data Issues, Methodology and Initial Results (No. WPS7432) pp. 1-66. The World Bank. http://documents.worldbank.org/curated/en/360021468187787070/A-global-count-of-the-extreme-poor-in-2012-data-issues-methodology-and-initial-results. Accessed July 6, 2017.

Nyariki DM, Wiggins S, Imungi JK (2002). Levels and Causes of Household Food and Nutrition Insecurity in Dry land Kenya. Ecology Journal of Food and Nutrition 41:155-176.

Nyota HN (2011). Transaction Costs and other Determinants of Choice of Compliance Arrangements with Global-GAP Standards Among Smallholder French Beans Farmers: The Case of Kirinyaga South District, Kenya. http://erepository.uonbi.ac.ke:8080/xmlui/handle/11295/13952. Accessed November 6, 2015

Obare GA, Omamo SW, Williams JC (2003). Smallholder Production Structure and Rural Roads in Africa: The Case of Nakuru District, Kenya. Agricultural Economics 28(3):245-254.

Onyeiwu S, Liu J (2013). Determinants of Income Poverty in Rural Kenya: An Empirical Analysis. Journal of Economic and Sustenance Development 2:1.

Organisation for Economic Co-operation and Development (OECD) (2008). Growing Unequal? | OECD Read Edition. http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/growing-unequal_9789264044197-en. Accessed July 6, 2017.

Organisation for Economic Co-operation and Development (OECD) (2011). Divided We Stand | OECD Read Edition. http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/the-causes-of-growing-inequalities-in-oecd-countries_9789264119536-en#.WV30eVFRW1s#page3. Accessed November 13, 2015.

Owuor G, Ngigi M, Ouma A, Birachi E (2007). Determinants of Rural Poverty in Africa: The Case of Smallholder Farmers in Kenya. Journal of Applied Sciences 7(17):2539-2543.

Oxford Poverty and Human Development Initiative (OPHI) (2017). "Kenya Country Briefing", Multidimensional Poverty Index Data Bank. OPHI, University of Oxford. https://www.google.com/search?q=Available+at%3A+www.ophi.org.uk%2Fmultidimensional-poverty-index%2Fmpi-country-briefings%2Fandie=utf-8andoe=utf-8andclient=firefox-b-ab#q=Available+at:+www.ophi.org.uk/multidimensional-poverty-index/mpi-country-briefing+kenyas/. Accessed March 28, 2017.

Oyugi NL, Mwabu G, Masai W (2000). The Determinants of Poverty in Kenya. African Journal of Economic Policy 7(1):47-64.

Ravallion MC, Shaohua SP (2009). Dollar a Day Revisited. World Bank Economic Review 23(2):L163-184.

Ravallion M, Datt G, Van de Walle D (1991). Quantifying Absolute Poverty in the Developing World. Review of Income and Wealth 37(4):345-361.

Republic of Kenya (2003a). The Investment Program for the Economic Recovery Strategy for Wealth and Employment Creation (IP-ERS). Ministry of Planning and National Development. Government Printer. Nairobi

Swanepoel C (2005). Poverty and Poverty Dynamics in Rural Ethiopia (Working Papers No. 03/2005). Stellenbosch University, Department of Economics. https://ideas.repec.org/p/sza/wpaper/wpapers14.html. Accessed July 6, 2017.

APPENDIX

Appendix A1. Correlation of factors affecting observed poverty.

		Gender of the household head	Household size	Primary	Secondary	Age of Household head	Never Like Risks	Always Like Risks	Type of farmer	Membership to groups	Did the household try to access credit last year	Net French Bean Income	Total Net Household Income	Total annual asset value	Off-farm income	Expenditure per adult equivalent	Total Land size owned (acres)
Gender of the household head	Pearson Correlation	1	0.082	-0.074	0.052	-0.007	0.022	0.031	-0.022	0.071	0.016	0.033	0.075	0.070	0.034	-0.035	0.035
	Sig. (2-tailed)		0.068	0.102	0.253	0.882	0.619	0.495	0.622	0.115	0.721	0.464	0.097	0.123	0.456	0.435	0.432
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Household size	Pearson Correlation	0.082	1	0.015	0.004	0.100*	0.034	0.016	-0.040	0.017	-0.016	0.053	0.026	0.075	0.012	-0.025	0.017
	Sig. (2-tailed)	0.068		0.741	0.924	0.027	0.449	0.725	0.373	0.711	0.723	0.241	0.569	0.098	0.794	0.586	0.703
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Primary	Pearson Correlation	-0.074	0.015	1	-0.816**	-0.048	0.082	-0.078	0.000	-0.047	-0.045	-0.034	-0.147**	-0.100*	-0.129**	-0.016	-0.065
	Sig. (2-tailed)	0.102	0.741		0.000	0.291	0.069	0.085	0.998	0.297	0.318	0.450	0.001	0.027	0.004	0.725	0.150
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Secondary	Pearson Correlation	0.052	0.004	-0.816**	1	0.004	-0.059	-0.048	0.011	0.027	0.065	0.007	0.071	0.091*	0.054	0.030	0.056
	Sig. (2-tailed)	0.253	0.924	0.000		0.933	0.193	0.284	0.812	0.547	0.151	0.877	0.118	0.044	0.231	0.506	0.215
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Age of Household head	Pearson Correlation	-0.007	0.100*	-0.048	0.004	1	-0.079	0.003	0.087	0.064	-0.004	0.033	0.018	0.114*	0.029	0.035	0.113*
	Sig. (2-tailed)	0.882	0.027	0.291	0.933		0.082	0.956	0.055	0.155	0.931	0.460	0.685	0.011	0.515	0.438	0.012
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Never Like Risks	Pearson Correlation	0.022	0.034	0.082	-0.059	-0.079	1	-0.105*	-0.054	-0.060	-0.049	-0.008	-0.051	-0.044	-0.053	-0.012	-0.028
	Sig. (2-tailed)	0.619	0.449	0.069	0.193	0.082		0.019	0.233	0.182	0.282	0.851	0.261	0.335	0.240	0.782	0.538
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Always like risks	Pearson Correlation	0.031	0.016	-0.078	-0.048	0.003	-0.105*	1	0.103*	0.042	0.061	0.087	0.132**	0.113*	0.105*	-0.032	-0.008
	Sig. (2-tailed)	0.495	0.725	0.085	0.284	0.956	0.019		0.023	0.348	0.177	0.054	0.003	0.012	0.020	0.478	0.862
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Type of farmer	Pearson Correlation	-0.022	-0.040	0.000	0.011	0.087	-0.054	0.103*	1	0.135**	0.108*	0.101*	-0.005	0.032	-0.039	0.003	0.059
	Sig. (2-tailed)	0.622	0.373	0.998	0.812	0.055	0.233	0.023		0.003	0.016	0.025	0.908	0.473	0.385	0.940	0.189
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Membership to	Pearson Correlation	0.071	0.017	-0.047	0.027	0.064	-0.060	0.042	0.135**	1	0.137**	0.046	0.046	0.049	0.054	0.044	-0.054

Appendix A1. Contd.

groups	Sig. (2-tailed)	0.115	0.711	0.297	0.547	0.155	0.182	0.348	0.003		0.002	0.313	0.312	0.278	0.233	0.327	0.228
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Did the household try to access credit last year	Pearson Correlation	0.016	-0.016	-0.045	0.065	-0.004	-0.049	0.061	0.108*	0.137**	1	0.095*	0.099*	0.045	0.020	-0.028	-0.080
	Sig. (2-tailed)	0.721	0.723	0.318	0.151	0.931	0.282	0.177	0.016	0.002		0.036	0.029	0.317	0.657	0.536	0.076
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Net French Bean Income	Pearson Correlation	0.033	0.053	-0.034	0.007	0.033	-0.008	0.087	0.101*	0.046	0.095*	1	0.397**	0.034	0.187**	0.058	0.019
	Sig. (2-tailed)	0.464	0.241	0.450	0.877	0.460	0.851	0.054	0.025	0.313	0.036		0.000	0.457	0.000	0.199	0.673
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total Net Household Income	Pearson Correlation	0.075	0.026	-0.147**	0.071	0.018	-0.051	0.132**	-0.005	0.046	0.099*	0.397**	1	0.069	0.826**	0.007	0.044
	Sig. (2-tailed)	0.097	0.569	0.001	0.118	0.685	0.261	0.003	0.908	0.312	0.029	0.000		0.126	0.000	0.880	0.327
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total annual asset value	Pearson Correlation	0.070	0.075	-0.100*	0.091*	0.114*	-0.044	0.113*	0.032	0.049	0.045	0.034	0.069	1	0.030	0.024	0.079
	Sig0. (2-tailed)	0.123	0.098	0.027	0.044	0.011	0.335	0.012	0.473	0.278	0.317	0.457	0.126		0.509	0.600	0.080
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Off-farm income	Pearson Correlation	0.034	0.012	-0.129**	0.054	0.029	-0.053	0.105*	-0.039	0.054	0.020	0.187**	0.826**	0.030	1	0.002	0.048
	Sig. (2-tailed)	0.456	0.794	0.004	0.231	0.515	0.240	0.020	0.385	0.233	0.657	0.000	0.000	0.509		0.957	0.285
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Expenditure per adult equivalent	Pearson Correlation	-0.035	-0.025	-0.016	0.030	0.035	-0.012	-0.032	0.003	0.044	-0.028	0.058	0.007	0.024	0.002	1	-0.008
	Sig. (2-tailed)	0.435	0.586	0.725	0.506	0.438	0.782	0.478	0.940	0.327	0.536	0.199	0.880	0.600	0.957		0.854
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total Land size owned (acres)	Pearson Correlation	0.035	0.017	-0.065	0.056	0.113*	-0.028	-0.008	0.059	-0.054	-0.080	0.019	0.044	0.079	0.048	-0.008	1
	Sig. (2-tailed)	0.432	0.703	0.150	0.215	0.012	0.538	0.862	0.189	0.228	0.076	0.673	0.327	0.080	0.285	0.854	
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492