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Full Length Research Paper

Adoption of soybean by smallholder farmers in the Central Highlands of Kenya

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Current demand for soybean in Kenya is higher than production, and the deficit is filled through importation from neighboring Countries. Despite the high demand, production and adoption remain low. The study sought to determine factors influencing the decision to adopt soybean by smallholder farmers, assess acreage under soybean, and its production. Interviews were carried out using an interview schedule on 210 households randomly sampled from purposively selected farmer groups. Data were subjected to cross-tabulation for categorical variables to test for association. It was also subjected to a logistic regression model to predict factors affecting the decision to adopt soybean. Results showed that 41% of the households were adopters while 59% were non-adopters. The number of adopters increased from 28% to 88% over the six seasons. Acreage under soybean and its production increased over the six seasons. Farm size, membership of a farmer group and attendance of training on soybean production influenced the decision to adopt soybean positively while household head age negatively influenced the adoption of soybean. These results imply that the adoption of soybean can be enhanced by targeting younger farmers, farmers with bigger farm sizes, encouraging farmers to join farmer groups and increasing training on soybean.

Keywords: Adoption, acreage, production, soybean, smallholder farmers.

INTRODUCTION

Soybean (*Glycine max L. Merrill*) is an important legume crop, with potential for expansion in Africa. Globally, soybean accounts for about 84.5% of the grain legumes trade. Sub-Saharan Africa (SSA) accounts for about 1.3% of total land area under soybean and 0.6% of production in the world. Kenya's annual soybean production is meager, estimated at 2,007 metric tones (FAO, 2018). The annual demand is estimated at 120,000 metric tonnes, hence the significant deficit of over 95% is covered by importation from Uganda, Zambia, Malawi, Zimbabwe, Brazil, and Argentina (Muriithi et al., 2016).

Soybean is a multipurpose crop and therefore its increasing demand is based on its usefulness as a feed, food and fuel crop (Mubichi, 2017). The crop is also an alternative to addressing malnutrition among agriculture dependent communities as it comprises more than 36% protein, 20% oil, 30% carbohydrates, dietary fiber, minerals, and vitamins (Bruns, 2016; Sales et al., 2016). Despite these advantages, soybean production has remained very low in Africa (Abate et al., 2012). Its adoption

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and production is below the potential (3.0 - 3.6 t ha-1), with average yields in central highlands of Kenya ranging from 1.1 to 2.6 t ha-1 (Verde et al., 2013). In SSA the average yield has also remained very low at 1.1 t ha−1 in the past four decades, this is below the world average of 2.4 t ha−1. For instance, the average soybean yields in 2016/2017 in South Africa, Nigeria, Zambia, and Uganda was 2.29, 0.96, 1.94 and 0.6 t ha−1 respectively (Khojely et al., 2018).

To meet the rapidly rising demand, SSA countries imported 6.8 MT of soybeans annually at the cost of 4.4 billion USD from 2013 to 2016. The countries also annually imported 1.7, 3.3, and 1.8 MT of soybean grain, meal, and oil, respectively, from 2012 to 2016. Imports in 2011 were estimated at 1.6 million tonnes, valued at $1.22 billion. South Africa, Nigeria, and Kenya account for nearly 43%, 21% and 18% of the total import volume in this region, respectively. Other countries, including Ethiopia, Zambia, Zimbabwe, Seychelles, Botswana, Tanzania and Gabon also import significant amounts of soybean each year (Abate et al., 2012). South Africa is the leading soy meal importer in SSA, with annual imports of over one half million tons (Rusike et al., 2013). By increasing soybean yield, production and adoption, SSA countries will become soybean demand-driven rather than supply-driven, given that soybean demand is still proliferating in SSA (Khojely et al., 2018). The growing demand for soybeans offers a significant opportunity for smallholder farmers to increase their incomes (Lubungu et al., 2013).

The global yield increase of 1.3% will not be sufficient to meet the required production by 2050 (Ray et al., 2013). This suggests that adequate measures are required to promote soybean production especially in Kenya where production is low. Increased adoption of soybean can be a sure way of bridging the gap between production and demand, increasing food security and solving malnutrition issues in this region. However, adoption of soybean in the central highlands of Kenya has remained low and this can be attributed to weak extension services, lack of clear exchange mechanisms between farmers, researchers and extension agents and lack of enough knowledge on adoption behavior of soybean by farmers. We therefore aimed at determining the factors that influence adoption of soybean by smallholder farmers, assessing acreage under soybean, and its production in central highlands of Kenya.

MATERIALS AND METHODS

Description of the study area

The study was carried out in Embu, Meru and TharakaNithi counties in the central highlands of Kenya. These counties form part of Central highlands of Kenya which has an altitude ranging from 1,500 to 2,000 meters above sea level. Farmers in this region integrate crop and livestock in their small hold farms which mostly ranges between 0.2 and 3.2 hectares.

Embu County is located approximately between latitude $00^0$8'and $00^0$50' South and longitude $37^0$3' and $37^0$9' East. Average annual rainfall ranges from 886 mm to 1894 mm. The rainfall pattern is bi-modal with two distinct rainy seasons. Long rains occur between March and June while the short rains fall between October and December. Average temperatures are 23.9^0 C (Jaetzold et al., 2006).

TharakaNithi County lies between latitude $00^0$07' and $00^0$26' South and between longitudes $37^0$19' and $37^0$46'East. Average annual rainfall ranges from 664 mm - 2128 mm. The rainfall pattern is bi-modal with two distinct rainy seasons. Long rains occur between March and June while the short rains fall between October and December. Average temperatures are 24.1^0 C.

Meru County lies $00^0$6' North and about $00^0$1' South, and latitudes 37^0 West and 38^0 East. Average annual rainfall ranges from 633 mm - 2177 mm. The rainfall pattern is bi-modal with two distinct rainy seasons. Long rains occur between March and June while the short rains fall between October and December. Average temperatures are 23.7^0 C.

Sampling procedure and size

Two-stage random sampling technique was used in the selection of respondents. All the groups participating in soybean farming were identified. In the first stage, twenty-one groups from the ones practicing soybean farming were purposively selected (seven groups from each county). The second stage involved selecting a proportionate number of respondents from each of the twenty-one groups. The Selection was made randomly at this stage. Two hundred and ten households were finally used for this study.

Statistical data analysis

Farmers who had adopted soybean and those who had not adopted were carefully identified in the filled questionnaires before data entry. The data was then entered in SPSS software and was first analyzed using descriptive statistics. Data were subjected to Cross-tabulation for categorical variables to test for association using Pearson chi-square statistic and later subjected to a logistic regression model to predict factors affecting the decision to adopt or not to adopt soybean. Several studies have used logit model in the analysis of adoption of different technologies (Hagos et al., 2018; Onyeneke, 2017; Mugi-Ngenga et al., 2016; Macharia et al., 2012 and Mugwe et al., 2009). The model used the maximum likelihood estimation method to estimate the coefficients (Garson, 2008). The model was specified as follows:

$Ln\ Y = Ln\ (P_i / 1 - P_i)$

$Ln\ (Pi / 1 - Pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_{11} X_{11} + e$

Where Y= binary variable defined as 1 if the farmers adopt soybean and 0 if the farmer does not

P_i = probability of adoption of soybean

Ln = natural logarithm function

β_0 = intercept term

$\beta_1 - \beta_{12}$ = logistic regression coefficients

e = error term

X_1 - X_{11}= Explanatory variables

The explanatory variables used in soybean adoption model are described in (Table 1).

Selection of the explanatory variables included in the model was based on evidence from past studies. Correlation analysis was used to confirm that the explanatory variables are not internally correlated, avoid biased estimates, and ensure the usefulness of the predictions and policy implications based on the findings of the study (Chianu et al., 2007). Independent variables were also tested for endogeneity using STATA software. Before running the logit regression, Durbin–Wu–Hausman test was done to the independent variables to test for endogeneity. The variables were found to be exogenous as shown below.

Durbin (Score) Chi2 (3) = 5.3493 (P = 0.1479)

Wu-Hausman F (3, 190) = 1.7228 (P = 0.1637)

Adoption was defined as a binary variable that is "adopters"and "non-adopters"who were assigned a value of 1 and 0 respectively. A farmer who adopted soybean, “adopter”, was defined as one who had soybean in the field during the time of the interview, planted soybean for at least three consecutive seasons from March, April and May season in the year 2014 (MAM 2014) and who had a plan to continue growing soybean.

RESULTS

Planting of soybean by adopters and non-adopters in different seasons

Out of the households interviewed, **(**86; 41%) were adopters while (124; 59%) were non-adopters. In March, April and May season in the year 2014 (MAM 2014), (24; 28%) adopters planted soybean while (10; 8%) of non-adopters planted soybean. In the following season, October, November, and December in the year 2014 (OND 2014) adopters who planted soybean increased to (25; 29%) while non-adopters reduced to (9; 7%). In October, November, December season in the year 2016 (OND 2016) adopters who planted soybean increased to (76; 88%) while non-adopters reduced to (7; 6%). The number of adopters who planted soybean kept on increasing (Figure 1).

Area planted by adopters and non-adopters in different seasons

Adopters who planted between a quarter and a half of an acre of soybean in MAM 2014 were (13; 15%) while (2; 2%) non-adopters planted less than a quarter an acre in this season (Table 2). In the following season, OND 2014 adopters who planted between a quarter and a half of an acre of soybean increased to (16; 19%) while non-adopters remained the same (4; 3%). In MAM 2015, (18; 21%) adopters and (6; 5%) non-adopters planted between a quarter and a half of an acre of soybean (Table 2). Adopters who planted more than one acre of soybean in OND 2015 were (2; 2%). In the same season, 21% more adopters than non-adopters planted between a quarter and a half of an acre of soybean. In the sixth season, OND 2016 adopters who planted between a quarter and a half of an acre of soybean increased by 123% while non-adopters remained at 4%. These results imply that the area planted by adopters increased over the seasons while that of non-adopters remained constant.

Production by adopters and non-adopters in different seasons

In OND 2014 (16; 19%) adopters harvested between one and ten kilograms of soybean while only (2; 2%) non-adopters harvested between one and ten kilograms of soybean. In the following season, MAM 2015 adopters who harvested between one and ten kilograms of soybean increased to (21; 24%) and only 1% of adopters harvested over hundred kilograms of soybean (Table 3). In OND 2015 season 27% and 4% adopters and non-adopters respectively harvested between one and ten kilograms of soybean and (13; 15%) adopters harvested between ten and twenty-five kilograms. In the following season, MAM 2016 adopters who harvested between one and ten kilograms of soybean increased to (27; 31%) while non-adopters increased to (6; 5%). In the last season, OND 2016 adopters who planted between one and ten kilograms of soybean increased by 233% while non-adopters reduced by 60%. These results imply that if the trend continues the gap between demand and production will be reduced and this will reduce importation.

Table 1. Description of explanatory variables used in soybean adoption model		
Independent variable		**Description**
X_1:	AGE	Age in years of head of household (continuous variable)
X_2:	MSHH	Marital status of the household head (1=Single, 2= Married, 3= Widowed, 4=Divorced)
X_3:	OHD	Occupation of household head (1=Farming, 2=Off-farm business,3=Employed, 4=other)
X_4:	EDLH	Education level of household head (1=No education, 2= Lower Primary 3=Upper primary 4=Secondary 5=Tertiary)
X_5:	HHSIZE	Household size (continuous variable)
X_6:	YFE	Years of farming experience (continuous variable)
X_7:	FSIZE	Farm size (continuous variable)
X_8:	PSP	Perception of soybean to be profitable (1=yes, 2= No)
X_9:	BFG	Belong to a farmer group (1=yes, 2= No)
X_{10}:	ATRAIN	Attendance of training (1=yes, 2= No)
X_{11}:	ACSF	Availability of credit and saving facilities (1=yes, 2= No)

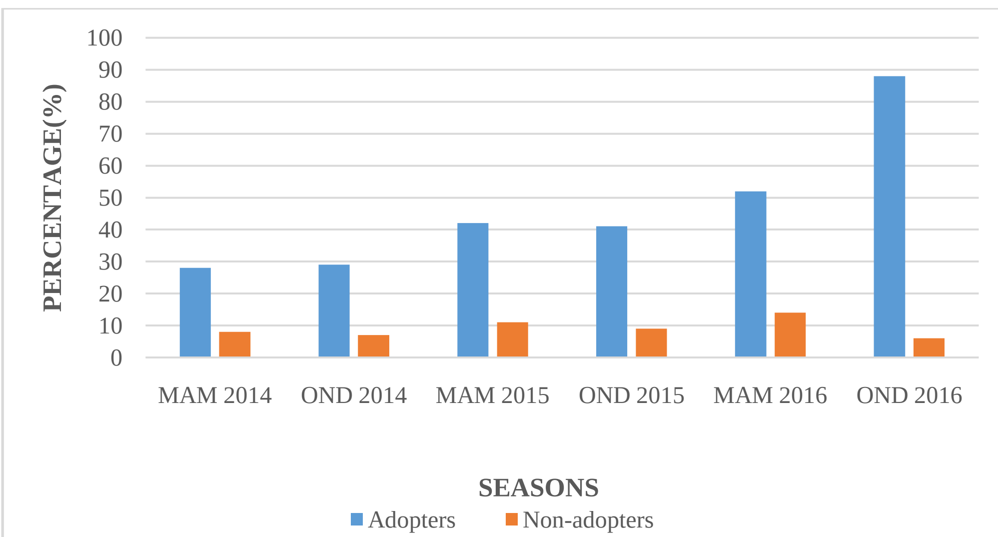

Figure 1. Percentage of adopters and non-adopters who planted soybean in different seasons.

Socio-demographic factors concerning the adoption of soybean in the Central highlands of Kenya

Age and household size of adopters and non-adopters

Mean age of adopters was 54.38 years while that of non-adopters was 53.70 years, though they were no significantly different (Table 4). This implies that adopters were older than non-adopters. These findings agree with that by (Ramaekers et al., 2013).

Non-adopters had a higher household size of 1.58 than adopters who had a mean household size of 1.45 although these means were not significantly different (Table 4).

Marital status of the household head

Majority of the respondents (169; 80%) were married out of this 59% were non-adopters while 41% were adopters (Table 5). There was an association between the marital status of the household head and the adoption of soybean

Table 2. Acreage planted by adopters and non-adopters in different seasons.

Area planted with Soybean in acres	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters
	MAM 2014		OND 2014		MAM 2015		OND 2015		MAM 2016		OND 2016	
< 0.25	9 (11%)	2 (2%)	13 (15%)	3 (2%)	14 (16%)	5 (4%)	16 (19%)	5 (4%)	18 (21%)	5 (4%)	24 (28%)	5 (4%)
0.25-0.5	13 (15%)	4 (3%)	16 (19%)	4 (3%)	18 (21%)	6 (5%)	24 (28%)	4 (3%)	26 (30%)	3 (2%)	29 (34%)	4 (3%)
0.51-1	2 (2%)	2 (2%)	0 (0%)	1 (1%)	3 (4%)	2 (2%)	1 (1%)	1 (1%)	7 (8%)	8 (7%)	1 (1%)	1 (1%)
> 1	0 (0%)	1 (1%)	1 (1%)	0 (0%)	0 (0%)	3 (2%)	2 (2%)	1 (1%)	0 (0%)	2 (2%)	2 (2%)	1 (1%)
None	62 (72%)	115 (92%)	56 (65%)	116 (94%)	51 (59%)	108 (87%)	43 (50%)	113 (91%)	35 (41%)	106 (85%)	30 (35%)	113 (91%)

Adopters = 86; Non-adopters = 124.

Table 3. Production by adopters and non-adopters in different seasons.

Soybean harvested in Kgs	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters
	MAM 2014		OND 2014		MAM 2015		OND 2015		MAM 2016		OND 2016	
1-10	9 (10%)	5 (4%)	16 (19%)	2 (2%)	21 (24%)	7 (6%)	23 (27%)	5 (4%)	27 (31%)	6 (5%)	30 (34%)	2 (2%)
10-25	7 (8%)	0 (0%)	9 (10%)	1 (1%)	10 (12%)	2 (2%)	13 (15%)	2 (2%)	15 (18%)	2 (2%)	17 (20%)	0 (0%)
26-50	5 (6%)	0 (0%)	7 (8%)	1 (1%)	9 (10%)	1 (1%)	9 (11%)	2 (2%)	10 (12%)	3 (2%)	11 (13%)	0 (0%)
51-100	3 (3%)	2 (2%)	3 (4%)	1 (1%)	5 (6%)	3 (2%)	7 (8%)	0 (0%)	7 (8%)	0 (0%)	7 (9%)	1 (1%)
>100	1 (1%)	2 (2%)	1 (1%)	3 (2%)	1 (1%)	1 (1%)	2 (2%)	2 (2%)	1 (1%)	5 (4%)	2 (2%)	3 (2%)
None	62 (72%)	115 (92%)	50 (58%)	115 (93%)	40 (47%)	100 (88%)	32 (37%)	113 (90%)	26 (30%)	108 (87%)	19 (22%)	118 (95%)

(Pearson $\chi2$ = 215.304, p = 0.001). This implies that having a spouse increases a household's access to labor which is essential in soybean growing. Household heads having spouses have a higher probability of adopting soybean as they have more labor than those who do not have spouses.

Occupation of the household head

Majority of the respondents (171; 81%) practiced farming as their source of livelihood (Table 6). Majority of adopters (80%) also practiced farming as their source of livelihood. There was a significant relationship between the occupation of the household head and the adoption of soybean (Pearson $\chi2$ =

Table 4. Mean age and household size of adopters and non-adopters.

Characteristic	Adopters n=86	Non-adopters n=124	*t*-test p-value
Age of the Household head in Years	54.38	53.70	Ns
Household size	1.45	1.58	Ns

Ns= Not Significant.

Table 5. Marital status of the household head and adoption of soybean

Marital status of Household head	Adopters n=86	Non-adopters n=124	X^2 p-value
Married	70(41%)	99(59%)	
Windowed	12(52%)	11(48%)	0.001*
Single	2(17%)	10(83%)	
Divorced	2(31%)	4 (67%)	

∗Association significant at α = 0.05.

Table 6. Occupation of the household head and adoption of soybean.

Occupation of the household head	Adopters n=86	Non-adopters n=124	X^2 p-value
Farming	69 (40%)	102 (60%)	
Employed	5 (45%)	6 (55%)	
Off farm business	2 (18%)	9 (82%)	0.001*
Retired	7 (64%)	4 (36%)	
Others	3 (50%)	3 (50%)	

∗Association significant at α = 0.05.

216.004, *p* = 0.001). This implies that household heads who practice farming as their main source of livelihood are more likely to adopt soybean than household heads who are employed or who have an off-farm business. Those who practice farming are more likely to use and adopt a new strategy to increase yield and diversify their usual practices compared to those who are employed or have an off-farm business. For instances, Geta et al. (2013), Martey et al. (2014) and Mugi-Ngenga et al. (2016) found that household heads who solely practiced farming invested in inputs to increase yields.

The Education level of the household head

There was a significant relationship between the education level of the household head and the adoption of soybean (Pearson $\chi 2$ = 211.689, *p* = 0.001). Majority of the respondents (80; 38%) had upper primary education. Majority of adopters (36%) had attained education up to upper primary level (Table 7). Lack of education poses a challenge on a farmer's ability to understand and access information on newly introduced technologies. It is more likely that a farmer who has gained education will access up-to-date agricultural information as opposed to a farmer who is illiterate. A farmer who has no education at all will not be able to understand the information in a simple agricultural brochure or even from a workshop organized by extension workers (Adolwa et al., 2012).

Farm characteristics in relation to the adoption of soybean in the central highlands of Kenya

Farm size and years of farming experience of adopters and non-adopters

The average farm size of adopters was 3.24 acres while that of non-adopters was 3.04 acres (Table 8). The implication of this is that adopters tend to have bigger farm sizes than non-adopters.

Adopters had a significant (p=0.0269) higher farming experience of 19 years than non-adopters who had a mean of farming experience of 17 years (Table 8).

Table 7. The Education level of the household head and adoption of soybean.

The education level of the household head	Adopters n=86	Non-adopters n=124	X^2 p-value
No education	6 (46%)	7 (54%)	
Upper primary education	31 (39%)	49 (61%)	0.001*
Secondary education	30 (44%)	38 (56%)	
Lower primary education	10 (38%)	16 (62%)	
Tertiary education	9 (39%)	14 (61%)	

∗Association significant at α = 0.05.

Table 8. Mean farm size and years of farming experience of adopters and non-adopters.

Characteristic	Adopters n=86	Non-adopters n=124	*t*-test p-value
Farm size in acres	3.24	3.04	Ns
Farming experience in years	19	17	0.0269*

∗Association significant at α = 0.05, Ns= Not Significant

Perception of soybean to be profitable in relation to the adoption of soybean in the central highlands of Kenya

The majority of households, (172; 82%) perceived soybean to be profitable while the rest (38; 28%) did not perceive soybean to be profitable (Table 9). There exists a significant relationship between perception of soybean to be profitable and the adoption of soybean (Pearson $\chi2$ = 218.942, *p* = 0.001). This implies that farmers with a positive perception of the profitability of soybean have a higher likelihood of adopting soybean than those farmers with a negative perception of the profitability of soybean.

Membership of farmer group in relation to the adoption of soybean in the central highlands of Kenya

The majority of households, (119; 57%) were members of a farmer group while the rest (91; 43%) were not members of any farmer group. Majority of adopters, (74; 86%) were members of a farmer group while the majority of non-adopters, (78; 63%) were not members of any farmer group (Table 10). Adoption of soybean was associated with membership of the farmer group (Pearson $\chi2$=262.514, *p*=0.001). This implies that when farmers are in a farmer group, they have a higher likelihood of adopting soybean than those farmers who are not in a farmer group and therefore encouraging and sensitizing farmers to join farmer groups would promote adoption.

Availability of credit and saving facility in agriculture in relation to the adoption of soybean in Central highlands of Kenya

In the majority of households, (117; 56%) credit and saving facilities were available, while the rest (93; 44%) credit and saving facilities were not available in agriculture. Majority of adopters households, (51; 59%) had accessibility to credit and saving facilities in agriculture (Table 11). There exists a significant relationship between the availability of credit and saving facilities in agriculture and the adoption of soybean (Pearson $\chi2$ = 211.764, *p* = 0.001). This implies that farmers with credit and saving facilities in agriculture have a higher likelihood of adopting soybean than those who do not have them, therefore, making credit and saving facilities available in agriculture will increase adoption of soybean.

Logit regression model analysis of factors influencing the adoption of soybean in the central highlands of Kenya

The results of the Logit model are presented in (Table 12). The model was significant at p<0.01, and it had good explanatory power and correctly predicted 77.9% and 87.1% adopters and non-adopters respectively.

Results showed that four factors significantly influenced the adoption of soybean in the Central highlands of Kenya. Age of the household head negatively influenced adoption (β= -3.280, P=0.008) of soybean at 5% probability level (Table 12). This implies that younger households had a higher probability of adopting soybean than older households. Total farm size positively influenced the adoption of soybean (β= 1.347, P=0.015). This implies that farmers with bigger farm sizes have a higher probability of adopting soybean than farmers with smaller farm sizes.

Membership of farmer group positively influenced adoption (β= 2.358, P=0.001) of soybean (Table12). This

Table 9. Perception of soybean to be profitable and adoption of soybean.

Perception of soybean to be profitable	Adopters n=86	Non-adopters n=124	X^2 p-value
Yes	78 (45%)	94 (55%)	0.001*
No	7 (23%)	23 (77%)	

*Association significant at α = 0.05.

Table 10. Membership to a farmer group and adoption of soybean.

Member of a Farmer group	Adopters n=86	Non-adopters n=124	X^2 P value
Yes	74 (62%)	45 (38%)	0.001*
No	12 (13%)	78 (87%)	

*Association significant at α = 0.05.

Table 11. Availability of credit and saving facility in agriculture and the adoption of soybean.

Availability of credit and saving facilities in agricultural enterprise	Adopters n=86	Non-adopters n=124	X^2 P value
Yes	51 (44%)	66 (56%)	0.001*
No	35 (38%)	58 (62%)	

*Association significant at α = 0.05

Table 12. Factors influencing adoption of soybean in the central highlands of Kenya.

Independent Variables	β	S.E.	Wald	Sig.	Exp (β)
Age of household head	-3.280**	1.229	7.123	0.008	0.038
Marital status of household head	1.679	1.182	2.015	0.156	5.358
Occupation of the Household head	0.592	1.263	0.219	0.640	1.807
Education level	0.393	1.023	0.147	0.701	1.481
Household size	0.591	0.631	0.877	0.349	0.554
Years of farming experience	1.480	1.049	1.988	0.159	4.392
Total farm size	1.347**	0.555	5.888	0.015	3.847
Perception of soybean to be profitable	-0.675	0.711	0.901	0.343	0.509
Membership of farmer group	2.358**	0.537	19.279	0.001	0.095
Attendance of trainings	3.136**	1.536	4.170	0.041	0.043
Availability of Credit for farming	0.426	0.475	0.805	0.370	1.531
Constant	2.458	1.554	2.502	0.114	11.683
Correctly predicted adopters as adopters	77.9%				
Correctly predicted non-adopters as non-adopters	87.1%				

N=210, **Significant at 5% probability level.

implies that households which are in a farmer group are more likely to adopt soybean than households which are not in a farmer group.

Attendance of training on soybean positively influenced adoption (β= 3.136, P=0.041) implying that increasing training on soybean production will increase adoption of the crop in the central highlands of Kenya.

DISCUSSION

The number of adopters increased over the six seasons from 28% to about 90%. Farmers adopted soybean incrementally (planted soybean to see how it will perform before planting more). The production and acreage under soybean also increased over the six seasons. At first, few farmers planted soybean, and the number kept on increasing. This increase in acreage and production means that the demand for soybean can be achieved and soybean will no longer be imported. The study has shown that about 2.8 tonnes are produced annually in the region and this means that there is still a considerable gap between production and demand. These results show that much effort has to be put to enhance adoption and production of soybean.

Age of the household head negatively influenced the decision to adopt soybean. Farmers' age has been found to increase as well as decrease the probability of adoption. In a study by Letaa et al. (2015) in Tanzania, farmers' age was found to negatively influence common bean adoption, while a study by Grabowski et al. (2016) in Zambia reported farmers' age to positively influence adoption of cotton, where adopters were more advanced in age. The negative influence of the household head age on the decision to take up soybean in the current study can be explained that young farmers tend to be more innovative due to their longer planning horizons. It may also be older farmers are more risk-averse and less likely to be flexible than younger farmers and thus have a lesser likelihood of trying crops like soybean. This may also be because younger farmers are often better exposed to trying innovations and have lower risk aversion and they have the time to experiment with new strategies as opposed to the older farmers who are accustomed to their farming practices (Akinola et al., 2011). The negative influence of age on adoption in the current study is consistent with the findings of Nguyen-van et al. (2016) in Vietnam who found age to influence the adoption of tea varieties negatively. The importance of age in influencing (negatively) adoption is also in agreement with several other studies, for example, Oganda et al. (2014) in Kenya; Owombo and Idumah (2015) in Nigeria; Salifu and Salifu (2015) and Wongnaa et al. (2018) in Ghana.

Farm size positively influenced the adoption of soybean. This implies that the adoption of soybean increased with an increase in farm size. Farmers who own and cultivate larger farms are more likely to spend more on conservation as it is associated with greater wealth and increased availability of capital, which makes investment more feasible. Soybean is not substituting another crop, so this additional crop demands more land. Therefore, agricultural extension officers and researchers should realize that small land size is not stimulating factor for adoption but a limiting factor (Ramaekers et al., 2013). The positive influence of farm size on adoption of soybean can be attributed to farmers with large farms diversifying crop production and trying new crops in their farms. These findings agree with previous studies Bamire et al. (2010); Odoemenem and Obinne (2010) which found farm size to have a positive and significant influence on utilization of improved cereal production technologies. These results also agree with studies by Challa and Tilahum (2014); Owombo and Idumah (2015); Saliu et al. (2016) and Wongnaa et al. (2018) who found farm size to influence adoption of agricultural technologies positively. The findings disagree with those by Jaleta et al. (2013) and Aidoo et al. (2014) who found farm size to affect the adoption of maize production technologies negatively. Ramaekers et al. (2013) also found the land size to influence the adoption of climbing beans positively in the Central highlands of Kenya.

Membership of farmer group positively influenced the adoption of soybean. This implies that households belonging to farmer groups are likely to be more knowledgeable than households that do not belong to any group. This could be because the farmers in groups share their experiences and challenges hence fostering a positive way forward. Moreover, groups could be effective in persuading farmers to try new technologies and encourages the sharing of knowledge and experiences among members. Membership of a group provides valuable learning and collective bargaining opportunity for farmers. Groups provide a means of collective action by farmers, providing resources such as credit, labor, and information. Membership of farmer groups also enables individuals to have access to capacity building efforts such as training and study tours and information on new agricultural technologies. Stringer et al. (2009), notes that group membership increases the information which also improves its access and adoption. These results are in agreement with previous studies by Matata et al. (2010) who found that farmers who did not adopt improved fallow were non-members in farmer groups and hence groups were needed in order to improve farmers' awareness and knowledge on improved fallow. The findings are consistent with those of Sisay et al. (2015) and Ahmed (2015), who observed that membership in a group had a positive influence on IMVs adoption in Ethiopia. Also, Ugwumba and Okechukwu (2014) and Ojo and Ogunyemi (2014) found similar results in Nigeria and Mmbando and Baiyegunhi (2016) in Tanzania.

Attendance of training on soybean positively influenced the adoption of soybean. This implies that adoption may increase with an increase in training on soybean. The more trained the households were the more knowledgeable they were likely to be in soybean production. The results agree with those of Pierre-André et al. (2010) who found that through training the farmers acquired knowledge that led to increased agricultural production and income generation. Similarly, Wongnaa et al. (2018) found that training by extension agents improved the level of adoption of improves seeds. Training is a vehicle by which effective and resource-conserving land management is locally promoted and widely adopted. Training also addresses the challenges of lack of knowledge by creating awareness. The results of this study agree with those by Yirga and AwHassan (2015); Owombo and Idumah (2015) and Ghimire et al. (2015) who found a positive influence of training through the extension on the adoption of agricultural technologies.

CONCLUSION

Acreage and production of soybean increased over the six seasons. The results also showed that the factors that significantly influenced the decision to adopt or not to adopt soybean were: age of household size (negatively), total farm size (positively), membership of farmer group (positively) and attendance of training (positively). These results imply that the adoption of soybean could be enhanced by targeting younger families, farmers with bigger farms sizes, training farmers on soybean production and encouraging them to join farmer groups where they can learn from each other. The results also imply that if acreage and production of soybean continue to increase, the vast gap between demand and supply of soybean will be reduced. Importation will also be reduced and thus saving some expenditure of the country.

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