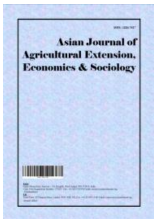

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Factors Affecting Adoption of Integrated Pest Management Technologies by Smallholder Common Bean Farmers in Kenya: A Case Study of Machakos and Bungoma Counties

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Authors' contributions

This work was carried out in collaboration between both authors. Author RAE contributed to the design of the study, data collection, analysis and writing the draft of the paper. Author RJU contributed to data collection and editing the paper. Both authors read and approved the final manuscript.

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ABSTRACT

Common Bean is an important pulse crop in Kenya. The yields of common beans in Kenya have been low and declining. The decline in Common Bean yields has been due to biotic and abiotic stresses. Research was carried out to determine factors that influenced the adoption of Integrated Pests and Disease Management technologies in Bungoma and Machakos counties, Kenya. A multi-stage sampling procedure was used to randomly sample 502 smallholder farmers in Bungoma and Machakos counties. Primary data were collected from sampled farmers by carrying out face to face interviews using a structured questionnaire. Data were analyzed using descriptive statistics and Logistic regression using Statistical Package for Social Scientists (SPSS) version 20 Software.

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Descriptive statistics results showed that farmers in the two study sites used both modern and indigenous technical knowledge (ITK) to control pests and diseases on their bean crops and produce. The Logistic regression results showed that five factors significantly influenced the choice of IPM technologies by farmers. These were: region, level of education of the household head, access to extension services, household food security status and availability of markets for beans. Access to extension and region were highly significant at 1% significance level. To achieve high yields the factor that significantly increased adoption of IPM in bean production such as access to extension should be enhanced.

Keywords: Adoption; integrated pest management; common bean; logit model; Kenya.

1. INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is an important pulse crop in Eastern Africa. Common bean is one of several genera of flowering plants in the family Fabraceae, which are used for human or animal food. The wild forms of *P. vulgaris* and *P. lunatus* are distributed in both Mesoamerica and South America, while those of *P. dumosus, P. coccineus*, and *P. acutifolius* have a geographic distribution that is restricted to Mesoamerica [1]. Common bean is grown on all continents except Antarctica. The world leader in production of dry beans is Myanmar (Burma), followed by India and Brazil. In East Africa, the leading producers is Tanzania followed by Kenya, Uganda and Rwanda [2]. Common bean is rich in proteins, fiber and other nutrients and it is an important crop for improving food security in the region. In Kenya, common bean has been the most important pulse crop grown by smallholder farmers even though dry bean output in Kenya has been declining over the years, despite the effort to increase area under beans [3] and International Trade Centre, [4]. A study carried out in Trans-Nzoia County in western Kenya has shown that dry bean outputs has been declining over the years [5]. Common bean is a major source of proteins for rural and urban poor households and has a potential to improve smallholder household incomes when marketed but its production has not kept pace with demand. In 2014, production in Kenya was approximately 600,000 metric tons while demand was estimated at 755,000 metric tons [6]. The gap in production is filled by imports from countries such as Tanzania and Uganda [4]. Bean yields in Kenya have been low and in some cases have remained constant or have declined over the years. The decline in bean yields has been attributed to a number of a biotic and biotic stresses such as low rainfall, poor soils, pests and diseases and low adoption or non-use of improved technologies by small holder farmers in the country [7].

Dry beans are important in the diet of rural and urban low income households and has been identified as one of the crops that can contribute to food and nutrition security of these households. Regular consumption of common bean and other pulses is now promoted by health organizations because it reduces the risk of diseases such as cancer, diabetes or coronary heart diseases [8]. This is because common bean is low in fat and is cholesterol free. It is also an appetite suppressant because it digests slowly and causes a slow sustained increase in blood sugar. Researchers have found that common bean can delay the reappearance of hunger for several hours, enhancing weight-loss programs. Compared to other sources of proteins dry beans are relatively cheap compared to animal based proteins such as beef and chicken [9]. Therefore, promotion of improved bean varieties and accompanying technologies such as Integrated Pest Management (IPM) is imperative if production and consumption of dry beans is to be increased. However, the slow or non-adoption of improved bean varieties and related technologies is a major concern and may be a major contributor to the low yields of beans in the country and hence none achievement of food and nutrition security in the country.

A number of technologies have been developed and disseminated to smallholder farmers to be used to control pests and diseases in order to improve agricultural productivity. These comprise of simple technologies such as new crop varieties and more complex, knowledge intensive ones such as integrated pest and disease management or integrated soil fertility management (non-varietal). However, few of these technologies are adequately adopted by the target end users to make significant impact on their livelihoods [10,11]. Integrated Pest Management (IPM) technologies have been developed by researchers and can contribute to increased food production if adopted and applied. However, adoption of these technologies has been low. A number of factors have been advanced to explain the low adoption. In the past scientists developed the technologies without adequate end user involvement and failure to consider their social and economic situations, their production circumstances, and the relevant factors that enable adoption under those circumstances. Technology adoption is influenced by the farmers' perception of its effect as well as the dissemination methods used and farmer engagement [12,13].

Low adoption of agricultural productivity has been linked to low adoption of technologies. Adoption of new /improved technologies is necessary if bean production is to be increased in Kenya. To move forward with new and effective Integrated Pest Management (IPM) technology dissemination, it was critical to understand the factors that enhance or constrain the adoption of such technologies. In this respect, research was conducted to determine factors that influenced the adoption of IPM technologies among smallholder bean farmers in Machakos and Bungoma counties of Kenya. The specific objectives of the research were to assess the factors that were likely to influence the adoption and diffusion of IPM technologies and, to draw implications on the effective ways of disseminating these technologies to allow quick adoption and diffusion.

2. METHODOLOGY

2.1 Study Sites and Site Selection

Two study sites were selected, Machakos County in eastern Kenya to represent the Arid and Semi-arid lands (ASALs) and Bungoma County in western Kenya to represent high potential areas.

Machakos County was administratively sub-divided into 11 Sub-counties. Mwala and Kathiani Sub-counties were selected for the study (Fig. 1). Machakos County is located in eastern Kenya, its geographical coordinates are Latitude: -1°31'0.01" S and Longitude: 37°16' 0.01" E.

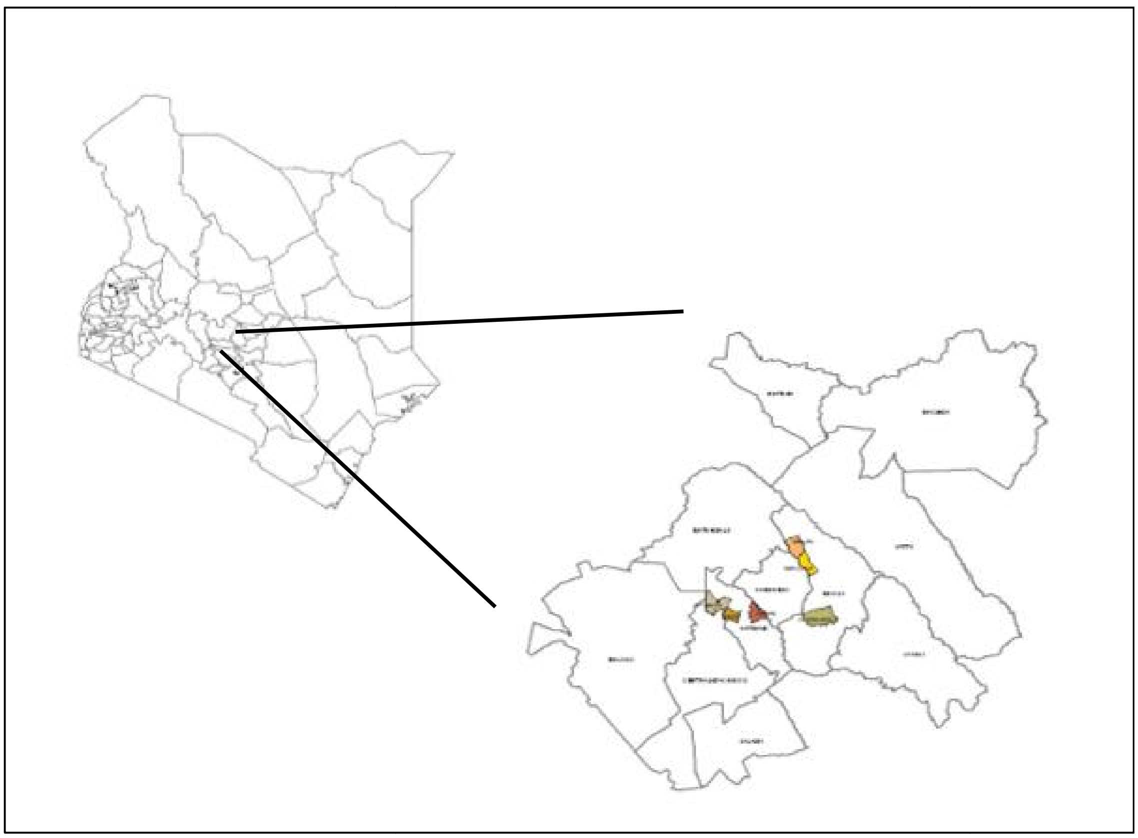

Fig. 1. Map showing the Machakos County study sites

Mwala Sub-County covers 483 Km^2 with 171.8 Km^2 suitable for agriculture, whereas Kathiani Sub-County covers a total area of 205.8 Km^2 with about 171.8 Km^2 being suitable for agriculture. The two sub-counties fall within agro-ecological zones, Upper Medium (UM2)-Upper Medium (UM3) and Lower Medium (LM2)-Lower Medium (LM5) [14]. Rainfall is bimodal with short rains from October to December and long rains from March to May. Rainfall varies between 500-750mm per annum. The soils are mainly sandy loam with marram. The slope of the land ranges from gentle to fairly steep. The major economic activities in the Sub-counties include livestock production (dairy, local zebu animals, sheep, goats and indigenous poultry) and crop farming. The major crop enterprises include maize, beans, cow peas, pigeon peas and horticultural crops such as mangoes, pawpaw, onions and tomatoes. The major limiting factor to agricultural production is inadequate water and lack of adequate inputs such as fertilizer and seed.

Bungoma County was administratively sub-divided into 10 Sub-counties. Bungoma East and Bungoma Central Sub-counties were selected for the study (Fig. 2). Bungoma County is located in western Kenya, its geographical coordinates are Latitude: 0°33'48.60" North and Longitude; 34°33'37.98" East.

Bungoma Central covers 235.4 Km^2 of which 195.4 Km^2 is suitable for agriculture, whereas Bungoma East covers 401 Km^2 with 325 Km^2 suitable for agriculture. The two Sub-counties fall within agro-ecological zones UM1-UM4 and LM1-LM2 [15]. The total population of the two sub-counties was 353790 persons and 70,000 households with an average farm size of 2.0 ha per household. Rainfall received is bimodal with first (long) rainy season from March to July and second (short) rainy season from September to October. Rainfall varies between 1000-1700 mm per annum. The soils are well drained, deep to extremely deep dark reddish brown friable

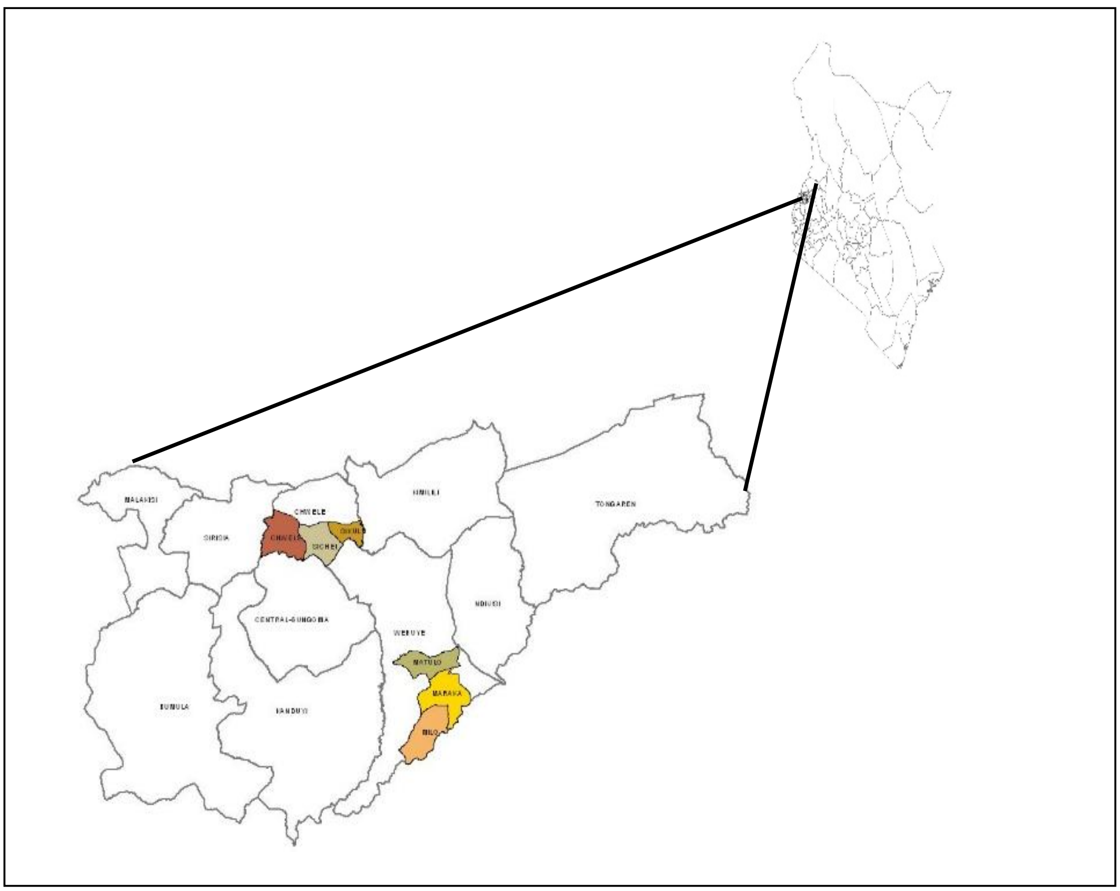

Fig. 2. Map showing the Bungoma County study sites

clay, friable sandy clay loams and brown sandy loams. The slope of the land ranges from gentle to fairly steep. The major economic activities in the sub-counties include livestock production (dairy, local zebu animals, sheep, goats and poultry) and crop farming. The major crop enterprises include maize, beans, sorghum, cassava, cow peas, millets and horticultural crops such as mangoes, pawpaw, onions, kales, tomatoes, cabbages, carrots, chilies and local vegetables. The major limiting factor to agricultural production is pests, diseases and lack of adequate inputs such as fertilizer and seed.

2.2 Data Sources

Both primary and secondary data were used in the study. Data that were collected and used in the analysis included data on household characteristics such as demographics, assets, land holding and utilization, knowledge on bean varieties, input and labour use and other socio-economic characteristics of the farm. Data were also collected on the adoption and use of IPM information and technologies. A structured questionnaire was used to capture data. Data was collected in the months of June, July and August 2012.

2.3 Sampling Procedure and Data Collection

Multi-stage random sampling procedures were used to obtain the sample of farmers for primary data collection as follows:

2.4 Machakos County

Two Sub-counties were selected from Machakos County where beans were grown. These Sub-counties were Mwala and Kathiani. From each Sub-counties three sub-locations were randomly selected. In Kathiani the three sub-locations were: Ngiini, Kaiani and Mitaboni. In Mwala Sub-counties three sub-locations; Mbiuni, Kyanganga and Makiliva were selected for the study. Simple random sampling was used to select farmers from the lists of households provided by the Assistant chiefs of the selected Sub-locations. Forty-two farmers were randomly selected from each sub-location. The total sample was 252 households from six sub-locations.

2.5 Bungoma County

Two Sub-counties were selected from Bungoma County. These were Bungoma East and Bungoma Central. From each Sub-county three sub-locations were randomly selected. In Bungoma East three sub-locations were selected and these were: Milo, Maraka and Matulo. In Bungoma Central the three sub-location; Sichei, Sikulu and Chwele Rural were selected for the study. Simple random sampling was used to select the household from the lists compiled by Assistant Chiefs in the selected Sub-locations. The total sample was 252 households from six sub-locations.

Individual interviews were conducted with household heads or designated member of the household such as wife, or son/daughter of the sampled household head. A total of 504 households were interviewed. Where the selected farmer was not willing to respond or could not be found, the farmer was replaced by the name directly below or above on the list, but these were very few.

2.6 Analytical Methods

2.6.1 The theoretical model

A number of studies have investigated various socio-economic, cultural and political factors that influence the farmers' decision to adopt new technologies [16]. In many of the adoption behavior studies, the dependent variable assumes the value of 1 or 0 and the models used were exponential functions while univariate and multi-variate logit and probit models have been used extensively to study the adoption behavior of farmers and consumers. In this study the Logit model was used to analyze factors that influence farmer's choice to adopt IPM technologies in Machakos and Bungoma Counties in Kenya.

The Logistic equation is given as [17],

$$\Pr(Y{=}1) = \frac{e^{\beta' X}}{1+e^{\beta' X}} \tag{1}$$

With the cumulative distribution function given by

$$F(\beta' X) = = \frac{1}{1+e^{\beta' X}} \tag{2}$$

Where; β' represents the vector of parameters associated with X

Assuming the probability that farmer n would choose to use IPM technologies was equal to the proportion of bean farmers using IPM technology, the individual empirical models estimated was given by;

CHOICE of IPM = ß1REGN + ß2FARMSIZE + ß3GHHD + ß4HHEADAGE + ß5NYEARS + ß6 HHSIZE + ß7 ACCEXT + ß8 HHFSECURE + ß9 MKTAVB

2.7 Definition of Variables in the Model

The variables in the empirical model were as follows:

2.7.1 Dependent variable

The dependent variable was a dummy variable which took a value of 1 if a household adopted IPM and zero otherwise; Y=1 if the household adopted IPM and 0 otherwise

2.7.2 Independent variables

The independent variables consisted of nine variables: household size, gender of household head, age of the household head, farm size, education level which was indicated by the number of years the household head had spent in school, access to extension services, status of household food security, available markets for bean products and the region.

The household size (HHSIZE) was computed by taking the total number of people living in the household and calculating the adult equivalent of the number of household members at the time of the survey. It was envisioned that household size may influence the adoption of IPM technologies. Households with a large number of people may be forced to use technologies that increase food production as there are more mouths to feed compared to smaller families. Large families may need more food and yet could have financial constraint that make them not able to purchase pest and disease control technologies which may be more appropriate for them. This variable was expected to have a positive impact on adoption and use of IPM by the household.

Another variable was gender of household head (GHHD). Generally male-headed households tend to have more resources and access to information on various types of technologies compared to female-headed households. This variable was presented as a dummy variable assuming the value of 1 if household was male-headed, zero otherwise. This variable's impact on adoption of IPM technologies is unknown. It can either be positive or negative

Another variable which was thought to have influence on the adoption of these technologies by households was the age of household head (HHAGE). This variable was taken as a proxy for experience of the farmer in the growing of beans and use of IPM. It was measured in number of years. Older household heads may have more experience in using the technologies available and also they may have resources such as land compared to their younger counterparts. On the other hand, older household heads may be more averse to taking risks so that they do not easily adopt new technologies. It follows that younger household heads may be able to adopt new technologies such as IPM in a bid to increase output of crops on their farms. Therefore, this variable is expected to have either a positive or a negative impact on adoption of IPM.

The fourth explanatory variable that may influence the adoption of IPM technologies by the smallholder households was related to the size of the farm (FARMSIZE). Households with large parcels of land may be able to try out new technologies as they do not face a land constraint encouraging them to adopt new bean and IPM technologies to increase production at the farm level. This variable was expected to have a positive impact on choice of new technologies by households in the study area.

Another variable that was considered to influence adoption of IPM by the household was level of education of the household head (NYEARS) which was a continuous variable indicating the number of years the household head had attended formal school. This variable may influence the choice of new technologies by households as more educated household heads may be in formal employment giving them access to finance which might give them opportunity to try out new technologies. Also educated household heads may have access to better information on new technologies such as IPM.

Access to Extension services was one of the factors that influenced adoption of IPM technologies by bean farmers. A study by Donkor et al. [18] indicated that farmers who access extension services which was a proxy for access to knowledge significantly increased adoption of chemical fertilizers, which in turn increased the yield of Rice in Ghana. This variable was expected to have a positive sign implying that this variable will have a positive impact on adoption.

Household food security status-households that were food secure might want to adopt new IPM technologies in order to sustain their status. This variable was expected to have a positive sign.

Market availability for beans. It has been shown that an assured market is a great enabler for farmers to adopt new technologies. This variable was also expected to have a positive sign.

The Region (REGN) where the household was located was also incorporated as a dummy variable. Bungoma County in western was selected to represent the high potential areas whereas Machakos in Eastern represented the low or ASAL areas.

Data was analysed using Statistical Package for Social Scientists (SPSS) version 20 Software.

3. RESULTS AND DISCUSSION

3.1 Household Characteristics for Western and Eastern Study Sites

Characteristics of the sampled households are presented in Table 1. On average land holdings are small but much smaller for female headed households in Bungoma County, Kenya. This finding is in agreement with a baseline study carried in East African countries [19] which indicated that in most of East and Central African countries, land was mainly owned by males. Approximately 17.5 and 22% of the households in Bungoma and Machakos were headed by females even though some respondents in the male headed households were females. The analysis using disaggregated data by gender of the household head showed that mean land under beans was about 0.52 Ha in Bungoma and 0.85 Ha in Machakos (Table 1). This result concurs with the results of the USAID/KALRO [20] impact study carried out in October 2017 in Machakos County. More land was planted with beans in Machakos County compared to Bungoma County. This could be attributed to the maize and bean diet prevalent in eastern Kenya.

Most households owned at least one mobile phone in the two study sites. Households in Machakos owned on average two mobile phones whereas households in western Kenya owned on average one mobile phone. This may mean that mobile phones could be an important garget in passing information to the farming households in these two study sites. Short message service (sms) could be an important dissemination pathway especially for farmers with a high level of literacy.

Most households in the two study sites did not own any rain water harvesting gargets such as water storage tanks which implies minimal rain water harvesting even in areas of high annual rainfall such as western Kenya. Rain water harvesting can contribute immensely to improvement in agricultural production as farmers will be able to irrigate and produce high value crops such as vegetables during the dry seasons.

3.2 Use of IPM Technologies by Farmers in Bungoma and Machakos Counties

Approximately 11% of sampled farmers did not apply any IPM techniques in the study sites in Bungoma county, western Kenya compared to 69% of the sample farmers in Machakos County in eastern who did not apply IPM techniques in their crop production activities to control diseases and pests (Table 2). These differences could perhaps be explained by the fact that Bungoma County is much wetter and therefore crops are more prone to disease and pest attacks compared to Machakos County which is in the Arid and Semi-Arid Lands (ASAL) area and much drier. Approximately 10% of the farmers in Bungoma County and 1% of farmers in Machakos County applied ash as method of controlling pests in storage, approximately 4.4% used drying in Bungoma whereas none of the farmers in Machakos used drying as means of pest control, 16% of respondents in western used early planting as a method of controlling pests and diseases, 5 % used planting of resistant varieties and approximately 4 % used foliar feed for controlling pests and diseases in western Kenya. The results of this study concur with those of [21,22]. The use of ash and drying among other cultural methods for controlling pests and diseases in storage of crop produce was part of the Indigenous Technical knowledge (ITK) systems which was used by farmers in many developing countries.

In Table 2 present that, farmers use both modern and Indigenous Technical Knowledge (ITK) to control disease and pests on their crops.

There were more farmers in Bungoma study sites who applied both modern and ITK methods to control pests and diseases on their crops and storage of produce compared to the Machakos study sites. Chemicals such as Diaznon and Actellic are popular with the farmers in the control of diseases and pests on the farmers' fields and in storage of harvested produce respectively in both counties. Among the ITK, ash was the most used to control diseases and pests on produce in storage. Some farmers applied products such as foliar feed to control pests and diseases on their crops though technically they were not meant for this purpose. This could imply that some farmers lack knowledge on products that are available in controlling pests and diseases on their crops.

Table 1. Summary of household characteristics in Bungoma and Machakos study sites

Household characteristics	Western Kenya (Bungoma East & Bungoma Central)			Eastern (Mwala and Kathiani-Machakos)		
	Female	Male	All	Female	Male	All
Land						
Mean land size (Ha)	1.76	2.37	2.24	3.2	3.2	3.44
Mean land size under beans (Ha)	0.43	0.54	0.520	0.798	0.815	0.853
Demographics						
Sample by HH gender (%)	22	78	-	17.5	82.5	-
Sample by respondent gender (%)	30	70	-	51.6	48.4	-
Mean household head age (Years)	50.0	46.6	47.4	54.1	47.7	53.6
Formal education (Years-mean)	6.9	9.5	9	7.1	10.2	10
Farming the primary Occupation of household head (%)	78	64	67.2	95	76	79.4
Farming as secondary occupation (%)	6	29	35	4	24	28
Household assets						
Number of mobile phones	1.04	1.52	1.42	1.04	1.51	1.67
Number of Hoes/Jembe	2.84	3.08	3.03	4.41	4.93	4.85
Mean number of cows	1.16	1.11	1.12	1.8	1.6	1.63
Mean number of bulls	0.36	0.43	0.98	0.79	0.87	0.86
Mean number of goats	0.4	0.35	1.11	4.35	3.86	3.94
Mean number of poultry	7.8	6.42	6.94	13.70	15.15	14.90
Mean number of donkeys	0.01	1.72	1.13	0.02	0.02	1.6

Source: Survey results, 2012

Table 2. Types of IPM technologies used by farmers in Bungoma and Machakos counties

Type of ipm used	Bungoma Kenya, N=252 %	Machakos Kenya, N=252 %
Does not use	10.71	69.44
Ash	10.32	0.79
Diaznon (Chemical pesticide)	16.27	1.59
Drying	4.37	0
Early planting	16.27	0
Planting resistant varieties	4.76	0
Actellic (Chemical pesticide)	5.56	3.97
Ash and other practices	9.52	0
Foliar feed	3.57	0.40
Crop rotation	2.38	3.97
Other modern pesticides (Chemical)	15.48	12.70
Intercropping	0.79	0
Goat waste	0	7.14
Total	100.00	100.00

Source: Survey data, 2012

Table 3. Factors that influence the choice of IPM technologies in Bungoma and Machakos counties Kenya-Logit analysis results

Variable	Coefficient	Std error	z	p>|z|
Region	1.32	0.220	6.00	0.000***
Farm size (Ha)	0.06	0.317		0.860
Gender of household head (male=1, 0 otherwise)	0.124	0.195	0.63	0.526
Household head age (number of years)	0.143	0.007	1.86	0.62
Education level (number of years spent in school)	0.055	0.031	1.79	0.073*
Household size (number of people in the household in man equivalents)	-0.044	0.032	-1.37	0.171
Access to extension services	0.828	0.232	3.56	0.000***
Household food security status	-0.387	0.223	-1.74	0.082*
Available market for bean product	0.494	0.209	2.37	0.018**
Constant	--3.31	0.724	-4.57	0.000***
Number of observation = 484				
LR ch12 (9) = 65.5				
Prob > chi^2 = 0.000				
Pseudo R^2 = 0.0977				

** 10 % significance level, ** 5% significance level and *** 1% significance level*

Source: Survey results, 2012

3.3 Factors that Influence Adoption of IPM Technologies in Bungoma and Machakos Counties

From the Logit model results, there were eight variables that influence the choice of IPM by smallholder farmers. Five of these factors were statistically significant; these were region, level of education, access to extension services, household food security status and availability of markets for the bean produced as shown in Table 3.

The results from the Logit Model indicated that all identified variables together contribute to determine the adoption of IPM technologies. Farm size, gender of the household head and age of the household head were not statistically significant. The region variable was statistically significant at 1% which implies that the region where the farmer is located will influence their choice to adopt or not to adopt IPM technologies. For instance, Bungoma County has high rainfall with conditions that favour higher incidences of pests and diseases compared to Machakos County. This results confirm the descriptive analysis in Table 2 which showed that there were high numbers of farmers who were not using IPM in Machakos County which is Arid and Semi-arid.

Education level of the household head had a positive influence on the adoption of IPM and was significant at 10% significance level. This result are similar with the results of a number of studies that have indicated that the level of education influences adoption of agricultural technologies [23]. Research carried out by Mlenga [23] working in Swaziland found that education level of the household head influenced adoption of conservation agriculture. The results showed that a household head with some form of education was three times more likely to adopt conservation agriculture compared to a household head without any education.

Access to extension services was a highly significant factor in influencing the adoption of IPM technologies in Bungoma and Machakos counties. A number of studies have shown that access to extension significantly influences adoption of agricultural technologies [24,18]. For example, the study by Donkor [18] found that access to extension significantly promoted adoption of chemical fertilizers by smallholder farmers in Ghana. The study further established that access to extension services and adoption of fertilizer exerted a positive influence on rice productivity. A study by Kirinya et al. [25] which was carried out in Uganda showed that the important factors that influenced farmers' decision to adopt IPM technologies in Uganda included socio-economic and institutional factors. The socioeconomic factors included household income, land and social Capital whereas institutional factors included access to extension services. These empirical results from the

Ugandan studies corroborate empirical results of the adoption of IPM in Machakos and Bungoma in Kenya. Farm size, access to extension services and availability of markets for beans significantly influenced the adoption of IPM technologies by farmers in Machakos and Bungoma counties of Kenya.

4. CONCLUSION AND IMPLICATIONS

This paper used household level survey data to examine factors that influence adoption of IPM technologies by smallholder farmers in Bungoma and Machakos counties of Kenya. The analysis aimed at revealing important factors that influenced the adoption of IPM technologies in bean productions in the two study sites. These results add to the body of knowledge which will help bean breeders, policy makers and other stakeholders in the Bean value chain to take into considerations important factors revealed in order to improve adoption and use of IPM technologies by smallholder farmers in Kenya which in turn will impact on productivity.

Our main results from descriptive statistics showed that smallholder farmers had adopted some of the IPM technologies in varying proportions. Both improved and indigenous IPM technologies were adopted and used by farmers in dealing with the problem of Pests and Diseases in bean production. The adoption of IPM technologies was influenced by physical (environmental and climatic) conditions of the region where the farmers were located.

The Logit Model produced results which were efficient in explaining the adoption of technologies by smallholder farmers. These results were further corroborated by similar studies in other parts of developing countries such as India, Uganda and Ghana. The study concluded that the region, the level of education, food security status of the household, access to extension services and markets availability for the beans produced were positive and significant influencers of farmers' choice to adopt IPM technologies. Controlling Pests and Diseases on the bean crop on smallholders' farms is important if productivity is to be increased whereas adoption of IPM technologies is critical in dealing with Pests and Diseases on the bean crops. Therefore, to achieve better yields the factors that influence adoption should be reinforced and information/knowledge on these issues availed to farmers in an effort to increase adoption of the IPM technologies. Access to extension services in the study sites need to be enhanced as contact with Extension workers increased the knowledge level of farmers on new /improved agricultural technologies, which in turn increases uptake of the technologies by farmers leading to increased productivity. Improving Extension services (institutional factor) required that the various stakeholders on the bean value chain be brought on board and enabling policies be formulated.

5. LIMITATIONS OF THE STUDY

The study used cross-sectional data which was collected in the year 2012 and also was specific to two regions of Kenya, therefore caution should be applied if the results of this study are to be used in other parts of the world which do not have similar agro-ecological and socio-economic conditions as the study sites in Kenya.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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