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Influence of Farmers' Socio-economic Characteristics on Adoption of Bambara Nut Production in Western Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Authors SWL and PV designed the study and wrote the protocol. Author PV supervised the work. Author SWL managed the analyses of the study. Author PV wrote the first draft of the manuscript. Author SWL edited the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

A survey was conducted to determine the effect of the socio-economic and institutional factors on farmers' adoption of Bambara nut as food security crop. Purposive survey research design was used to generate both qualitative and quantitative data. 384 respondents were interviewed in the study. Proportionate sampling technique was used to select 131, respondents from Kakamega North Sub- county, 127 from Butere and 94 from Matungu and 32 respondents from Mumias sub-counties based on population. Primary data was collected through structured questionnaire, interview schedules alongside focused group discussion. Findings indicated that that seven variables were statistically significant and contributed to adoption. These factors include: sub-county of farmer's residence, gender, farm size, on-farm income, labor, member of social group, marketing problems, access to extension services and respondents' access to credit. Four other

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factors (age, level of education marketing and credit) were not significant. Chi-square test showed that the estimated model fitted the data reasonably well and indeed the variables were jointly significant in explaining adoption of Bambara production and utilization in Kakamega County. In order for smallholder farmers to benefit from neglected food crops there is need for stakeholders to contribute towards formulating relevant policies and impliment research programmes that will promote and commercialize amongst others Bambara amongst smallholder farmers. This would lead to increased smallscale growing of Bambara nut and thus contribute to ensuring food security at household level among resource poor farmerss in Kakamega Count of Kenya.

Keywords: Adoption; bambara nut; food insecurity; smallholder farmers; underutilized crop.

1. INTRODUCTION

Bambara nut *Vigna subterranea* (L.) is regarded as minor crop in most regions and is characterized by a small commercial value of production and trade compared to the major crops despite its potential for contributing to improved incomes, food security and nutrition, and for combating micronutrient deficiencies [1]. Bambara has a number of agronomic advantages and when cooked it contains sufficient quantities of protein (9%), carbohydrate (63%) and fat (6.5%) [1-3]. Indeed. When adopted, the crop has the potential to act as an alternative sources of food. This can reduce the risk the of food insecurity by ensuring sustainable food production, alleviating food security and poverty and increasing small scale farmers' incomes particularly in areas with little rainfall [4] [3]. The leading global producers of Bambara nut are Nigeria, Niger, Ghana, Zimbabwe, Botswana, South Africa, Swaziland and Cote d'voire [5]. Its common name actually appears to be derived from the tribe of Bambara of Mali [5]. In Kenya, Bambara nut is considered an orphaned crop. It is a popular traditional food crop among the Luhya communities in Kakamega, Bungoma and Busia Counties, the Giriama and Kamba communities at the Coast and to some extent the Luo community in Nyanza Siaya, Homabay and Migori Counties [6].

Bambara nut production in Kenya, like other food crops has been declining for the last three decades [6]. More scientific research on adoption of improved agricultural production practices for these staple food crops and other nutritious and drought- tolerant crops like Bambara nut is needed. Therefore in the present study, analysis of factors influencing farmers' adoption of new innovation have been utilized to investigate their association of socio-economic and adoption of Bambara nut production as a food security crop in Kakamega county. This can help achieve sustainable agricultural development and reduce problems of food insecurity, malnutrition, hunger and poverty as aligned with the millennium development goal number one and goals one and two of sustainable development goals [7].

Adoption studies are important in since they tend to assess impacts of agricultural research, aid to priority setting for research and also provide information for policy reform [8,9]. Several adoption studies have been conducted in Kenya to explain determinants of adoption. Similar adoption efforts have been expanded in developing countries [10]. According to [11] adoption is defined as the degree to which a new technology is used on long run equilibrium when farmers have complete information about the technology and its potential. On the other hand, aggregate adoption is defined as the process of diffusion of a new technology within a given geographical region. [12], pointed out that factors affecting adoption differ across countries and are location specific thus calling for studies that are location specific. Most adoption studies in Kenya have considered fertilizer and hybrid seed in maize [9,10,12] and with little done on crops such as Bambara nut and horticulture, which, are key drivers of the Kenyan economy. Hence, understanding of adoption processes is important for extension workers, policy makers and researchers. These processes can then be replicated in the promotion of indigenous underutilized crop species like Bambara nut crop which has the potential of ensuring food security to vulnerable communities.

According to [11], adoption of innovations is a function of several factors. Adoption is construed as a sequential process of decision making that involves five stages namely; awareness, interest, evaluation, trial and adoption. Thus it is a full-scale acceptance and integration of the technology. During the adoption process, an innovation is evaluated using six criteria relating to innovation characteristics namely: relative cost, trial-ability, compatibility adaptability,

observable ability and complexity. These aspects are considered by the farmer in turn to examine the factors determining the probable adoption of new technological innovations [13]. Comparable to other crops, relatively little work on breeding and adaption of Bambara nut has been done. Farmers in some areas of Western Kenya, Kakamega County have continued to have problems of malnutrition and food insecurity even during rainy season, when this would have been sufficient for drought-tolerant crops like Bambara nut. This has sometimes led farmers' quest for humanitarian assistance in terms of food aids and other food coping strategies. Adoption studies on under-utilized crop species such as Bambara nut, that address the role of institutional factors on adoption is limited. Thus farmers' access to extension and institutional information related to physical market, credit availability, improved farming practices and crop varieties, climate change and potential adaptive strategies as a food security crop during times of hunger is lacking are desirable.

There is need for Kenya to promote the cultivation and utilization of orphan crops to solve problem of food security. Most orphan crops are resilient to environmental extremes and harsh weather conditions. Thus, they are the very basis of the farming systems and constitute an integral part of their livelihoods and food security. Similarly, orphan crops require low inputs that are affordable and sustainable to acquire by the rural poor farmers so as to create an important source of income and empowerment for women who are the main growers of the crop [14]. For purposes of this study, the focus was on the factors affecting adoption of Bambara nut. The specific objective of this study was to evaluate the impact of socio-economic and institutional factors on smallholder farmers' adoption of Bambara nut cultivation as a food security crop in Kakamega County of Kenya. Kakamega county which is located in Western Kenya lying on longitude 34°45' 0" East and latitude 0°17' 0"N of the equator. The county lies within altitude 1,250m-2,000m above sea level, with an average annual rainfall of 1250-1750 mm per annum. The average temperature in the County ranges from a minimum of 11°C to 30°C a maximum with an average of 21°C.

2. METHODOLOGY

The target population in this study comprised of small-scale smallholder farmers. Purposive survey research designs were used to generate both qualitative and quantitative data. Purposive sampling technique was used to select the four Bambara growing sub-counties with generally high crop cultivation. Primary data was collected through structured questionnaire and interview schedules. Then, proportionate sampling technique was used to select 131 respondents.

The data collected was subjected to an analysis using SPSS version 16. A regression model was used to express adoption (dependent variable) in terms of the independent variables which included sub-county, age, gender, farm size, level of education, group membership, on-farm income, labour, access to credit, market and extension services [15-17]. The regression was;

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 \ldots\ldots b_{11}X_{11+} \text{ Error} \quad (1)$$

Where;

Y = Adoption; a = constant; b_1, b_2, b_3, b_4…..b_{11}= Beta coefficients representing the relative impact on the predictor variable for each of the independent variables, X_1= sub-county; X_2 = gender; X_3 = education; X_4 = age; X_5 = land size; X_6 = income; X_7 = labour; X_8 = social group; X_9 = market; X_{10} = extension service and X_{11} = credit.

3. RESULTS AND DISCUSSION

The number of respondents in Kakamega North Sub-county was the highest 131 (34.0%). Butere sub-county had 127 (33.0%) respondents respectively. But Matungu and Mumias Sub-countiess had the least proportion of respondents at 25.0% and 8.0%. The majority of respondents (54.5 %) were females while male proportion was 45.5%. This may imply that Bambara nut farming activities are mainly conducted by females. The proportion of Bambara nut adopters to non-adopters was 74.5% and 25.5% respectively. The relatively high proportion of crop adopters amongst sugarcane farmers maybe a coping strategy to ensure food supply given the long maturation period of cane crops.

There were great variations in ages of the respondents across the four districts (Table 1). 64% of the respondents in all the districts were in the age set of 31-50 years. Chi-square test between farmers' age and adoption of the Bambara nut revealed that there was no significant variation ($\chi^2_{3,.05} = 5.982$). The findings imply that age may not be a determinant of

Bambara adoption. These findings were similar to [18,19] who indicated that the expected effects of age as an empirical question was not confirmed in previous adoption studies.

With regard to education, over 95.3% of the study population had a minimum of basic (primary) education while 4.7% did not possess any basic education. Thus most of the respondents were literate and were in a position to interpret Bambara nut extension related messages. Chi-square test to establish association between farmer's level of education and adoption of the Bambara nut as a food security crop indicated that there was no significant difference X^2=7.81. This implied that there was no significant association between level of education and adoption of Bambara nut production as a food security crop. The findings can be explained by the fact that generally the level of schooling of the respondents in the study area was advanced.

A great proportion of respondents 83.3% were low income earners (less than Kshs100, 000 pa) and that 74.5% of famers had adopted Bambara nut production as a food security crop (Table 1). Chi-square test revealed that there was a highly significant relationship X^2=15.474 between adoption of the Bambara nut production as a food security and gross annual income from on-farm activities in Kakamega County. Low income implies reduced capability to procure farm input. Previous studies indicate that household income from on-farm activities could be used as proxy to working capital as it determines the available capital investment in the adoption of practices [20].Indeed this is one-way household poverty level could be assessed [6]. Focused group discussions and available secondary data information [21] had established that low capital base of farmers in the study districts had not hampered farmers' ability to adopt Bambara nut production as a food security crop. This can be explained by the fact that Bambara is not a capital intensive crop. This justifies the fact that Bambara nut crop in Kenya is considered a minor crop and mostly grown by the rural poor farmers.

A great proportion of farmers held less than 2 acres of land (Table 1). Chi square test conducted between farm size and adoption of the Bambara nut production indicated no significant variation (X^2=5.387). Thus farm size does not define Bambara nut farming and as such have no negative effect on farmers' ability to adopt the crop. These findings disagree with those of [22] [23] who indicated that farm size affects crop adoption. Similarly, the results disagreed with those reported by [24,25], where large scale farmers are more inclined to adopt new practices than small scale farmers. The difference can be explained as unlike Bambara that is an underutilized crop species, the other crops studied were mainstream food crops.

With regard to accessibility to credit facilities, 24% of the respondents had received credit while over 70% had not. A Chi Square test showed that there was a highly significant variation (X^2=12.414). Thus, there was significant association between accessibility to credit and adoption of Bambara nut production practices. 47.0% of respondents in the study area had legal ownership of their parcels of land thus were in possession of title deeds which often is used as collateral in obtaining credit from loaning institutions but, even then, they were not taking the initiative to apply for credit. Thus availability of credit increases farmers' access to alternative resources to finance adoption of new technological innovations [26]. Access to credit boosts farmers' readiness to adopt technological innovations. Of the farmers who had accessed credit facilities, none went towards improvement of Bambara nut production. This explains the negative significant relationship between Bambara nut adoption and availability of credit facilities.

80.0% of respondents had membership to different social groups while about 20% were not (Table 2). Association between farmers' membership in social groups and adoption of the Bambara nut production was highly significant variation (X^2=18.546) as most respondents were members of social groups for various benefits including economic gains (60%), social gains (13.0%) and information gathering (7.8%). Focused group discussions established that a farmer's membership in social groups' leads to better access to technical agricultural information. It is worth noting that, a farmer's membership in social groups significantly influenced farmers' ability to adopt Bambara nut. Agriculture extension officers in the study areas reported that farmer groups were more accessible compared to individual farmers. These findings concur with those of [27-29] who established that women belonging to social organizations adopted more soil management practices.

Table 1. Adoption and non-adoption of bambara nut cultivation in relation to farmers' social economic characteristics in Kakamega County, Kenya

Characteristic		Adopters bambara nut		Non-adopters bambara nut		Total	
		No.	**%**	**No.**	**%**	**No.**	**%**
Level of education	Secondary	123	32	49	12.8	172	44.8
	Primary	99	25.8	27	7.0	126	32.8
	Tertiary	47	12.2	10	2.6	57	14.8
	University	6	1.6	5	1.3	11	2.9
	None	11	2.9	7	1.8	18	4.7
Age (years)	20-30	41	10.7	22	5.7	63	16.4
	31-40	100	26.0	39	10.2	139	36.2
	41-50	87	22.7	22	5.7	109	28.4
	>51.0	58	15.1	15	3.9	73	19.0
Farm income pa (Ksh.)	< 50,000	137	35.7	66	17.2	203	52.9
	50,001 - 100,000	92	24.0	25	6.5	117	30.5
	100,001 - 150,000	44	11.5	3	0.80	47	12.1
	>150,001	13	3.4	4	1.0	17	4.5
Farm size (Acres)	< 2.0	154	40.1	55	14.3	209	54.5
	2.1-5.0	110	28.6	30	7.8	140	36.5
	5.1-10	17	4.4	12	3.1	29	7.5
	>10.1	5	1.3	1	.30	6	1.5
Availability of credit facilities	Yes	71	18.5	21	5.4	92	24
	No	215	56.0	77	20.1	292	76
Difficulty in marketing	Yes	136	35.4	49	12.25	185	48.2
	No	150	39.1	49	12.25	199	51.8
Extension	Yes	136	35.4	33	8.6	169	44
	No	150	39.1	65	16.9	215	56
	Totals	**286**	**74.5**	**98**	**25.5**	**384**	**100**

Table 2. Adoption of bambara nut production in relation to social groups, Kakamega County, Kenya

District	Membership in social groups					
	Yes		No		Total	
	No.	%	No.	%	No.	%
Kakamega North	104	27.08	27	7.03	131	34.11
Mumias	29	7.55	3	0.78	32	8.33
Butere	113	29.43	14	3.65	127	33.07
Matungu	62	16.15	32	8.33	94	24.48
Total	**308**	**80.21**	**76**	**19.79**	**384**	**100**

**percentages expressed as proportions of the total number of respondents*

Regression analysis indicated that four factors; level of education, land size, marketing and extension service delivery were not statistically significant in determining farmers' adoption of Bambara nut in Kakamega County. These factors did not seem to significantly sustain small holder farmers' decision to adopt Bambara groundnut growing and utilization as a food security crop at household level crop and hence need not be considered when designing agricultural intervention programs for increased adoption of growing Bambara groundnut as a food security crop at household level. For instance as seen from Table 1, level of education and land size had their beta coefficients of 0.072 and 0.055 respectively, while extension delivery and marketing had their beta coefficients as 0.008 and 0.027 respectively. These results can be explained by the fact that there were no great variations in respondents' level of education and land sizes within and between the surveyed sub-counties of farmers growing sugar cane under study. The volume of Bambara nut grown at farm level is too little to warrant proper marketing and there had been no provision of any Bambara nut related extension service by any institution either. However, studies by various researchers have found a positive relationship between farm size and technological adoption [30]. Thus operators of large farms are likely to spend more on land-improving practices. In many cases, large farm size is associated with increased availability of capital, which makes investment in innovations more feasible. According to [31], technology complexity can have a negative effect on adoption and this could only be dealt with through education, indeed, the case of Bambara nut.

Findings indicated that seven other factors (respondents' age, sub-county residence, gender, on-farm income, labor availability, accessibility to credit and membership to social groups) were statistically significant and affected crop adoption. The coefficient of respondent's sub-county was -0.138 while the t-value was -2.711, and was therefore highly negatively significant ($p<0.01$). This implies that any change in county study district resulted in 13.8% decreases in level of adoption of Bambara nut production as a food security crop. Non-Bambara producing areas in Kakamega County are either main producers of maize and tea [32,33]. This indicates that priorities on adoption of Bambara nut production vary from district to district with negative direction among districts. The coefficient of gender was 0.134 while the t-value was 2.578. Thus, all other factors held constant gender affects and contributes up to 13.4% adoption of Bambara nut production as a food security crop. These findings, where gender and adoption were significant, agreed with those found by [34-36,20]. From the foregoing, gender aspects need to be considered when designing agricultural intervention practices for increased adoption of production and utilization of Bambara nut production. Study [20] reported non-significant difference effect of gender on factors influencing improved maize technology adoption in Ghana. The positive significant relationship between respondents' gender and adoption of Bambara nut production as a food security crop could be attributed to the association with female farmers. The coefficient of age was – 0.115 while the t-value was –2.191, thus, a significant inverse relationship between respondents' age and adoption of Bambara nut was found. The results showed that a unit increase in age resulted in 11.5% reduction in production and utilization of Bambara nut as a food security crop. Thus as farmers become older, they are less likely able to adopt as they become less energetic and risk aversive. These findings agree with studies on adoption of land conservation practices in Niger by [37] and Hybrid Cocoa in Ghana by [38], where adoption was negatively related to age. However the findings disagree with those recorded by [18] where age was found to

positively influence adoption of sorghum in Burkina Faso. The relationship between respondents' level of income and adoption of Bambara nut production was negatively significant. The coefficient and t-value of annual farm income were -0.133 and -2.409, respectively. The inverse relationship implies that a unit increase in annual farm income resulted to 13.0% decrease in decision to adopt Bambara nut.This can be explained by the fact that any increase in household levels of income lessens level of poverty and probably leads to less consumption of Bambara nut which is considered a poor man's crop. Thus as household income increases household eating habits also change away from underutilized crops. These results disagree with the findings of [26] who found income to positively influence adoption of mulching technology in Yam in Osun State, Nigeria. The coefficient of labor was 0.213 while the t-value was 4.346. The positive significant relationship implies that unit increase in labor availability increases probability of adoption of Bambara a margin of 21%. Labor availability is one of the single most important factors that affect farmers' decisions regarding adoption of any improved farm practices. Non-availability of labor at peak periods can result to use of women and children as the main source of family labor [39,27,30]. The coefficient and t-value of farmers' membership to social organization were 0.096 and 1.830. This implies that a unit increase in farmers' membership to social organizations increases adoption probability of Bambara nut production by almost 9.6%. These results are similar to those recorded by [19] who found out that the membership in social groups provided the much social needs of the farmers can improve diffusion and facilitated collective approach solutions to problems. Thus, membership in social groups such as co-operative societies had been found to enhance the interaction and cross-fertilization of ideas among farmers. Farmers who are non-members of associations are expected to have lower probabilities of adoption and lower level of use of crop adoption practices. Similarly, results were observed by [40]. The coefficient of credit access was 0.106 while the t-value was 0.990. Credit had a positive significant relationship implying that availability increases the probability of crop adoption by 10.6%. [41] reported that availability of credit had a positively influence on adoption of poultry technology by relaxing the binding capital constraints that farmers face during initial investments or helped to finance the variable costs associated with production of improved poultry breeds. Study [26] reported that credit positively influenced adoption and the uptake of new mulching practices of Yam production in Nigeria.

If smallholder farmers are to benefit from the immense potential Bambara nut crop has, there is need for realistic solutions to be implemented to address aforementioned constraints. The approaches and strategies need be through participatory decision-making processes involving farmers and the Ministry of Agriculture Livestock and Fisheries in the country so as to initiate relevant programs and deliberate policies that can address promotion of Bambara nut crop. Promotion and increased utilization of Bambara nut amongst small holder farmers in Western Kenya can achieved through building on factors that positively increase adoption of the crop and reducing or removing factors that negatively influence adoption.

Table 3. Determinants of smallholder sugarcane farmers' adoption of bambara groundnut growing as a food security crop at household levelin Kakamega County, Kenya

Variable	Coefficients (beta)	S.E	t-value	p-value
Intercept	.766		4.336	.000
Sub-county	-0.138	0.018	-2.711**	.007
Gender of farmer	0.134	0.045	2.578*	.010
Education level	0.072	0.022	1.463	.144
Farmer's age	-0.115	0.022	-2.191*	.029
Land size	0.055	0.032	1.026	.306
On-farm income	-0.133	0.018	-2.409*	.016
Labour availability	0.213	0.054	4.346**	.000
Social group	0.096	0.016	1.830**	.0068
Marketing problems	-0.008	0.045	-.151	.880
Extension service	0.027	0.046	0.487	.626
Credit facilities	0.106	0.056	1.990*	.047

Chi-square= 50.80

4. CONCLUSION

Sub-county of residence, farm income and age were factors that negatively influenced smallholder sugar cane farmers' adoption of Bambara nut growing as a crop that could reduce the disaster risk of food insecurity and nutrition at household level in the study. However, labour availability, membership to social group, gender, and respondents' access to credit were seemed to positively influence adoption of Bambara nut growing as a crop that could reduce the disaster risk of food insecurity at household level. Four factors namely: Land size, level of education, marketing and provision of extension service did not seem to have any significant influence smallholder sugar cane farmers' adoption of Bambara nut growing as a crop that can reduce disaster risk of food insecurity at household level in Kakamega County. There is need for Ministry of Agriculture Livestock and Fisheries in Kakamega County and indeed central government to develop programs and deliberate policies that can will maintain and improve the agricultural extension services to address the food and nutritional security needs of the rural poor who have nurtured and continue to grow Bambara nut as food security crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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