The Socio-Economic Determinants of the Adoption of Improved Sorghum Varieties and Technologies by Smallholder Farmers: Evidence from South Western Kenya

Isaiah K. Okuthe
Ministry of Energy and Petroleum, Kenya

Fred U. Ngesa
Department of Agricultural Education and Extension
Egerton University, Kenya.

Washington W. Ochola
Department of Agricultural Education and Extension
Egerton University, Kenya.

Abstract

In many parts of Kenya, sorghum remains an important crop for rural food security. Since many sorghum producing areas still experience periodic food deficits, production must be increased in order to ensure food security. The growing of improved sorghum varieties in Kenya has been promoted by agricultural extension service as one of the ways to achieve this. However, the adoption of technologies associated with these varieties by small scale farmers is still low resulting, probably, in the low production of the crop. Using data collected in Western Kenya in 2013, this study found that resource constraints limit many farmers adoption of improved sorghum varieties and technologies. The farmer's age, gender, level of education, monthly income, access to market, access to credit and inputs all had a significant positive effect on the likely hood of adoption. These findings raise important questions as to whether improved sorghum varieties and related technologies are really affordable to poorer holder farmers.

Keywords: Adoption; Improved sorghum varieties and technologies: Smallholder farmers

Introduction

Poor performance in the agriculture sector that has led to decline in agricultural production and overall low economic growth (Food and Agriculture Organization, 1986; Ministry of Agriculture and Rural Development, 2001b; Rosegrant, Paisner, Meijer & Witcovear, 2001) is especially critical in the southwestern Kenya region along Lake Victoria (Government of Kenya, 1993). This has called for the intensification of agriculture through development of improved varieties and production technologies. In many parts of Kenya, sorghum, (*Sorghum bicolor (L) Moench)*, which is an important food and feed crop in the semiarid tropics (Nwanze *& Yuornl*, 1994), remains an important crop for rural food security. Since many sorghum producing areas, including HomaBay, still experience periodic food deficits, the production of the crop must be increased in order to ensure food and income security through the development of improved sorghum varieties and technologies. Increased adoption of these varieties and their associated technologies could be enhanced through the development of institutional strategies.

Sorghum is the fifth leading cereal in terms of world production and one of the coarse grain cereals grown as a rain fed crop in the semi arid areas (Push Pamma, 1993; Dendy, 1995). It is grown in approximately 50 million hectares with a production of 70 million tons (Food and Agriculture Organization, 1994; National Research Council, 1996). More than 300 million people in more than 30 countries depend on sorghum as the main source of energy and protein (NRC, 1996). Almost 30% of the harvested sorghum area is in sub Saharan Africa (Food and Agriculture Organization, 1993). In eastern Africa, more than 70% of sorghum is cultivated in the dry and hot low lands (Mukuru, 1993). In Kenya, sorghum is an important cereal in the medium and low altitude areas (Enserink, 1995). O'Neill and Kamau (1990) estimated that 52% of sorghum in Kenya is grown in Nyanza and 23% in Western province of the country.

Per capita sorghum consumption in Kenya is approximately 3.0 kg per year (Food and Agriculture Organization, 2002). It is an important food crop around Lake Victoria region, an area where maize does relatively poor or fails due to erratic rainfall, pests and diseases (Wanyama, Njue & Kidula, 1995). This is because sorghum has long been recognized as a drought resistant / tolerant crop (Omanya, Nyabundi & Ayiecho, *1996*). House (1995) indicated that sorghum will continue to be an important food crop especially in areas where it is better adapted than other cereals, particularly in draught prone areas and under high temperatures and water logging.

Sorghum grain is utilized in preparing foods like "ugali", porridge and for making alcoholic beverages. Sorghum stalks are used as dry season fodders and as fencing materials (House, 1995). Industrial uses of sorghum include use as animal feed, making of industrial starch and for fuel alcohol production (House, 1995). There are good prospects for the expansion of the industrial market for sorghum if its yields can rise fast enough to catch up with yields of competing cereals (Food and Agriculture Organization & International Crops Research Institute for the Semi-Arid Tropics, 1996). Sorghum is mainly grown by small-scale farmers in semi arid areas for subsistence farming (Muriithi, 1990). The majority of these farmers, however, do not produce enough sorghum to meet family requirements in most years. This has been attributed to a number of constrains which include variable rainfall, bird damage, striga weed, disease problems and insect pest damages (FAO & ICRISAT, 1996).

Ndhiwa is among the six divisions in Homabay district and lies in lower midland (Lm3) agro-ecological zone. It is situated at an altitude of 1200-1400m above sea level. The mean rainfall is about 1300mm received in a bimodal pattern. Long rains starts from February to June with peak occurring in March – April, while short rains starts from August to November with its peak in October. The division has three types of soils; black cotton soil (vertisols), silt loam, and clay loam (luvisols) with drainage being poor in some of the soils (Jaetzold & Schmidt, 1982). The vegetation is mainly savanna type with thick bushes and open grass. Trends over the past 50 years indicate a continuous decrease in vegetation cover due to increased agricultural activity.

Research Methodology

Research Design

The study employed an *ex-post-facto* survey design. This type of design involves data collection after a naturalistically occurring event (Fraenkel & Wallen, 2000; Casely & Kumar, 1992). It involves collection of information from a sample that has been drawn from a population that has received a natural treatment not designed by the researcher (Fraenkel & Wallen, 2000). In this study the introduction of sorghum varieties and technology were not introduced by the research as treatment but by KARI. The study will attempt to describe the institutional factors in relation to adoption of these varieties and technologies in retrospect (*after-the-fact*). This design is appropriate for the study since it facilitates the collection of information from a sample of a population in order to describe their characteristics as they relate to the "fact". In this study, the characteristic of sampled sorghum farmers has been described and their influence on the adoption of improved sorghum varieties and recommended technologies analysed. Though non- response has been found to be a problem in surveys, according to (Fraenkel & Wallen, 2000), appropriate techniques were used to help reduce its problem including calling back on absentee respondents and random replacement where necessary as well as using large samples. Surveys are cost-effective and exploratory enabling the researcher to make inferences (O'Connor, 2002).

Study Location

The study was carried out in Ndhiwa Division of Homabay District. It is one of the six divisions in Homabay District, located in the southwestern part of Kenya along Lake Victoria. It is located between longitude 34^0 12' and 34^0 40' east and latitudes 0^0 28' and 0^0 40' south (G.O.K, 2001). The Division is further sub divided into 4 locations and 11-sub -locations. It has a population of 43,231 and a density of 182 persons per square kilometer (G.O.K, 2001). According to Jaetzold and Schmidt (1982), the division lies in lower midland (lm3) agro-ecological zone. It is situated at an altitude of 1200-1400m above seal level. The mean rainfall is about 1300mm received in a bimodal pattern. The Division has three types of soils; black cotton soil (vertisol), silt loam, clay loam (luvisoils) with drainage being poor in some of the soils.

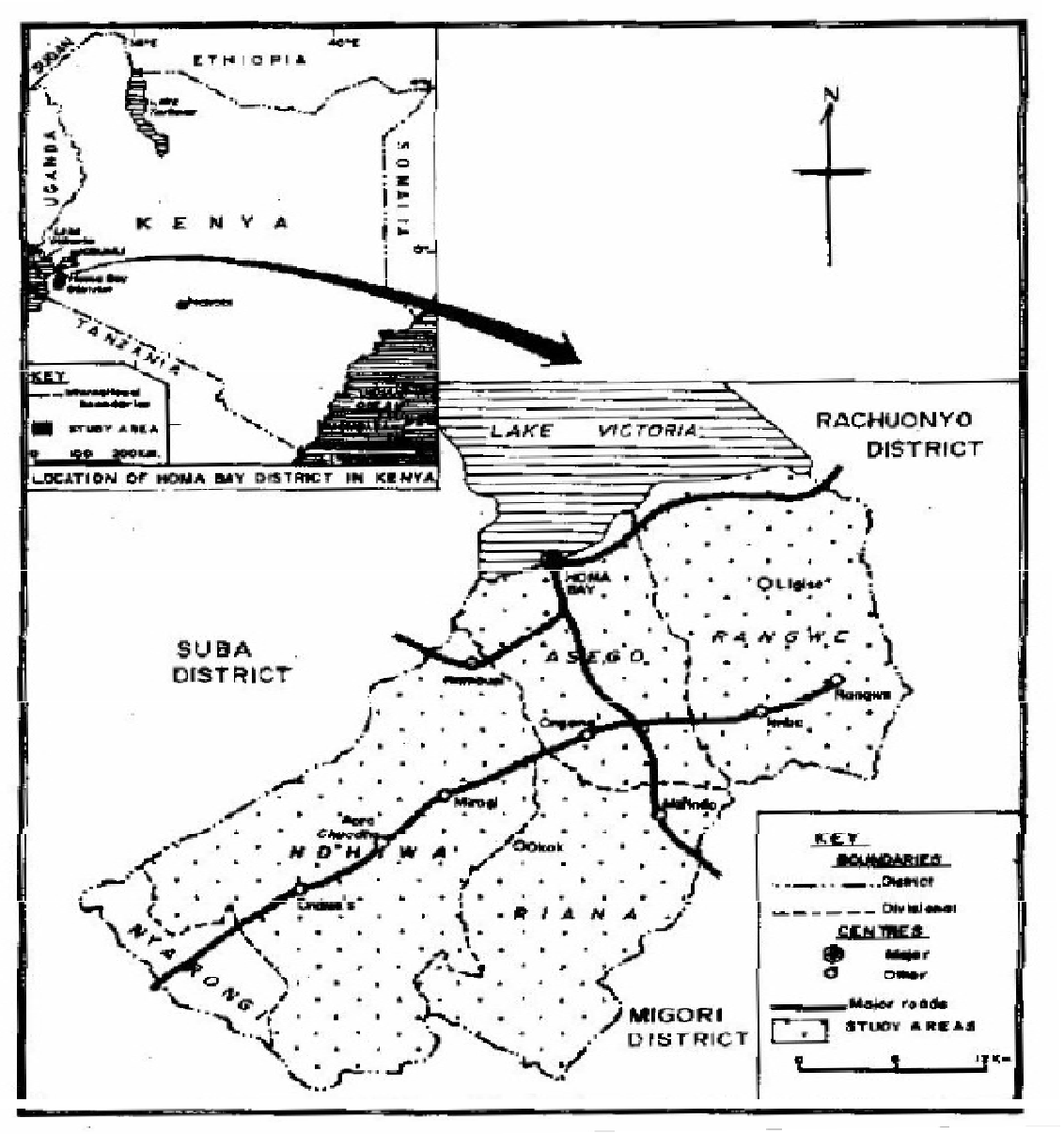

Figure 3: Location map of the study area

Sorghum is a significant food security crop in the study area and efforts by KARI to introduce sorghum in the district were concentrated in the division, which is a representative of the population (G.O.K, 2002). Figure 1shows the location map of the study area.

Study Population

The target population was all small-scale sorghum farmers in Ndhiwa division. Ndhiwa division has a population of 7,202 small-scale sorghum farmers distributed in the 4 locations and 11 sub locations (G.O.K, 2004).

Sample size and Sampling Procedure

A sample of 105 farmers was used in the study. According to Kathuri and Pals (1993), a minimum of 100 is recommended for a survey research. This gives a reasonable unit for analysis. This gave a reasonable number for analysis from each location for the study. The sample was obtained using stratified proportionate random sampling to select respondents. This gave a reasonable number from each location of the study. The location of the small-scale farmers was used as the criterion for proportionate random sampling. All the small-scale farmers in the four locations were used to enable random selection of farmers to be included in the study.

A computer random number generator was used to select the number of households in each stratum.

Locations	Farmers	Population	Sample
North Kanyamwa	1800	0.25	25
South Kanyamwa	2010	0.28	25
Central Kanyamwa	1390	0.19	20
West Kanyamwa	2002	0.28	35
Total	7202	1.00	105

Instrumentation

A questionnaire was used in the collection of information from the farmers to be involved in the study. The tool was used to collect data required to achieve the study objectives. A questionnaire was chosen because of the ease of administration and scoring of the instrument besides the results being readily analyzed (Ary, Jacobs & Razarieh, 1979; FAO, 1990c). The items on the questionnaire were developed on the basis of the objectives of the study. Appendix A consists of part (A) which elicits data on selected socio-economic and personal characteristics of the respondents; Part (B) are information on adoption levels of improved sorghum varieties and technologies. The instrument was administered to the farmers by the researcher himself in order to facilitate elaboration of any aspects that may not be easily understood by the respondents.

Validity

The questionnaire was tested in order to check its content, construct and face validity. Content validity was to ensure that the content that the instrument contains is an adequate sample of the domain of content it is supposed to represent. Face validity delt with format of the instrument and includes aspects like clarity of printing, font size and type, adequacy of workspace, and appropriateness of language among others. Construct validity determined the nature of psychological construct or characteristics being measured by the instrument. Experts, supervisors and peers from the Department of agricultural education and extension, Egerton University helped in the review to ensure the instrument accurately measured the variables it intended to measure in the study.

Reliability

The instrument was pre-tested with a sample of 20 households similar to the study area and. This was done in the neighboring division, Rangwe that has similar characteristics to the study area. The number 20 was chosen for pre-test because according to Kathuri and Pals (1993) it is the smallest number that can yield meaningful results on data analysis in a survey research. The results of the pilot-test indicated a reliability coefficient of 0.7 for the whole instrument using the cronbach's alpha coefficient. More items were added into the questionnaire to improve its reliability.

Data Collection Procedures

An appointment for administration of questionnaires to the respondents was prepared with the assistance of divisional extension coordinator, frontline extension workers and the village headmen. The instrument was then administered to sorghum farmers to collect the required data in face-to-face interview and their responses recorded accordingly. The study focused mainly on household heads for interview schedule to cater for uniformity of data collection process. Male and female small-scale farmer were interviewed because gender was not taken as an independent variable in the study. In case the farmer was absent, then the most responsible member was interviewed. This was a member who at one time w had been entrusted with the responsibility of overseeing the sorghum production activities for a period spanning one year or more.

Data Analysis

After data collection, the questionnaires were cleaned for errors made during data collection. Summarized and coded data were into the computer after which analysis of quantitative data was done using the Statistical Package for Social Sciences (SPSS). For objectives 1 and 2 descriptive statistics, namely percentages, means, and standard deviations were be used.

For hypothesis 1 and 2, chi-square was used to determine the relationship between the independent variables and the dependent variable. The hypotheses were tested at 0.05 significance level.

Result and Discussion

Adoption of improved sorghum varieties

Farmers were asked to respond to a set of questions on the adoption of improved sorghum varieties. The results obtained indicated that out of 105 farmers 61 farmers (58.1%) used local composites, while 44 farmers (41.9%) used the hybrid. Table 2 presents the frequencies and percentages of sorghum seed planted.

Table 2: Sorghum variety grown

Seed planted	Frequency	Percentage
Local composite	61	58.1
Hybrid	44	41.9
Total	105	100.0

This shows that only forty four farmers (58.1) percent adopted the use of improved sorghum varieties. By implication this is low.

Adoption of sorghum production technologies

Farmers were asked to respond to a set of 8 questions on the techniques of sorghum production. The questions were based on the planting materials used, farm management practices such as weed control, pest and disease control, fertilizer application and harvesting procedures, the approximate yield in 90kg bags and post harvest technologies used to preserve yields. Table 3 presents the frequencies and percentages of how farmers used the sorghum production technologies.

Table 3: Use of sorghum production technologies

Sorghum production technologies	F	%
Use of fertilizer	28	26.7
DAP	1	1.0
FYM	48	45.7
Mix	10	9.5
Use of top dressing fertilizers	4	2.0
Control of pest and diseases	16	15.2
Chemical technologies	1	1.0
Indigenous/cultural method	104	99.0
Post harvest technologies	26	24.8

The results obtained (Table 4) indicated that out of 105 farmers 28 farmers (26.7%) had used fertilizer during planting: DAP (1.0%), Farm Yard Manure (45.7%), mixture of different types of artificial fertilizers(9.5%). Four farmers (2.0%) indicated that they top dressed their crops. Sixteen farmers (15.2%) indicated that they controlled pest and diseases. The other group of farmers (99%) argued that they used indigenous technologies or cultural method while one farmer (1.0%) indicated that he bought insecticide. Twenty six farmers (74.8) indicated that they sold most of their produce immediately without storing for a long period. This means that they did not use any of the long storage methods apart from the use of sacks. The adoption level of sorghum production technologies is relatively low despite the favorable farmer characteristics.. This means therefore that the adoption level was influenced by other factors other than the farmer characteristics.

General characteristics of Farmers

The farmers were asked to respond to a set of questions on their characteristics that have influence on adoption of improved sorghum varieties and production technologies. The characteristics include age distribution of the farmers, the estimated size of farmland used for agriculture, gender distribution among farmers, level of education of the farmers, and approximate level of gross monthly income for the framers. The general characteristics are discussed in relation to how they influence level of adoption of improved sorghum varieties and technologies.

Age distribution of the farmers

The farmers were asked to indicate the category of their age. Forty-five out of one hundred and five farmers (42.9%) interviewed indicated that they were between the ages of 31-40 years. Table 4 presents the frequencies and percentages of age group of the farmers interviewed.

Table 4: Age of the farmers

Age group	Frequency	Percentage
Below 20 years	1	1.0
21-30	22	21.0
31-40	45	42.9
41-50	29	27.6
Above 50 years	8	7.6
Total	105	100.0

As shown above, forty-five out of one hundred and five farmers (42.9%) interviewed indicated that they were between the ages of 31-40 years. This is a prime age when the farmers are very active and ready to risk by adopting technologies delivered to them. Farmers who are within group 18-43 years tend to be more active in practical, " hands- on" activities as compared to older farmers. Burkey (1996) indicates that groups with majority of members with similar age group are expected to be more effective. This is because individuals of same or similar age groups tend to have similar interests. This study therefore found out that farmers who are young were better adopters than old farmers. Rogers (1983) argued that younger and educated farmers are more inclined to adopt new practices. This was supported by Wasula (2000), who found that the age of a household head significantly influenced the adoption of contour vegetative strips. However studies by Ndiema (2000), found no relationship between ages and the technology adoption.

Gender distribution o f the farmers

More than half of the farmers interviewed (56.2%) were female compared to 43.8% being male. Table 5 presents the gender distribution of the farmers interviewed.

Table 5: Gender distribution of farmers

Gender	Frequency	Percentage
Male	46	43.8
Female	59	56.2
Total	105	100.0

This is an indication that women handle most of the farm activities. Women also form most of the groups or farmers organizations. This shows that gender was related to sorghum adoption, which concurs with Oywaya (1995) who found significant differences in adoption between the male-headed households and female-headed households in Machakos, Kenya.

Levels of education of the farmers

On the level of education, the farmers were asked to indicate the highest level of education they attained. Table 6 presents the frequencies and percentages of the levels of education of the farmers.

Table 6: Level of education of the farmers

Level of education	F	%
None	7	6.7
Lower primary	26	24.8
Higher primary	48	45.7
Secondary school	21	20.0
Tertiary	9	2.9
Total	105	100.0

Forty-eight out of the one hundred and five farmers interviewed (45.7%) had at least upper primary level of education and 26 farmers (24.8%) had lower primary school level of education. Those with secondary school level of education and above were 22.9%. This is in agreement with Amudavi (1993), Chitere and Dourve (1985), and Ndiema (2000) who in their respective studies found that education is a significant factor in facilitating awareness and adoption of agricultural technologies. This is so because education enables one to access information needed to make a decision to use an innovation and practice a new technology. Education increases managerial competence and therefore enhances ability to diagnose, assess, comprehend, and respond to financial and production problems. High level of education enhances the understanding of instructions given and should also improve the farmers level participation in agricultural activities.

Approximate level of gross monthly income of the farmers

More than half of the farmers (91.4%) indicated that they get Kshs 3000-6000 as gross income. Nine out of the one hundred and five (8.6%) indicated that there gross monthly income were between Kshs 6,000 and Kshs 10,000. Table 7 presents the levels of gross monthly income of farmers.

Table 7: Approximate level of gross monthly incomes of farmers

Monthly income	Frequency	Percentage
< 3000	46	43.6
3001-6000	50	47.6
6001-10000	7	6.7
> 10001	2	1.9
Total	105	100.0

Household income can be used as a proxy to working capital because it determines the available capital for the investment in the adoption of technologies and it is a means through which the effect of poverty can be assessed. According to the World Bank (2000), poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income. Household income has a bearing on the socio-economic status of farmers. Farmers from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of technology (World Bank, 1983). This is in consistent with the findings of Anyango (2000), who found that farm income had a significant relationship with the adoption of soil conservation measures.

The Influence of Socio Economic Factors on the Adoption of Improved Sorghum Varieties and Technologies

The hypothesis was stated in the null form that there was no significant relationship between the institutional factors and the adoption of improved sorghum varieties and technologies. The hypothesis testing was done based on each of the institutional factors. The institutional factors included; interaction with extension, access to credit and inputs, membership of group organization and access to market. All data was collected and recorded in a discrete form. The results of the data analysis using chi-square are presented below.

The relationship between the tenure and land on improved sorghum varieties

Data analysis using cross tabulation using chi-square test revealed that there was no significant relationship between the land tenure and adoption of improved sorghum varieties (chi-square value =7.172, df 0=8,p> 0.05). Therefore the null hypothesis was not rejected indicating that there was no evidence from the available data to show that there was a significant relationship between land tenure and adoption. The chi-Square results are presented in table 8.

Table 8: Chi-square results on relationship between land tenure and land on improved sorghum varieties.

FAMILY LAND OWNERSHIP	*LAND*	*ON*	*IMPROVD*		*SORGHUM VARIETIES*
	3-4	2-3	1-2	<2	None	Total
Communal	0	0	0	4	10	18
Private	1	7	23	16	37	84
Rented	0	0	1	2	0	3
Total	1	7	28	22	47	105

P>0.05 chi – square value =7.172, of =0.518

These findings agree with those found by Mwale (1998) where land ownership did not seem to have a significant effect on the adoption of agro forestry system in Central America and Caribbean. According to current (1995) what seemed important was how farmers feel safe about their property with or without the land ownership. This could also be due to the low importance given to sorghum as a crop in Ndhiwa division.

Relationship between land and ownership and sorghum varieties grown

Data analysis by cross-tabulation using chi-square test, revealed that there was no significant relationship between land ownership and land on improved sorghum varieties (chi-square value = 9.917, df = 6, p>0.005). Therefore the null hypothesis was not rejected indicating that there was no evidence from the available data to show that there was significant relationship between land tenure and adoption. The chi- square results are presented in table 9.

Table 9: Chi-square results on relationship between land ownership and sorghum varieties grown

Land ownership	**More than one**	**KARI 1**	**MTAMA**	**SERENA**	**SEREDO**	**TOTAL**
communal		0		1	16	18
	1					
private	2	1		15	66	84
rented	14	0		0	2	3
total		1		16	84	105

P>0.05 chi-square value =9.917, df= 6 p=0.128

These findings agree with those found by Mwale (1998) where land ownership did not seem to have a significant effect on adoption of agro forestry systems in Central America and Caribbean. According to current (1995) what seemed important was how farmers feel safe about their property with or without the land ownership.

Relationship between source of input and sorghum variety grown.

Analysis by cross tabulation using chi-square test, revealed a significant relationship between source of agricultural inputs and land improved sorghum variety (chi-square value=40.037 df=16, p< 0.005).the null hypothesis was therefore, rejected and alternate accepted which showed that there was a significant relationship between membership in agricultural organization and adoption of improved sorghum varieties. Table 8 presents the result of cross tabulation by chi-square on the relationship between sources of inputs and land on improved sorghum varieties.

Table 10: chi-square results on relationship between source of input and land on improved sorghum varieties.

Seed and fertilizer sources	**Sorgum varieties grown**				
	More than 1	**KARI mtama**	**Serena**	**Seredo**	**Total**
Local shops	1	0	5	37	43
Neighbors	1	0	7	9	17
Members family	1	0	3	23	27
NGO'S	1	1	1	14	17
market	0	0	0	1	1
Total	4	1	16	84	105

P<0.05 chi-value =45.898*, df=24, p=0.05

This finding concurs with Ascroft *et al*., (1993) where only 5% of less progressive farmers obtain inputs from reputable sources. This is disadvantageous to farmers who operate on a small-scale level and are less influential to the input and credit sector. The optimal effective sorghum technologies require more fertilizer, improved seed variety right timing and planting to perform well. Inputs are therefore a strong facilitator in enhancing effective access to new technology.

Relationship between source of input and land improved sorghum varieties.

Data analysis by cross tabulation using chi-square test Revealed a significant relationship between source of inputs and land on improved sorghum varieties (chi-square value =17.057, df = 12, p<0.05). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was a significant relationship between membership in agricultural organization an adoption of improved sorghum varieties. Table 11 present the result of the analysis by cross tabulation by chi-square on the relationship between source of inputs and land on improved sorghum varieties.

Table 11: Chi-square results on relationship between source of inputs and land on improved sorghum varieties

Seed and fertilizer sources	**Land on improve sorghum varieties**					
	3-4	**2-3**	**1-2**	**<1**	**None**	**Total**
Local shops	1	5	15	9	13	43
Neighbors	0	0	0	1	16	17
Family members	0	1	7	8	11	27
NGO's	0	0	6	4	7	17
Market	0	1	0	0	0	1
Total	1	7	28	22	47	105

***p<0.05 ch-square value=40.037, df=16, p=0.001**

The finding concurs with Ascroft *et al*., (1993) where only 5% of less progressive farmers obtained inputs from reputable sources. This is disadvantageous to farmers who operate on a small scale level and cannot access inputs easily. The optimal effective sorghum technologies require more fertilizer, improved seed variety, right timing at planting to perform well.

Relationship between use of credit and land on improved sorghum varieties

Analysis by cross tabulation using chi-square test, revealed a significant relationship between use of credit in sorghum production and land on improved sorghum varieties (Chi-square value=11.783,df=-4, p<0.05). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was significant relationship between membership in agricultural organization and adoption of improved sorghum varieties. Table 12 presents the results of the analysis by cross tabulation by chi-square on the use of credit and land on improved sorghum varieties.

Table 12: chi-square results on relationship between farmer's use of credit and land on improved sorghum varieties.

Use of credit on sorghum varieties	Land on improved sorghum varieties					
	3-4	2-3	1-2	<1	None	total
Yes	0	0	6	3	0	9
No	1	7	22	19	47	96
Total	1	7	28	22	47	105

*p<0.05, chi-square value =11.783,df=4, p=0.017

This finding concurs with Ascroft *et al*., (1993) where only 5% of less progressive farmers obtained loans. This is disadvantageous to farmers who operate on a small scale level and are less influential to the credit sector. Poor credit conditions may also be another reason that suppresses the capacity to adopt an innovation. Although credit may appear quite rational to a farmer, social sources outside his control dictates his propensity to adopt the technology. The optimal effective sorghum technologies require more fertilizer, improved seed variety and right timing at planting to perform well. Credit therefore is a strong facilitator in enhancing effective access to technology.

Relationship between use of credit and variety of sorghum.

Analysis by cross tabulation using chi-square test, revealed a significant relationship between use of credit in sorghum production and variety of sorghum grown. (Chi-square value=12.639,df=-3, p<0.05). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was significant relationship between membership in agricultural organization and adoption of improved sorghum varieties. Table 13 presents the results of the analysis by cross tabulation by chi-square on the use of credit and variety of sorghum grown.

Table 13: chi-square results on relationship between farmer's use of credit and land on improved sorghum varieties.

Use of credit on sorghum varieties	Land on improved sorghum varieties					
	3-4	2-3	1-2	<1	None	Total
Yes	0	0	6	3	0	9
No	1	7	22	19	47	96
Total	1	7	28	22	47	105

*p<0.05, chi-square value =11.783, df=4,p=0.017

Relationship between use of farm produce and land on improved sorghum variety

Data analysis by cross tabulation using chi-square test revealed a significant relationship between the use of farm produce and land on improved sorghum variety (chi-square value =32.546, df=4.p<0.05). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was a significant relationship between a membership in agricultural organization and adoption of improved sorghum varieties. Table 14 presents the results of analysis by cross tabulation by chi-square on the relationship between use of farm produce and land on improved sorghum variety.

Table 14: chi-square results on use of farm produce and land on improved sorghum varieties

Use of farm produce	Land on improved sorghum variety					
	3-4	2-3	1-2	<1	None	Total
Subsistence	0	4	14	12	47	77
Commercial	1	3	14	10	0	28
Total	1	7	28	22	47	105

P<0.05 chi-square value =32.546,df=4, p=0.000.

These findings agree with Ascroft *et al*., (1993) where only 8% of less progressive farmers had access to the market. The lack of market information represents a significant impediment to market access especially for small holders' produce. It substantially increases transaction costs and reduces market efficiency (Mwale, 1998). These findings also agrees with Pearse (1974) that market disadvantaged small, less educated and less influential farmers.

Relationship between use of farm produce and land on improved sorghum varieties

Data analysis by cross tabulation using chi-square test, revealed a significant relationship between use of farm produce and varieties of sorghum grown. Chi-square value=32.546, df=-4, p<0.05). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was significant relationship between membership in agricultural organization and adoption of improved sorghum varieties. Table 15 presents the results on the relationship between use of farm produce and variety of sorghum grown.

Table 15: chi- square results on the relationship between use of farm produce and variety of sorghum grown

Use of farm produce	Sorghum variety grown				
	More than 1	Kari mtama 1	Serna	Seredo	Total
Subsistence	2	0	14	61	77
Commercial	2	1	2	23	28
Total	4	10	16	84	105

*p<0.005, chi-square value=32.546, df=4, p=0.000.

These findings agree with those found by Ascroft *et al*., (1993) where only 10% of small holder farmers had access market. The lack of market information represents a significant impediment to market access especially for small holders' produce. It substantially increases transaction costs and reduces market efficiency Mwale (1998).

Summary, conclusions and policy implications

This study was set to investigate the influence of socio-economic factors on the adoption of improved sorghum varieties and technologies in Ndhiwa division, Homabay District, Kenya. The study was necessary because the performance of sorghum has remained low even after introduction of improved varieties and technologies. The low adoption levels of the technologies and the overall production of sorghum in the area. The studies used an *ex-post-facto* research design with a survey methodology. Data was collected from a sample, of 105 farmers from different locations in the area.

Results of data analysis indicated adoption of improved sorghum varieties was better than the adoption of technologies though the adoption levels of both remained low. The study also confirmed that socio-economic factors such as age, gender, level of education, gross monthly income, access to market, availability of inputs, access to credit facilities, and means of transport all affected the adoption of improved sorghum varieties and technologies. Farmers belonging to farmer's groups were found to adopt improved sorghum varieties and technologies than those who are not in any group.

In view of the data analysis and results shown in chapter four it can be concluded as follows:

- Close to 40% of the farmers in the study area had adopted improved sorghum varieties while close to 30 % of the farmers had adopted sorghum production technologies. This was low given that the varieties and technologies have been in existence more than three years.

- The study further concludes that gender, age, level of education, access to credit, membership of groups, access to input and market influenced adoption of improved varieties and technologies. Since these influenced adoption, strategies should be developed so as to target groups and marketing for increased production of the crop.

- Farmers level of education does influence the use of technologies and varieties and, therefore it is related to adoption of improved sorghum varieties and technologies, a finding which concurs with other studies cited earlier. It requires that farmers are educated on new technologies and varieties governing the crops production.
- Farmers mentioned a number of constraints that act as deterrents to adoption of improved sorghum varieties and technologies. These include: Lack of awareness of sorghum technology information, lack of where to secure inputs, high cost of inputs and market. Low level of frequency of extension contacts with farmers was also a common problem, which hindered faster rate of adoption. Others (Amudavi, 1993) have also cited these problems.
- The most dramatic change that will influence adoption of improved sorghum varieties and technologies is the development of institutional strategies that target small-scale farmers so that potential adopters can adopt the varieties and technologies to improve production.

The following recommendations have been suggested from the findings and conclusions of the study.

- Frequency of contact between the farmers and the extension agents was also quite low hence did not seem to influence adoption. However there are a number of institutions dealing with sorghum production that include CARE-Kenya, C- MAD, KARI, Ministry of Agriculture and Diocese of Homabay. These institutions could be encouraged, to step up their extension efforts. There should be a linkage between these institutions, extension agents, farmers and researchers.
- Breeders should encourage multistage development of varieties and technologies that favour small-scale sorghum farmers since they form a large proportion of farmers in Kenya today.
- Farmers should be encouraged to form groups so as to be able to market their produce and secure credit
- Strategies should be developed to favor young and women farmers since they are the majority who engage in agricultural activities on the ground.

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