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PERCEPTION AND SOCIO-ECONOMIC DETERMINANTS OF ADAPTATION STRATEGIES TO CLIMATE CHANGE AND VARIABILITY

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ABSTRACT
Climate change and variability have been identified globally as a major challenge to food security especially in Arid and Semi-Arid lands (ASALs). Agriculture and smallholder farmers have also been identified as the most vulnerable, mainly due to the former being rain-fed and the latter having inadequate adaptive capacity to the dynamics of climate change and variability. This study, therefore, sought to determine the social-economic factors that influence the adoption of adaptation strategies of climate change and variability, among smallholder farmers in Igambang'ombe Sub- County, Tharaka Nithi County. Descriptive research design was applied. Systematic random sampling was used to select the respondents and a semi-structured questionnaire with open and closed-ended questions was used for data collection. Observations and interviews were carried out, while systematic random sampling was used to select the respondents. Correlation analysis was used to assess which socio- economic factors influenced the adoption of adaptation strategies to climate change and variability. Some of the adaptation strategies considered included; accessed weather information Ox-ploughing and herbicide use for preparation, terracing and intercropping, crop and variety diversification The study showed that age (42%), farmer's farming experience (40%), and level of education of the household head (24%), were the key factors influencing the adoption of adaptation strategies to climate change and variability. Adaptation was also associated to access and frequency of extension services. Access to farm subsidy and credit was also important. Farmers and agriculture stakeholders needed to upscale training, guided by specific socio-economic farmer characteristics.
Keywords: Adaptation, Smallholder farmer, Adaptation strategies, Perception.

INTRODUCTION
Climate change and variability have been identified as a major global challenge to the development of communities, thus requiring great attention (IPCC, 2014) The United Nations identified climate as a key causal factor affecting food security globally with agricultural production being most vulnerable both locally, and globally (UN, 2007, IPCC, 2001). Various socio-economic, demographic, political, institutional, and policy trends have been noted to limit the abilities of smallholder farmers to adapt to climatic variations (Rosenzweig & Hillel, 2000). Adger *et al*. (2003) indicated that future climate change adaptation will be a function of an individuals' capacity, that is, that of the smallholder farmers, their social networks, and the state; and nations from which these individual farmers hail from. This calls for progressive and deliberate enhancement of the smallholder farmer's resilience and capacity to cope and adapt to climate change by all stakeholders of adaptation. Kerandi and Omotosho (2008) identified farmer knowledge enhancement, for example, on the rainfall onset dates and the length of the growing season as one of the capacities that farmers need. They argued that this would go a long way in enabling farmers to make timely decisions on-farm operations thereby helping mitigate the effect of climate change on the adaptation of crop production. According to Camberlin and Okoola (2003) this knowledge is key in the determing the tactics farmers will employ in adapting to the varying and unpredictable climate scenarios.

Kandji and Mackensen (2006) proposed that policymakers themselves and other agencies that assist farmers need to be adequately informed of the specific local farmer circumstances that influence decision-making in climate change adaptation. Reliable information has to be generated from time to time to inform these decision-makers and agencies

which empower the communities towards adaptation. They need to specifically determine the drivers of adaptation in each local scenario these will go a long way in helping them face the uncertainties posed by drought and other climate threats. In response to the experienced and perceived impacts of climate change and variability, the Kenya Government enacted a Climate Change law (GoK, 2010). In the application of the Act, it was envisioned that the actions or responses to the impacts of climate change were to be translated into decisions and development plans, and implementation strategies. This included building resilience and enhancing the adaptive capacity of people. As a result, the National Government and other development agencies have initiated support programs aimed at strengthening the adaptive capacity of smallholder farmers in semi-arid Kenya.

Climate change and variability has been and remains a problem in semi-arid Kenya. It affects agricultural productivity, and is a major cause of food insecurity and loss of livelihoods. The National Government and other development agencies efforts have initiated support programs aimed at strengthening the adaptive capacity of smallholder farmers programs which include demand-driven extension services, provision of drought-tolerant crop cultivars, and dissemination of climate forecasts, input subsidies, and provision of farm implements among others.

Despite these efforts, farmers in Igambang'ombe Sub- County continue to experience low farm productivity, remain food insecure, relatively poor, and vulnerable to climate variability. This situation pointing at a possibility of a disconnection between the smallholder farmer's knowledge on how to adapt to a varying climate and the decisions they make at the farm-level. Against this background, the study sought to determine socio-economic factors; that influence the adoption of adaptation strategies of climate change and variability in Igambang'ombe sub- County. Study findings will inform the smallholder farmer, policymakers and other agricultural stakeholders on what to consider for improved uptake of adaptation strategies to climate change and variability thereby improving the farm incomes and livelihoods of smallholder farmers. The specific objectives of the study were to determine the social-economic factors of the smallholder farmers that influences the adoption of adaptation strategies to climate change and variability in Igambang'ombe Sub-County, Kenya.

METHODOLOGY

The study adopted a descriptive research design which involved a household survey and interviews (Kothari, 2012). Through systematic random sampling, 100 farmer households were sampled from a total of 7,139 households from of Igambang'ombe Sub- County. Closed and open-ended questionnaires were used in this study; to collect both qualitative and quantitative data from the field.

RESULTS

Socio-Economic Factors That Influence Adaptation To Climate Change And Variability

The results in this section highlight the various socio-economic factors, of the smallholder farmer that influence climate change and variability adaptation strategies. These include; Gender, Age, Education, farming experience, household size, income and re-investment, access to credit, access to subsidy and remittances, market linkages, land size and use, Access to extension.

Gender and Age of Household Head

The findings in table 1 showed that (84%) of households was male-headed and (16%) were female headed. On exploring the age distribution, it was observed that 72% of the farmers were over 39 years and youthful farmers were only 28%. Of the over 39 years 61% were males and 11% were females. Abdul-razak *et al.*, (2017), noted in Ghana, that the adaptive capacity of farming communities was influenced by social factors like age and education, with Muthoni & Wangui, (2015) on women and climate change, pointed out that the use of climate information in Tanzania varied between men and women, with the women requiring and using the information more to alleviate food insecurity.

Table 2: The Farmer's Age per Gender

Age in Years	% Male	% Female
<18	1	0
19-28	0	2
29-38	16	5
39-48	18	4
49-59	22	4
>60	21	6
Total	78	21

Farmers Education Level

The results showed that 58% of the farmers had primary level education and below of which 42% were males. Of the remaining, 35% had secondary and 7% with tertiary education level with 30% and 6% males, respectively (Figure 1). This can potentially undermine climate change adaptation training. According to Nhemachena & Hassan, (2007), educated farmers were more likely to adopt technologies than uneducated ones. This is because they understand better the implications of climate variability and change and also easily learned new skills. In the case of Igambang'ombe, few farmers are likely to benefit or have the capacity to utilize climate change training due to the prevalent low level of education. The concern for the low level of education has also been raised by the County Government of Tharaka Nithi as indicated in the integrated development plan CIDP (TNC, 2018). The County plan

report estimated the population with no formal education at 17%, with the majority found in Tharaka South and North Sub- Counties. Figure 7 displays the level of education of the farmers per gender.

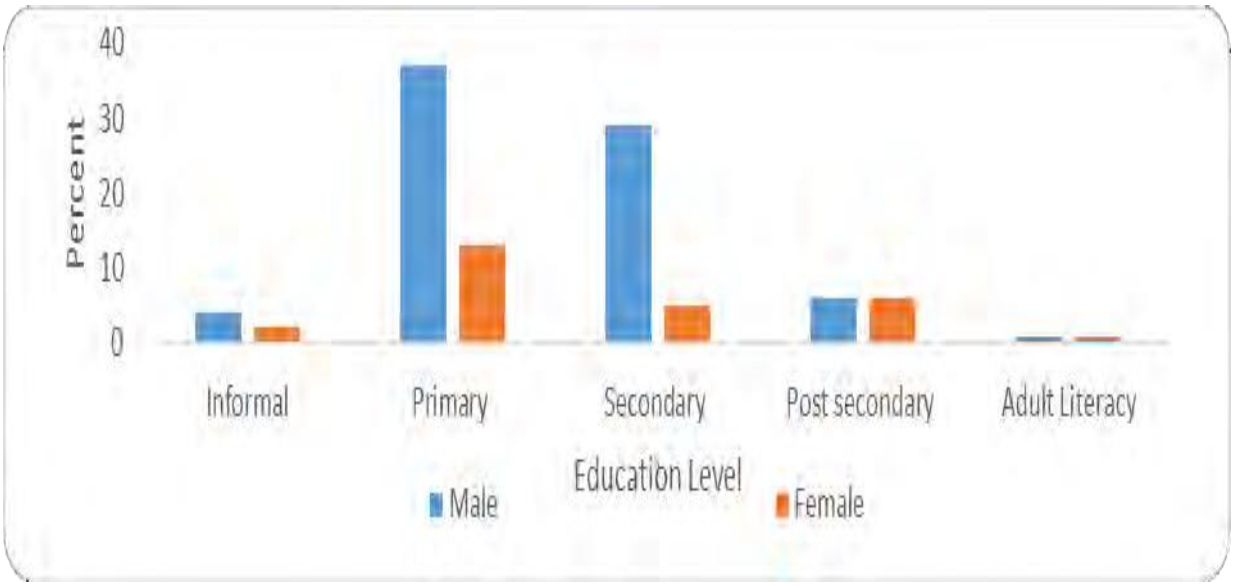

Figure 1: Farmer education per gender

Household Head Farming Experience

The results of the study indicated that 54 % of the household heads had a farming experience of 21-50 years. Out of the remaining 46%, 17% had a farming experience of 1-5 years (Figure 2). Generally, the more the experience, the higher the chances of good performance, but in farming, smallholders tend to be antagonized by experience and are not able to free themselves from it; to embrace new ideas and technologies. Ainembabazi *et al.,* (2015) admitted that indeed there is a positive relationship between the adoption of agricultural technologies and the farming experience of a farmer. Nevertheless, Ainembabazi *et al.,* (2015) further observed that the relationship is convex, in that, it influences adoption during the early stages of adoption, up to and until the time when the farmers perceive the usefulness of technology, after which it starts to decrease. This happens until skill retraining on the technology is done. Hence extension training becomes an accelerator of technology adoption.

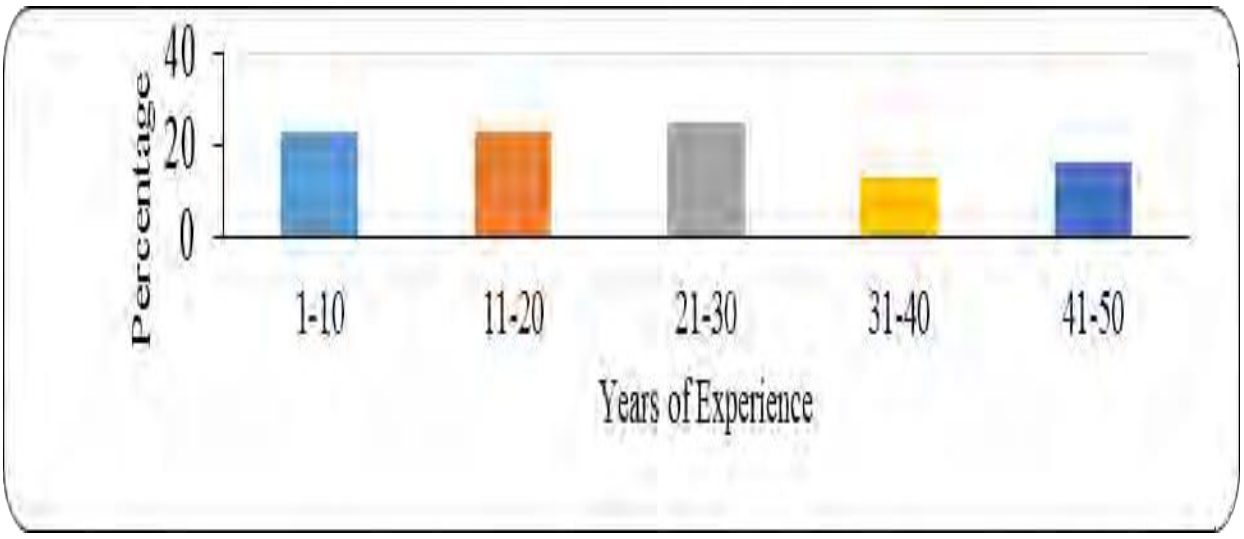

Figure 2: Farmer farming experience

Farmer Response on Household Size

Table 2 shows the household sizes of the smallholder farmers in the study area. The majority, (87%), had 3-10 members. Out of these, 46% had 3-5 members, and 41%, 6-10 members. There is a possibility that a large family strains household resources and limits climate change adaptation activities. A study by Oyekale and Oladale, (2012) in Ghana observed that larger households adapt more; taking into account that the household members provide labour for adaptation activities. This agrees with Ali & Erenstein, (2017) who observed that there was a positive association between the adoption of technologies regarding crop or variety choice, adjusting of planting date with socio-economic factors as household or family size, and wealth.

Table 3: The Household's Family size

Household size	Frequency	Percent
1-2 Members	11	10
3-5 Members	48	46
6-10 Members	43	41
10 and above	3	3
Total	95	100

Annual Household Income and Re-investment for Adaptation Activities

Table 3 shows the estimated annual income and the corresponding re- investment into adaptation activities of the respondents. It showed that 77% of the households earned less than KES 101, 000 annually, and only 63% of them re-invested up to KES 10,000 back to the farm for adaptation activities. Generally and in practical terms, if there was to be an improvement in climate change adaptation among smallholder farmers, they need to invest more of their income in climate change adaptation strategies and activities than is currently observed. Macharia (2009) observed that in Meru South, low farm income was a major constraint in the implementation of soil and water conservation among smallholder farmers growing coffee. Oyekale & Oladele, (2012) in their study Ghana showed that household incomes were related positively with adaptation; where households with high incomes were likely to re-invest to adaptation than those with low ones. Thus, the low farm income and re-investment among smallholder farmers are likely to limit the adaptation strategies of climate variability and change. Observation of low income and re-investment among Igambang'ombe farmers was reported in the National Bureau of Statistics Census of 2009 report on the poverty level index, as noted in Tharaka Nithi (CIDP), 2013 where the poverty index for Igambang'ombe was estimated at 50% high.

Table 4: Farmer response on annual household income and re- investment to adaptation activities

Annual income in KES	<or = 10000	10,001-30,000	30,001-40,000	40,000-50,000	> 50,000	Total
1,000-50,000	22	5	2	0	1	30
51,000-100,000	28	17	2	0	0	47
101,000-150,000	2	3	1	2	0	8
151,000-200,000	6	0	1	0	0	7
201,000-300,000	3	1	0	0	1	5
301,000-400,000	2	1	0	0	0	3
Total	63	27	6	2	2	100

Income diversification (Off-farm Livelihood)

The study sought to determine whether respondents engaged in any off-farm activity for income diversification. Figure 3 shows the result were as follows the off-farm sources of income that they were engaged in 54% of the respondents did not engage in any off-farm livelihoods, 19% owned businesses, 6% engaged in the sale of handicraft and 6% in firewood sale, 1% got pension remittances and 7% were employed hence drew a salary. The findings of the study confirmed that farmers look for alternative livelihoods out of the farm when their cropping business is threatened by climate change and variability. Agricultural productivity in the tropics is equated to the reduction of crop yield, resulting in loss or reduction of household incomes and livelihoods (Fischer *et al.*, 2004 and Tubiello, 2014). This explains the reason why households have off-farm activities and low re-investment to adaptation activities.

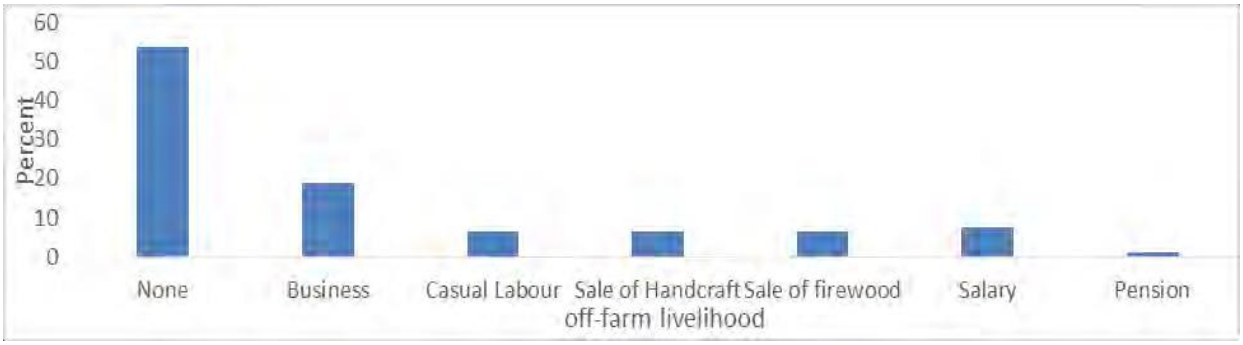

Figure 3: Off-farm Livelihoods

Access to Credit and Farm Subsidies

The study determined whether farmers had access to credit facilities for any agricultural activities; 72% said yes while 28% said no (Figure 10). The main sources of credit were farmers groups (51%), farmers' SACCO ((35%) commercial banks (10%), and National Government (5%) as shown in Table 4.

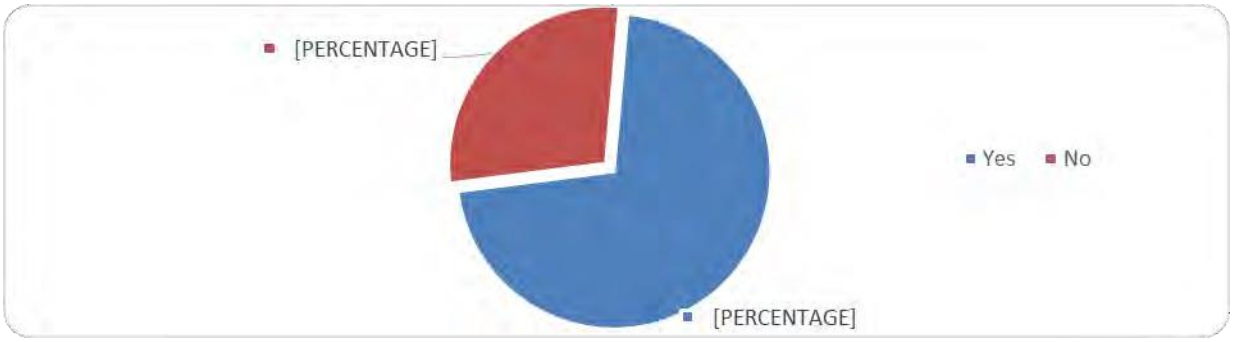

Figure 4: Percentage farmers accessing credit

Table 5: Farmer response on source of credit

Source of credit	Frequency	Percent
Farmers Self Help Group	48	50
Farmers SACCO	33	35
GoK	5	5
Commercial Banks	10	10

Access to Farm Subsidies

The study sought to determine whether farmers had access to agricultural subsidies; 67% said yes while 33% said no (Figure 3). The study also established that farmers obtained the subsidies as follows; 30% said from GoK (National Government), 21% said from local NGO (One operating only in Tharaka Nithi), 11% said from other foreign NGOs while 10% said from COTN (County Government). The results of the study agree with Kurukulasuriya & Rosenthal, (2003) who argued that for households to reduce their vulnerability and increase their adaptive capacity, they need to source for farming loans from commercial entities and input subsidies.

Figure5: Access to Subsidies

Table 6: Farmer response on Source of Subsidies

Access subsidies	Frequency	Percent
Local NGO	20	21
Foreign NGO	10	11
GoK	29	30
County Government of Tharaka Nithi	10	10

The subsidies obtained by farmers included fertilizers by 57%, seeds by 52%, farm implements storage by 26% and farm storage structure by 12% as shown in (Figure 4).

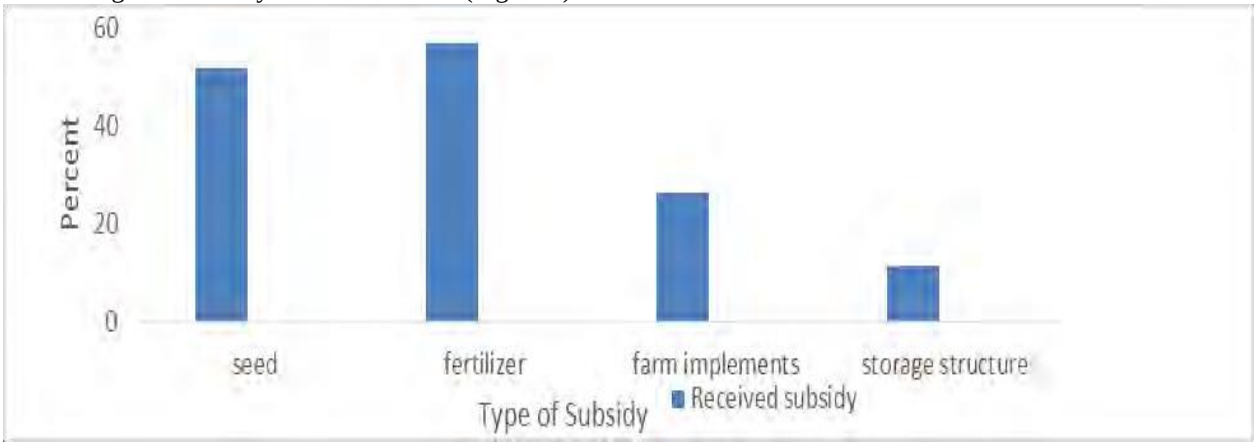

Figure 6: Type of subsidies accessed by farmers

Access to Remittances

The study sought to determine whether farmers received remittances from friends or relatives to finance farm activities. The results show that farmers received remittances from relatives and friends, as follows; 58% said no and 42% yes Figure 5. Out of the 42 % who received remittances 53% used the remitted cash for other purposes other than farm-oriented ones, 24% was to buy seed, 12% said for buying fertilizer, 7% said for ploughing and 4% said for pesticides purchase as shown in Table 6. Like subsidies, remittances are a social system where vulnerable communities living in the rural areas are supported by their relations earning their living in the urban areas, thereby enhancing them to be resilient to adverse climatic variation and change.

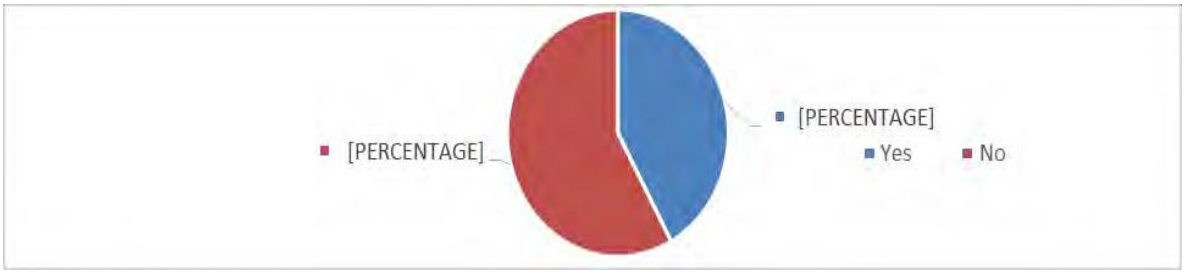

Figure7: Access to remittances

Table 7: Activities Supported by Remittances

Activity supported by remittances	Frequency	Percent
Buying Seeds	16	24
Buying Fertilizer	12	12
Ploughing	7	7
Non –farm activities	50	53
Pesticides	4	4

Household Land Size and Use

The results of the study showed that 97% of the households owned land of 10 acres and below (Table 16). On land use, 62% of the farmers allocated their land to crop farming, while 61% had allocated some land to grazing and 42% allocated land to forest. This agrees with findings by Cecchi (2010) that, households in mixed arid and semi-arid environments of Eastern Africa practiced pastoral, agro-pastoral, and mixed farming. In agreement with this observation, most households (61%) in Igambang'ombe have allocated land to crop and grazing, evidence that the people here are agro-pastoralists. The findings further corroborate with those of Ali & Erenstein, (2017) who observed that land size and use is positively associated with crop-related adaptation technologies adopted by farmers. Ali & Erenstein, (2017) observed that those with larger land size and committed to crop production are more likely to be keen on choosing crop types and varieties that are adapted to the climate. The guiding factor of these choices being tolerance to prevailing weather conditions, diseases and pests, and easily try out new crops; to get returns to their land investment and use.

Access to Extension Services

Table 8 shows responses on the access to and frequency of extension services, where 81% of the respondents indicated that they had access to extension service (Figure 6). Out of the total, 69% indicated that they received it weekly or fortnightly. A review on the impacts of climate change to agriculture acknowledged that the type, and the availability or access to both appropriate technology and extension service, are major drivers, and are factors of agricultural productivity (Kurukulasuriya, 2003). This concurred with Haregeweyn *et al.,* (2015) that relevant stakeholder support services, to smallholder farmers is necessary for meaningful climate change and variability adaptation process in agriculture.

Table 8: Farmer response on household land size and use

Land Use	Land size	Frequency	Percent
Total land owned	Less than 2.5 Acres	45	47
	2.5-10 Acres	48	50
	More than 10 Acres	2	3
Land under crops	Less than 2.5 Acres	59	61
	2.5-10 Acres	34	36
	More than 10 Acres	2	3
Grazing land	Less than 2.5 Acres	59	61
	2.5-10 Acres	10	11
	More than 10 Acres	1	1
	none	25	27
Forest land	Less than 2.5 Acres	40	42
	2.5-10 Acres	7	9
	More than 10 Acres	1	1
	none	46	48

It was also observed from the results that, the training by extension agents, focused mainly on energy saving, conservation agriculture (CA), and soil and water conservation technologies. Kimaro *et al.,* (2014) identified CA as a technology that would greatly increase agricultural productivity in fragile ecosystems as ASALs, and as earlier realized in this study, it is being practiced by a few farmers and may require scaling up for its impacts to be substantial in Igambang'ombe.

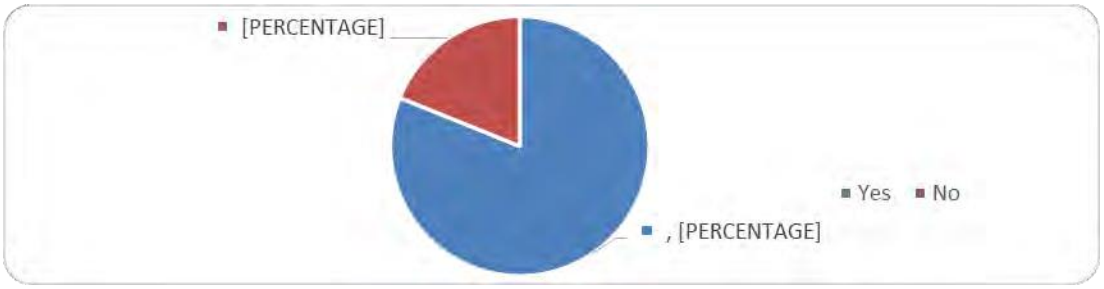

Figure 8: Access to extension service

Table 9: Access and Frequency of Extension Services by Farmers

Frequency of accessing extension services	Frequency	Percent
Weekly	43	45
Fortnightly	23	24
Monthly	17	18
Occasional	12	13

The study sought to determine the main crops that farmers grew for commercial purposes to earn income. The results were as follows; the combination of millet, green grams, and cowpeas was grown by 40% of the farmers, green grams, pigeon peas, and maize is grown by 23% of farmers and cowpeas, green grams, and sorghum by 21% and maize, bananas and mangoes combination by 16% of the farmers as shown in Figure 15. Food crops in Igambang'ombe were the main cash crops and hence the main source of household income.

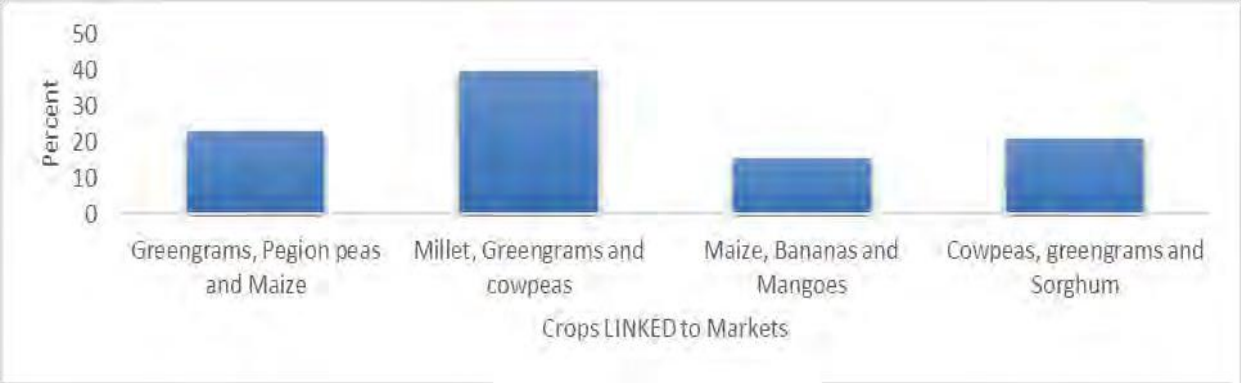

Figure 9: Percent responses on three main crops linked to markets

Besides, the study sought to determine where the farmers sell their produce and the results were as follows; 92% internally within the county while 8% export outside the county. On who links the farmers to markets, 95% indicated that they were linked by government agencies and 5% by the private sector as shown in Table 9. Agricultural markets and terms of trade are often affected by this climate variability; according to Kurukulasuriya & Rosenthal, (2003), how agricultural markets interact with climate variability should concern researchers and policymakers. The results agreed with (Ketiem *et al.,* 2007) that market availability and activity are a part of climate change adaptation in that they become an assurance for steady household incomes thereby improving the resilience of otherwise vulnerable communities living in the ASALs areas.

Table 10: Percent responses on linkage to market

		Frequency	Percentage
Market type	Internal within county	87	92
	Export outside county	8	8
Who links farmers to markets	Government Agency	90	95
	Private Sector	5	5

Correlation between Adaptation Strategies and Socio-Economic Factors of the Farmer

In the correlation analysis, the study focused on the relationship between the independent variables; gender, household size and income, farm size, age, education, farming experience, and the climate change adaptation strategies; dependent variables that include: land preparation methods and use, weather forecasting and information access, soil and water management as mulching and terracing), and crop enterprise diversification for drought and disease- pest resistance and/or tolerance. From the correlation analysis, the most important socio-economic factors significantly associated with the adoption of climate change strategies included age, education, and farming of the household head. Other factors with a significant association with the adoption of climate change adaptation strategies were found to be access to extension and frequency, access to farm subsidy, and credit. On the contrary, education however influenced significantly but negatively in weather forecasting probably due to the prevailing low literacy levels, with 58% being the primary level and below.

CONCLUSION

It was concluded that in Igambang'ombe, the socio-economic factors affecting the adoption of climate change adaptation strategies included the age of the household head (HH), which was a key determinant of the adoption of SWC strategies and on weather and climate forecasting access To 2-3 days forecasting. The latter being also affected by education level, and farming experience. On the other hand access to 2-3 months forecast was influenced by HH education, farming experience, and household farm size.

RECOMMENDATIONS

This study revealed that farmer training through extension service played a key role in influencing the adoption of climate change and variability adaptation strategies.

The training of farmers in the Igambang'ombe Sub-County should be cognizant of the existing household and farmer demographic characteristics and should be frequent and well-structured to meet specific identified farmer needs. Secondly credit and subsidy services from stakeholders also contributed greatly in supporting the adoption and the adaptation of climate change and variability and hence should be enhanced.

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