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Full Length Research Paper

Factors influencing availability and conservation of green water for sustainable agricultural production and livelihoods in drylands of Kenya

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Green water is the water that is used in biomass production, and if well conserved this water can boost agricultural production. Drylands experience erratic rainfalls, poor soils and high rates of evapotranspiration. This situation has been made worse by climate variability as drylands are very sensitive to climate change due to their delicate nature. The effect of climate change in ASALs has resulted in poor agricultural production hence loss of livelihoods. Good management of green water during the rainy season can greatly increase agricultural production thus improving livelihoods. This research paper investigated the biophysical and socioeconomic factors that influence green water management with a focus on Kyawango sub-catchment. Data collection was collected through focus group discussions, key informant interviews, observation study, and household questionnaires. The household survey was carried out in 147 households which was the target population for the research location. The results revealed that management of the green water is determined by biophysical factors such as rainfall, soil type and socioeconomic factors such as demographic and, governance. The researcher further suggests strategies of encouraging communities to conserve green water for increased agricultural production and improved livelihoods.

Key words: Climate variability, ecosystem services on farm, diversification.

INTRODUCTION

Drylands are defined by many scientists as ecosystems that comprise of grassland, woodland, rangelands, which occupy over 40% of the terrestrial surface (IUCN, 2019). According to Burrell et al. (2020), drylands occupy 41% of the earth's surface out of which 45% is used for agriculture. Globally, drylands is a home to 2 billion people (IUCN, 2019; FAO, 2016) and they are found in all continents (Mabhuye et al., 2018).

In Africa, drylands account for 80% of the total land (ICPALD 2021), 75% of these forms the agricultural land (Cervigni and Morris, 2016; Mwendwa, 2010). These areas annual potential evapotranspiration exceeds annual potential precipitation (Huang et al., 2017), thus making them to be characterized by water scarcity (FAO, 2016). He further states that drylands are classified into hyperarid, arid, semiarid, and dry subhumid areas. Despite their poor climatic conditions they assist the earth in carbon cycle and form a vital part in grazing fields by supporting the growth of grasslands, shrubs and woold lands (Hilding and Voilder, 2020).

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In Kenya, drylands occupy 80% of the total land with 60% being utilized for agricultural production as stated by Spilsbury (2019). Agriculture is the main backbone of the country's economy, thus playing a big role in ensuring food security and contributing greatly to poverty reduction (D'Alessandro et al., 2015; Nyariki and Amwata, 2019). The Arid and Semi-Arid Lands of Kenya are a home to 200 million people who are suffering as a result of high poverty levels and poor climatic conditions; thus contributing to the region's low agricultural production (Quevenco, 2015). In addition, the effect of climate change in form of floods, droughts, heat waves, and famine has resulted in severe suffering of the inhabitants of the affected regions and poor economic development (Herrero et al., 2010).

In the recent past, researchers have been putting more focus on blue water scarcity (Schyns et al., 2019). According to Quinteiro et al. (2015), very few studies have given focus to green water which is the component of water that is necessary for crop production. Falkenmark first discovered the concept of green water in 1995 as stated by Liu et al. (2019). According to Falkenmark, green water is the water that is stored in the saturated soil surface, this water does not flow nor recharge aquifers but it plays a great role in biomass production. Green water comprises of evapotranspiration and precipitation flows (Keys, 2018). Zhang et al. (2020) further observed that in drylands, green water accounts for 80% of the total water. This therefore means that green water plays an important role in biomass production in ASALS. Good management of this water will increase food security as well as improve livelihoods.

Falkemmark's research has been supported by a number of researchers agree that hunger eradication in sub Saharan Africa can be achieved through rain water harvesting and green water management (DTE, 2016; Amwata and Snelder, 2021). Climate change has been the biggest barrier to adequate agricultural production in Kenya, prompting the government of Kenya to highlight the significance of the climate change effects in the 2010 National Climate Change Response Strategy (GOK, 2013). The drylands bear the greatest effect as they are very vulnerable due to the poor climatic condition. The main objective of this research is to investigate factors that influence the green water conservation in drylands with a focus in Kyawango sub catchment in Machakos County.

MATERIALS AND METHODS

Area of study

The study site was the Kyawango sub-catchment located in Mwala sub county, Machakos County, an ASAL region in Eastern Kenya. The County occupies a total area of 6208 km^2 and receives a mean annual rainfall of about 500 mm and temperatures of about 18 to 29^{0}C (MoALF, 2017). The population around the sub catchment is approximately 163,000 people. The sub catchment is part of the Athi catchment which is served by the Athi River. Agriculture is the main economic activity. Figure 1 indicates the study area.

Research design

This research study employed a mixed research design. Descriptive survey design was used and Purposive sampling technique was used to select the villages that were close to the catchment; while Systematic random sampling was used to select the households in three villages that were close to the catchment.

Sample size determination

The Yamane (1967) formula was used to calculate the sample size as follows:

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where; n = sample; N = population size; E = 0.95 (level of precision.

The study region has a population of 163,032, then;

$$\boldsymbol{n} = \frac{163{,}032}{1 + 163{,}032(\mathrm{e}0.95^2)}$$

n = 147

Data collection

Both quantitative and qualitative data were collected in evaluating the impact of climate change on livelihoods across Kyawango sub-county and the various water conversation strategies employed by farmers in this region. It therefore represents various stakeholders' key informants from the extension officer, meteorologist, farmer representative and trader. Households were sampled randomly along the catchment area, where one household was sampled one after every three to avoid data duplication.

House hold survey

The household survey was conducted in 147 households in three villages within the Kyawango sub-catchment namely; King'ali, Maweli and Kyawango. Purposeful sampling was employed as the three villages are closest to the sub catchment hence exert more pressure on the subcathment. The total population of Mwala is 163,000.

Focused group discussion

Semi Structured Questionnaires were used to collect the data from focused groups. The groups consisted of 10 individuals divided into different age groups and gender: female youth(18-35byears), female elderly (36-61 and above years); the same was replicated to the male gender making up the four groups. The semi structured questionnaires were developed into a Computer Aided Personal Interview (CAPI) platform to aid the use of an Android application – Open Data Kit (ODK) in collecting the data. Additionally, in each focused group, there was a note taker to capture additional information that was deemed useful in unraveling the concepts under investigation.

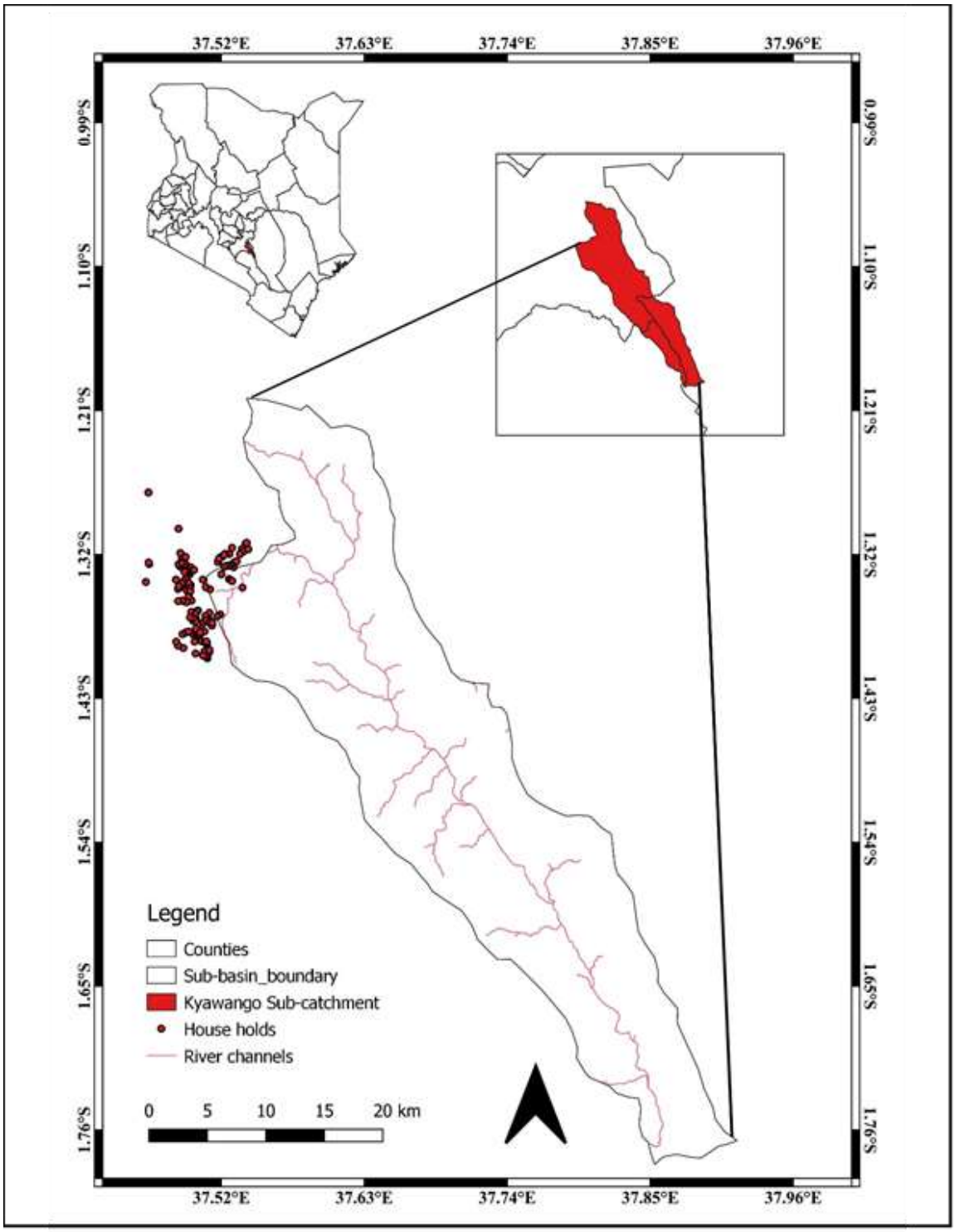

Figure 1. Location of Kyawango sub-catchment.
Source: QGIS.

Key informant interviews

5 Key Informant Interviews s were conducted involving county meterological officer, county water officer, extension officers, farmer representative and Business representative. A semi structured questionnaire was used in interviewing the KIs. 1 Farmer, 1 Extension Officer, 1 Meteorologist, a county water officer and a trader were interviewed to this effect.

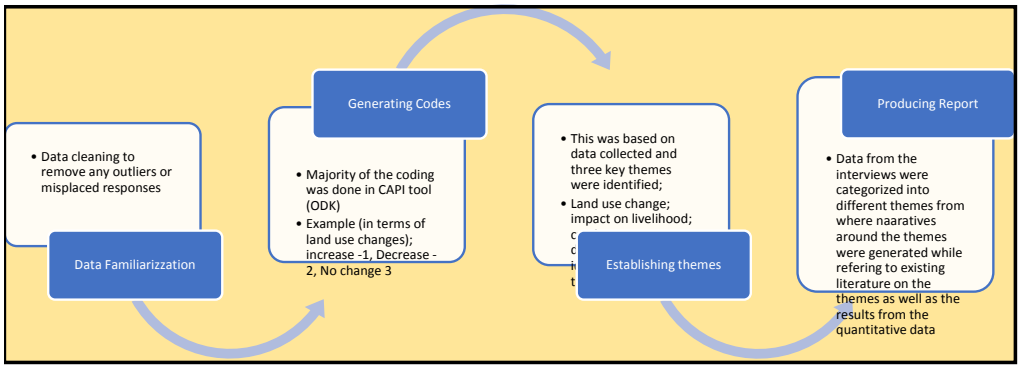

Figure 2. Thematic content analysis.

Data analysis and presentation

Analysis FGD and KII data

A semi-structured interview guide for the focused group discussions and key informant interviews was pe-coded into a Computer-Aided Telephone Interview (CAPI) tool. The ODK (Open Data Kit) was used to conduct both the KIIs and the FGDs, and responses were captured based on set questions and where need be, additional responses were interpreted based on the three thematic areas predetermined; land-use changes in the catchment, drivers of catchment degradation as well as the impact on livelihoods. Frequencies and tables were pulled out of the analysis to complement the quantitative data. A comparative analysis of the output based on different groups for the FGDs (youths, women, and men) from the different sublocations where the FGDs were held. This was used in understanding the impacts of land-use changes and catchment degradation on livelihoods.

Thematic content analysis

This approach was used to analyze qualitative data from the focused group discussions and key informant interviews. The method has been viewed as the foundation of qualitative research. An inductive approach was employed by the researcher; data was coded/categorized into themes. This ensured the analysis process was driven by data collected and not based on perceptions. This took the steps indicated in Figure 2.

RESULTS AND DISCUSSION

Household survey

The household survey was used to mainly collect demographic data. The sample size was 147 households within the three villages surrounding the catchment namely Kingali, Maweli and Kyawango. The following findings in Table 1 show the distribution of samples among the three sublocations in the study area. Maweli sub-location has the highest number in the sub-catchment area and hence would be considered to be having the greater impact on the catchment. From the survey and observations, the area is experiencing climate changes. For instance, the nearest river was already drying up. The Maweli inhabitants are forced to walk long distances to look for water for

This is also a clear indication that the region experiences poor agricultural production resulting to rural-urban migration in search of job opportunities. Rural-urban migration reduces the farm labor force thus further worsening the poor situation. Table 2 indicates the gender distribution of the respondents. It is worth noting that majority of the respondents were female. This could imply that farming is mostly practiced by women. Men engage in other economic activities.

Table 3 above indicates that majority of the respondents' households had between 4 and 9 members (63%). However, it is only a few households that had 10 or more members in a single home. This could be attributed to high poverty levels experienced in ASALs and fewer livelihood options forcing them to practice family planning. The low population rate reduces farm labour hence low agricultural production.

Table 4 shows that majority of the respondents are literate and are therefore able to recognize changes in the catchment area such reduced water levels in rivers, high temperatures 41% and 38% reported to have attended primary and secondary education respectively. From the table it is quite evident that majority of the respondents did not go beyond secondary school education. The level of education attainment determines the vulnerability of communities to climate change and variability as more literate communities have various ways of adapting to climate variability as well as livelihood options.

Table 5 indicates the number of years the respondents have lived in this catchment. The results shows that majority of the respondents have lived in the area for more than 5 years. This therefore means that they are able to notice any change that takes place in terms of climate variability and agricultural production and look for viable solutions to the problems that these changes result to. Table 6 shows table and pie chart illustrates the ages of the respondents. Majority of the respondents are between ages 31-60 years. This probably implies that the

Table 1. Sublocation of respondents.

Name of Sub-location	Frequency (n)	Percentage
Kyawango	45	31
Kingali	30	20
Maweli	72	49
Total	147	100

Table 2. Gender Distribution in the study area.

Gender	Frequency (n)	Percentage
Male	45	31
Female	102	69
Total	147	100

Table 3. Members of a household.

Household members	Frequency (n)	Percentage
<4	37	25
4-9	93	63
10 and above	17	12
Total	147	100

Table 4. Respondents' level of education.

Level of education	Frequency (n)	Percentage
Never been to school	9	6
Primary	60	41
Secondary	55	38
Tertiary/College	18	12
University	3	2
Informal	2	1
Total	147	100

Table 5. Number of years lived in the area.

Number of years	Frequency (n)	Percentage
<5	7	5
5-10	27	18
11-20	38	26
21-30	43	29
31 and above	32	22
Total	**147**	**100**

ages have access to credit facilities, access to land and technology compared to the ages between 18-30 and 61 and above. The data also illustrates that the ages 18-30 are engaged in other economic activities. It is worth

Table 6. Age distribution of respondents.

Variable (years)	Number	Percentage
18-30	31	21
31-60	91	62
61	25	17
Total	**147**	**100**

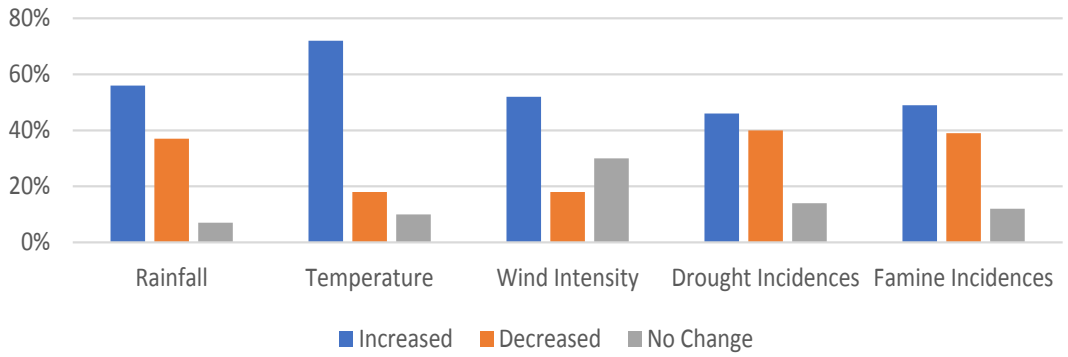

Figure 3. Changes in weather patterns.

Table 7. Effects of climate variability on agriculture, land use and livelihood/economic activities.

Variable	Frequency (n)	Percentage
Agriculture	114	78
Land use	23	15
Economic activities and livelihoods	10	7
Total	**147**	**100**

noting that from the ages 61 and above, only 17% participated in farming activities.

Figure 3 confirms that the area has experienced tremendous climate variability, rainfall intensity, temperature, wind intensity, drought incidences, and famine incidences have been increasing (at least 46% reported increase in each category). Temperatures have been significantly increasing at 72%. It is worth noting that both drought incidences and rainfall have been increasing at the same rate, this possibly means that inhabitants of these areas have poor water conservation strategies.

Table 7 depicts significant effects of climatic conditions on the agriculture, land use and livelihood/economic activities. on agriculture, it appears that despite the huge effects on agriculture, there are significantly low effects on land use and economic activities/livelihood (15 and 7%) respectively; that would mean that either land is used for other purposes other than agriculture and that there are alternative economic activities that the people engage in apart from agriculture or that the respondents do not understand the relationship between agriculture and livelihood/economic activities.

In depth analysis

A multinomial logit regression analysis run on impacts of changing climatic conditions and weather patterns against gender indicated in Appendix tables.

Focus group discussions

Climate changes that have been witnessed

While 100% agree that temperature and famine instances have increased, they were sharply divided (half) on the drought and rainfall instances in all the four villages. The changes appear common to all the villages because they are within the same ecological zone and therefore

experience the same weather conditions. These changes have been attributed to majorly the human activities such as deforestation, agricultural activities and climate change and weather variabilities, unreliable and changing rainfall patterns and wind intensity.

Actions taken by county and national government

The groups report of a few but unsatisfactory changes taken by either county or national governments, further that they have been left to survive on their own despite the harsh climatic conditions in the area. Though unsatisfactory, the changes have impacted their livelihoods in one way or the other. These changes include capacity building on farming practices, subsidized seeds.

The youths allege, however, that the county and national governments focus more on the elderly and leave them to survive. It was also noted that the distribution of government projects is skewed. Some areas are benefiting more than others. For instance, they cited the government project at Kabaa where farmers had opportunities to have furrows in their land thus transforming their agricultural production and livelihoods, they would have wished that such kind of projects be replicated in other areas

Effects of climatic changes

The farmers in the FDG stated that climate variability had impacted on their livelihoods and they have adopted other means to sustain their livelihoods; engaging in daily wages jobs like casual work and boda riding, Mango farming. Farmers in this study have diversified their livelihoods as a means of survival. The drying rivers, erratic rainfalls and the soil erosion has resulted to poor agricultural productions.

Type of farming

Majority of the individuals in the community practice mixed farming (both for subsistence and commercial purposes) and this is informed by the need to sustain their families as well as be in a position to buy other things needed for the household. There have been noted changes on water levels from the existing rivers, and as a result, farmers have incorporated strategies to transform their farming activities by digging trenches, water pans as well as employing conservation strategies in their farming activities like mulching and terracing.

Crops grown

Majority of farmers prefer maize, beans, pigeon peas, cowpeas, green grams and fruit trees. The choice of these crops is attributed to the low rainfall patterns in the area and the type of soil and the fact that majority of those crops are drought resistant. There have been notable changes in cropping seasons; the change in cropping seasons is attributed to the changing climatic conditions coupled by the changing weather patterns. As a result, harvesting has decreased due to crop failure.

Key informant interviews

Major problems associated with farming

Climate change, drought, water abstraction and human settlements were highlighted as the major problems associated with farming in the area of study. Also, there were other issues attributed to the problem of water including walking longer distances to either the river or nearest water points, sand harvesting and unreliable rainfall hence low ground water recharge. The government needs to employ more agricultural extension officers, as currently, one agricultural extension officer serves 4 wards thus making it difficult for him to discharge his duties effectively.

Water conservation measures for agricultural use

The community has employed three major strategies to conserve water including; installation of water tanks, construction of dams and practicing conservation agriculture/farming. The water storage methods were not affordable to all farmers.

Management techniques employed in the farm

The following management techniques have been employed in the farms: terracing, digging trenches/furrows and diversion channels for those who live near the rivers as well as construction of Zae pits and tight ridges

Changes in water levels in the rivers

There have been notable changes in water levels at the rivers and this has been changing drastically to the current times. There have been significant drops lately which have been attributed to increased human activities, climate change and increased water abstraction that put pressure on resources; thus leading to overexploitation and siltation in the rivers. The levels that were seen 30 years ago cannot be compared to the levels witnessed today; the drop has consistently been high.

Climatic changes

Rainfall patterns have changed and this has impacted crop productivity. There have been also high instances of

water, drought, and famine intensities as well as disease outbreaks in both livestock and crops. While the community practices mixed farming, there have been significant drops in food supplies as a result of climatic issues; majority, however, farm for subsistence use. Despite the low farm productivity, the demand for agricultural products has greatly increased and this could be attributed to the fact that Kenya is largely dependent on agriculture despite more than 75% of its land being either arid or semi-arid. An average income from farm produce ranges between 10,000 and 30,000 Kenyan shillings a season. Changes in planting seasons affect returns from farming, and these changes have been attributed to climate change issue, unreliable rainfall and increased human activities that degrade land and environment.

CONCLUSIONS AND RECOMMENDATIONS

Biophysical factors

From the study, it is evident that the rainfall pattern in the region is very unpredictable. This therefore implies that farmers should start land preparation early enough to benefit from the little rain. Secondly, as observed during the study the soil in the study area is so poor and sandy besides the region experiences high levels of soil erosion due to the bare land thus making it to have a low water retention capacity. For any water to be conserved, farmers really need to practice intensive green water conservation by going for viable on farm water conservation strategies ideal for the area. Some farmers cited lack of financial resources and technological know-how on on far water resources strategies. The government should consider coming up with ways of making credit facilities this region affordable to all farmers. In addition, more demonstrations and experiments on various on farm water conservation strategies be made accessible to all farmers. To curb the rampant soil erosion activities, tree planting activities should be organized if possible once a year in the sub catchment.

Governance

From the FDG and KII, the government is paying little attention to the plights of farmers; they cited few staff in the agricultural office. For instance, one extension officer serves four wards. For this reason, extension services can only be accessed by farmers who are willing to go an extra mile. In addition, farm inputs that are purported to be subsidized can only be afforded by very few farmers thus making a number of them to give up on farming activities and opt for other livelihood options.

The Kenyan government should come up with strategies that will endear the youth to farming activities to help reduce joblessness. As these strategies will help in achieving the big four agenda. The strategies could include revision of the curriculum by making agriculture and environment management a mandatory subject in schools. Furthermore, the former 4k clubs should be reintroduced back in schools and be made more vibrant and mandatory for all. This will greatly help in creating the foundation for agriculture. Encourage the youths to be innovative through competitions that promote technology and innovations.

Demographic factors

The economic status of farmers will determine the extent to which they can invest in farming activities. Farmers who have other jobs besides farming are able to hire farm labourers and invest in quality seeds that utilize the available water. From the study, we note that some farmers have diversified their livelihood options thus investing the income from these activities into farming; thus enabling them to increase their agricultural production, but for farmers who depend purely on agriculture cannot afford some agricultural services such as extension, subsidized seeds, fertilizers and technological advances. The focus group discussion with the youth farmers brought out the fact that the government seems to focus more on empowering aged farmers and ignoring the youth. The extension officer defended the government by stating that the youth in the area are not so keen on farming activities. A number of them have opted for motorcycle taxis and charcoal burning as well as looking for manual jobs where they get a daily income.

Furthermore, the youth preferred to move to urban areas to look for more opportunities thus shying away from farming activities. The survey indicated that the elderly of ages 61 and above and the youth of ages between 18-30 years were not active in agricultural activities. The government should introduce strategies that would attract the youth to agriculture and the aging labour force. It was also noted that in the study area majority of farmers are women. Most African countries are patriarchal. This therefore means that they could not be having access to credit facilities, land ownership rights so they cannot make decisions on issues that involve land thus derailing the uptake of strategies that involve green water conservation.

Diversification of livelihoods could also limit the uptake of green water conservation as people focus more on where they get daily income or a higher income thus giving little attention to practices that promote agricultural production. In such area with poor rainfall, the government should come with up with strategies that would increase agriculture production such as distribution of drought resistant varieties, capacity building through

trainings and demonstrations at the farm, credit facilities for farm produce, employment of more extension officer so that extension services can be easily accessed by famers.

Climate change mitigation and adaptation will only be successful where the community understands what is happening and is eager to change their attitudes and perception. The survey indicated that 47% of farmers have not attained secondary education. For them understand the climate change concept, the government should introduce monthly adult education on climate change, the effects and how to mitigate them.

In conclusion the success of green water conservation in ASALs lies in the motivation for increased agricultural production and policies that are friendly to level of farmers their gender notwithstanding. The mindset of locals regarding the poor soils and erratic rainfall can only be changed through improved agricultural extension services, credit facilities, market for ready produce, promotion of participatory research will hasten the uptake and dissemination of new information regarding on farm water conservation strategies. Other studies could look into ideal technology and innovations that could further improve the conservation of green water.

CONFLICT OF INTEREST

The authors have not declared any conflict of interest.

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APPENDIX

Table 1. Impacts of changing climatic conditions and weather patterns against gender.

Variable	Sub- location	Gender	Age	Education level	Impacts on agriculture	Impacts on Land use	Impacts on livelihoods/economic activities
Mean	2.184	1.694	1.959	2.673	0.918	0.122	0.136
Standard Error of mean	0.072	0.038	0.051	0.077	0.023	0.027	0.028
Standard deviation	0.876	0.462	0.618	0.938	0.275	0.329	0.344

Impacts of changing climatic conditions and weather patterns against gender were indicated. A Multinomial Logit regression analysis run on impacts of changing climatic conditions and weather patterns against gender indicated.

Parameter Estimates

Gender[a]		B	Std. error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower bound	Upper bound
Male	Intercept	-3.103	1.336	5.392	1	0.020			
	Temperature	0.360	.312	1.336	1	0.248	1.434	0.778	2.641
	[Rainfall=1.00]		1.779	1.149	2.397	1	0.122	5.923	0.623
	[Rainfall=2.00]		2.027	1.179	2.955	1	0.086	7.592	0.753
	[Rainfall=3.00]	0[b]	.	.	0	.	.	.	.

[a]The reference category is: Female. 56.302; [b]This parameter is set to zero because it is redundant. 76.578

Effect	Model fitting criteria	Likelihood ratio tests		
	-2 Log likelihood of reduced model	Chi-square	df	Sig.
Intercept	21.848[a]	0.000	0	.
Temperature	23.174	1.326	1	0.249
Rainfall	25.910	4.062	2	0.131

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Likelihood Ratio Tests; T-Test on paired samples

Paired samples correlations		N	Correlation	Sig.
Pair 1	Gender & 6.i) What is the household main source of livelihood?	147	-0.013	0.874
Pair 2	6. Education level & 2 (ii) Do this season determine the availability of food?	125	-0.061	0.500
Pair 3	6. Education level & 1.2 What is the main source of food for your family?	147	-0.057	0.489

Paired samples test	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Pair 1 Gender - 6.i) What is the household main source of livelihood?	.35374	.91264	.07527	.20498	.50251	4.699	146	.000
Pair 2 6. Education level - 2 (ii) Do this seasons determine the availability of food?	1.61600	1.00630	.09001	1.43785	1.79415	17.954	124	.000
Pair 3 6. Education level - 1.2 What is the main source of food for your family?	1.52381	1.02258	.08434	1.35712	1.69050	18.067	146	.000

The above statistics indicates significance correlations among the various variables tested; for example, there is a significance relationship between education level and main source of livelihood among the respondents ($p<0.05$) or rather less than 5%

Chi-Square tests

Gender * 2 (ii) Does this seasons determine the availability of food? Cross tabulation

			2 (ii) Does this seasons determine the availability of food?		Total
			Yes	No	
Gender	Male	Count	36	5	41
		Expected count	37.7	3.3	41.0
	Female	Count	79	5	84
		Expected count	77.3	6.7	84.0
Total		Count	115	10	125
		Expected count	115.0	10.0	125.0

Chi-square tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	1.459[a]	1	0.227		
Continuity correction[b]	.734	1	0.392		
Likelihood ratio	1.377	1	0.241		
Fisher's exact test				0.294	0.193
Linear-by-linear association	1.447	1	0.229		
No. of valid cases	125				

[a]1cells (25.0%) have expected count less than 5. The minimum expected count is 3.28. [b]Computed only for a 2x2 table. The results of the above Chi-square test indicate that gender is not significant on whether seasons determine food availability in the Kyawango catchment areas.

Source of livelihood and education level (Chi-Square test of correlation)

6.i. What is the household main source of livelihood? * 6. Education level cross tabulation

			6. Education level						Total
			Never been to school	Primary	Secondary	Tertiary/College	University	Informal	
6.i) What is the household main source of livelihood?	Farming	Count	8	50	46	12	1	1	118
		Expected count	7.2	48.2	44.1	14.4	2.4	1.6	118.0
	Daily wage labor	Count	1	9	4	0	0	1	15
		Expected count	0.9	6.1	5.6	1.8	0.3	0.2	15.0
	Business	Count	0	1	3	3	0	0	7
		Expected count	.4	2.9	2.6	0.9	0.1	0.1	7.0
	Employment	Count	0	0	2	3	2	0	7
		Expected count	.4	2.9	2.6	0.9	0.1	0.1	7.0
Total		Count	9	60	55	18	3	2	147
		Expected count	9.0	60.0	55.0	18.0	3.0	2.0	147.0

Chi-square tests	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	49.081[a]	15	0.000
Likelihood ratio	32.790	15	0.005
Linear-by-linear association	14.199	1	0.000
No. of valid cases	147		

[a]18 cells (75.0%) have expected count less than 5. The minimum expected count is 0.10. The chi-square test (above) to establish relationship between the source of livelihood (employment) and education level indicates that there is a significant relationship between education level and source of livelihood (form of employment). There is additionally no significant relationship between education level, age, sublocation and the increasing or decreasing whether patterns and climatic conditions (rainfall, wind intensity, famine, temperature, drought incidences) ($p>0.05$).