Agro-Pastoralists Viable Options towards Sustainable Climate Change Adaptation in West Pokot County, Kenya

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ABSTRACT

Climate change and variability is one of the most important developmental and environmental challenges on sustainable agricultural productions threatening small scale agro pastoral community livelihoods. This study examines how the agro pastoral community respond to the current and future weather and climate risks and recommend viable options towards sustainable climate change adaptation by small scale agro pastoralist community in West Pokot County, Kenya. The study adopted mixed research design combining both quantitative and qualitative data sources using stratified, purposive and random sampling techniques. Primary data was collected from a sample of 384 household heads and validated through focused group discussions (FGDs), key informant interviews (KIIs) and general observations. Data collected on perception to climate change were coded and analysed using descriptive and qualitative content analysis. The study found that the community have a thorough knowledge and understanding of their environment with perceptions revealing degradation of the available natural resources largely due to deforestation arising from agricultural land expansion. Drought, deforestation, landslides, floods and soil erosion are some of the major events adversely affect crop and livestock and contribute to vulnerability presently and in the future. The viable options recommended to reduce the present and improve future weather and climatic risks are awareness creation, tree planting, good agricultural practices, government support and agricultural insurance. The findings are key in guiding state and non-state actors together with the community in local level decision making for the conservation and restoration of degradation hotspots towards sustainable management of natural resources, resilience building, poverty reduction, food nutrition and livelihood security.

Keywords: Agro-Pastoralists, Sustainable Climate Change Adaptation, Viable Options, West Pokot

INTRODUCTION

The debate about climate change discourse is remarkably momentous and has been dynamic over the years. Climate change and variability is currently a global phenomenon that signifies major developmental and environmental challenges on sustainable agricultural production and livelihoods particularly in Sub Saharan Africa including Kenya. It is a reality and a huge threat to the people and communities living particularly in the Kenyan arid and semi-arid lands (ASALs) mainly attributed to over dependence on livelihood options that are sensitive to climate variability and change, reliance of natural resources, high rates of poverty, weak institutional capacity, and the low adaptive capacity to climate change impacts.

The ASALs being home to over 30 % of the Kenya population, and supporting more than 70 % of the livestock in the country and agro pastoralists, is recognized by the government under the Vision 2030 as an important and a potential driver for economic growth and development. It is worth noting that ASAL pastoralists and agro pastoralists, as well as policy makers, development and humanitarian partners are constantly searching for better ways of adapting to and mitigating the impacts of climate change. As efforts towards stabilizing the greenhouse gas emissions that consequently cause climate change continue, the

effects of climate change will still be experienced making adaptation and mitigation the only viable options in reducing the vulnerability to the impacts of climate change and global warming.

The concept of sustainable climate change adaptation is relatively new and is taking root and shape in informing the global development agenda in the nexus of policy makers, scientists and practitioners. The glamour for sustainable climate change adaptation in agriculture is increasingly being acknowledged and now urgently needed in the face of changing climate (Yang et al., 2020). The Intergovernmental Panel on Climate Change (IPCC) report of 2012 defines adaptation as "adjustments in human and natural systems, in response to actual or expected climate stimuli or their effects, that moderate harm or exploit beneficial opportunities." The adjustments could be in the form of response options which should be viable and appropriate to the changing climate currently and in the future. There are various adaptation options available grounded on diversified agricultural practices that are determined by cultural, demographic, economic, environmental and institutional factors. The climate change adaptation options/solutions adopted to address the socio economic and environmental factors should be sustainable in the sense of meeting the needs of the farming community without compromising the ability of the current or future generations to meet their needs.

West Pokot is one of the ASAL areas in the country that predominantly has a semi-arid climate. Semi-arid entails an agro ecological zone, which receives an average yearly rainfall of between 400 and 900 mm with an average monthly temperature surpassing 18 °C. The major source of livelihood is crop and livestock production and are likely to experience serious challenges. Climate variability exacerbates water shortage and soil moisture deficit in semi-arid areas. This study therefore intends to examine and recommend viable options towards sustainable climate change adaptation by small scale agro pastoralists in West Pokot County, Kenya.

METHODOLOGY

Study Area

The study area was the agro pastoral communities of West Pokot County (Figure 1). The area was chosen purposely due to the fragility of the environment being susceptible to variations in climatic conditions, and agro pastoralism as the main source of livelihood sustenance by the community, is adversely affected by climate variability and its extremes (droughts, floods and landslides). The county lies within longitudes 34° 47'and 35° 49' East and latitude 1° and 2° North and covers an area of approximately 9,123.2 km^2 (CGWP, 2013). From figure 1, the county is located in the North Rift along Kenya's Western boundary with Uganda border (CGWP, 2013) and it borders Turkana County to the North and North East, Trans Nzoia County to the South, Elgeyo Marakwet County and Baringo County to the South East and East respectively (CGWP, 2013).

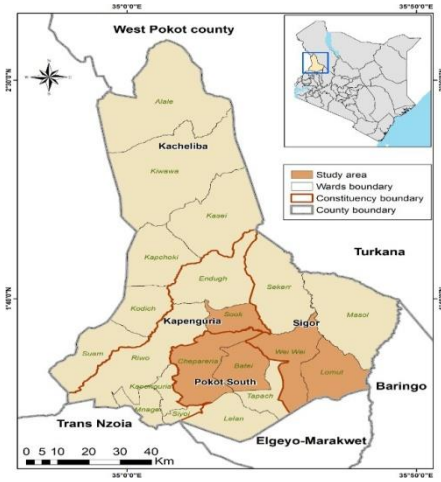

Figure 1: The Map of Agro Pastoral Community in West Pokot County

The county has majorly a semi-arid climate and two rainy seasons (Sombroek, et al., 1982; Jaetzold, et al., 2011). The long rains fall from March – July peaking in May and the short rains fall from September to early November. The annual rainfall varies from 500 to 1,600 mm being higher in the highlands than in the lowlands while for the annual mean temperatures range from 15.0 to 35.0 ?C in the lowlands and highlands respectively (Jaetzold et al., 2011; CGWP, 2013). The total population in the county was 621,241 persons (an average of 5.3 persons per household) growing at the rate of 5.2 % in comparison to the national average of 2.2 % as per the 2019 census (KPHC, 2019).

The county has three different agro ecological zones with variations in soils, rainfall amounts, temperature and the type of crops grown as well as livestock kept (CGWP, 2017). Agro ecological zone III, IV and V. Agro ecological zone III has a higher potential allowing production of various crops and livestock unlike zones IV and V mainly inhabited by the agro pastoralists and pastoralists and faced with crop and livestock production risks.

Research Design, Data Source, Sampling Procedure and Sample Size Determination

Mixed research design integrating both quantitative and qualitative forms of data collection (primary and secondary data sources) was employed. The quantitative and qualitative sources of primary data was assembled using household questionnaires, FGDs, KIIs and desktop literature review including published and unpublished national and county reports, refereed journals and on line resources were also collected.

The study employed stratified sampling. The county has twenty administrative ward units each representing a stratum. Only five administrative ward units (Batei, Chepareria, Lomut, Sook and Weiwei) representing the agro pastoral community were purposively considered for the study. The agro pastoral community has a population of 203,798 persons, 36,613 households and an area of 2,158.6 Km^2 (KPHC, 2019).
Proportionate stratified sampling was then used to assign the 36,613 households into the various agro ecological zones in the agro pastoral community. In each agro ecological zone, systematic random sampling was then employed where every third household was selected from the list of the population members.

A sample of small scale agro pastoralists was taken to represent the population of small scale agro pastoralists in the West Pokot County. Since the West Pokot County agro pastoral community has a target population of 36,613 households (KPHC, 2019), the sample size was determined using Krejcie & Morgan's (1970) formula (Equation 1). The formula is frequently used to calculate a sample size from a given finite population (P) such that the sample size was within plus or minus 0.05 of the population proportion with a 95 % level of confidence.

Where **S** = required sample size; $\mathbf{X^2}$ = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841); N = the population size; P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size) and d = the degree of accuracy expressed as a proportion (0.05). This gave **384** households as the sample size for the study.

The questionnaire consisted of an open and close ended questions and was administered to the 384 households to collect primary data. The data collected had information on household and socio economic characteristics, climate change perceptions, vulnerability and adaptation strategies. The study also employed Participatory Vulnerability Profiles (PVP) approach (Haan, Farmer, & Wheeler, 2001) targeting present vulnerabilities, current and future climate risk of present and future climatic variations and responses to reduce present vulnerability and improve resiliency to future risks.

Face to face interviews were carried out by nine trained research assistants aimed at reducing bias and errors while collecting data and acquainted with the research objectives and tools used and sourced from within the community using the structured questionnaires that had been pretested for validity. The questionnaire was programmed into Open Data Kit (ODK) platform and deployed on computers which allowed the utilization of in-built checks on data validity that restrict the entry and submission of data that does not meet the required criteria.

The data collected through the household questionnaire were further triangulated through FGDs, KIIs and general observations. Using a structured guide, a total of four FGDs, each consisting of 12 community members were carried out to get a balanced position of climate change situation in the targeted areas.

Data Analysis

Data collected on perception of small scale agro pastoral farmers to climate change through time were coded and analysed using descriptive and qualitative content analysis. The collected data was analysed by use of quantitative and qualitative techniques using Statistical Package for Social Scientists (SPSS V22). Frequency counts, means and percentages was calculated for all quantitative data and results presented using frequency distributed tables. Qualitative content analysis was used to analyse the qualitative data collected during the FGDs and KIIs. The transcriptions of the audio recordings were translated from Pokot/Kiswahili language into English. The transcriptions were studied repeatedly to develop an analysis structure. This basically involves constructing the emerging topics, categories, relationships, and conclusions drawn in line with the study objectives (Hsieh & Shannon, 2005). The results from FGD were illustrated by direct quotes and recounts particularly relevant experiences and the views of small scale agro pastoralists for authenticity (Newing, 2011).

RESULTS and DISCUSSION

Possible Causes of Perceived Changes in Climate Indicators

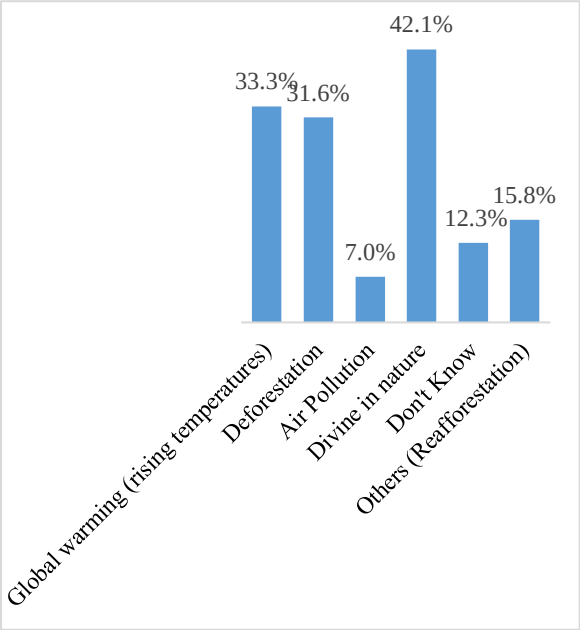

Figure 2: Household perceptions on the possible causes of changes in climate indicators

Figure 2 illustrates the possible causes of the perceived changes in climate indicators by the households. 33.3 % of the household attributed the cause to global warming (rising of temperatures), 31.6 % perceived the cause to deforestation, 7.0 % to air pollution, 41.2 % attributed the changes to being divine in nature, while 12.3 % didn't know and others (15.8 %) attributed the cause to reafforestation.

The results reveal that the households are aware about the causes of climate variability and change in the small scale agro pastoral community. The households associate climate variability and change with divinity (God's plan) and the activities of mankind such as deforestation, reafforestation, and air pollution that contribute to global warming. Similar results were reported by Recha et al., 2017 in a study conducted among the Tharaka people in the south eastern Kenya.

Changes in environmental conditions

The perception of the household on the condition of the environment (natural resources) in the agro pastoral community is presented in figure 3 below.

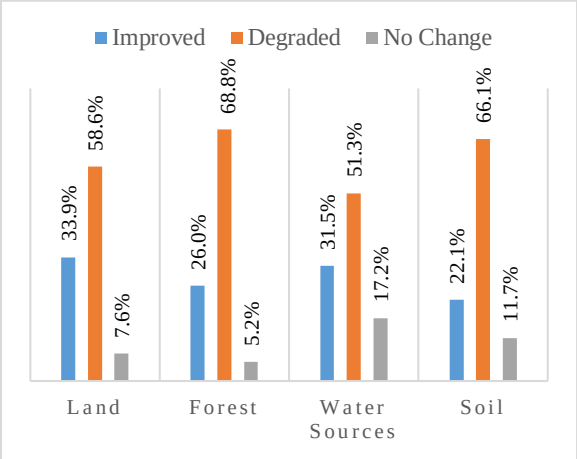

Figure 3: Household perception on the condition of the natural resources in the agro pastoral community

A majority of the households were able to discern that there is environmental degradation of the natural resources available in the community. The agro pastoral lands are fragile environments characterized by spatial and temporal rainfall variability with immense natural resources such as forests, water and soil. However, these natural resources are threatened by the ever rising human population and their increased economic activities (KPHC, 2019). This is attributed to the high demand for wood fuel and shelter in combination with unsustainable clearing of forest land and encroachment of water catchment areas for agricultural expansion, food production and other environmental services has led to land degradation thereby leading to soil and water erosion.

Most of the clearing of the trees in the agro pastoral community is observed to occur in farming pockets and steep slopes to access farm lands and water, along the roads for firewood and charcoal production, and along major rivers such as Muruny, Weiwei, Lomut, Kpas, Iyon and some other small permanent streams to enable irrigated agriculture. KIIs revealed that land has degraded, forest cover reduced due to encroachment and farm opening, water sources volume reduced and polluted and bare soil cover with minimal replenishment. FGD revealed that grasslands decreased as bushland increased, ‘‘In the past, there was an abundance of rains and wild animals including gazelles, antelopes, elephants, rhinos and buffaloes in our area. Moreover, scattered acacia bushland mainly acacia species including Acacia albida (‘Sangak’) A. tortilis (‘Ses’), A. elatior (‘Atat’), A. seyal (‘Ptari’), A. nilotica (‘Kopko’) and wood trees e.g. Balanites aegyptiaca (‘Tuyunwo’), Terminalia brownii (‘Koloswo’) and Ficus sycomorus (‘Mokongwo’) and pastures such as Hyperrheania hirsutum (‘Chaya’), Eragrotis superba commonly known as Maasai love grass (‘Chururkechirion’) and Cynodon plectostachyus (‘Seretion’) were available in plenty for our livestock. However, as population increased with time, pasture started to diminish as bushlands such as A. senegal (‘Panyarit’) and A. mellifera (‘Talamogh’) interspersed with Sanseveria ehrenbergii (‘Sorokit’) started to encroach with the most recent being Parthenium hysterophorus L. commonly known as carrot or bitter weed (‘Kerelmot’), an herb that is becoming invasively a nuisance causing allergies and making milk to test bitter’’. The results agree with the finding of Wasonga et al., 2003; Vehrs, 2016 among the Pokot pastoral communities in the ASALs. Moreover, P. hysterophorus L. is prolific weed invading new areas, disrupts environments, reduces agricultural and pasture production due to its allelopathic nature and affects human and livestock health (Patel, 2011; Adkins & Shabbir, 2014; Tabe Ojong et al., 2022).

The consequential effects are shortage of water and loss of productive agricultural land and forests threatening biodiversity, food security and livelihoods of small scale agro pastoral systems. In addition, it leads to increased release of large quantities of greenhouse gases such as carbon dioxide, methane, and nitrous oxide into the atmosphere thereby contributing to global warming.

The results agree with the findings that unsustainable human activities such as deforestation, land use change, pollution and the use of fossil fuels are the main drivers of climate variability and change (IPCC, 2014; Petersen et al., 2021; Rotich & Ojwang, 2021). Globally, food production accounts for 70% of fresh water consumption, 80% of deforestation, 30% of GHG emissions and the largest/greatest driver for biodiversity loss (IPCC, 2019). All these activities are responsible for elevated greenhouse gases (GHGs) that are responsible changes in the global climate system.

Community Vulnerability to Disasters/Hazards

With regard to community vulnerability to disasters/hazards, a small proportion, 22.7 % of the households opined that the community is vulnerable to disasters/hazards (figure 4). This essentially means that community awareness of disasters and hazards is still very low.

Vulnerability entails the tendency or predisposition to be adversely affected. Vulnerability to climate change is considered high due to social, economic and environmental conditions that amplify tendency to negative impacts and contribute to low adaptive capacity to climate hazards.

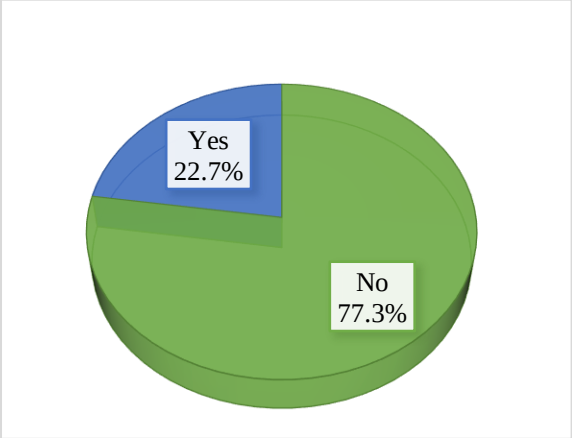

Figure 4: Household perception on vulnerability to disasters/hazards in the agro-pastoral community

The major events that contribute to community vulnerability as perceived by the household are drought (32.2 %), deforestation (18.4 %), landslide (17.2 %), floods (16.1 %) and to some extent soil erosion (5.7 %), high temperatures (3.4 %) and heavy rainfall (2.3 %). Other events are cultivating steep slopes, farming along river banks, livestock deaths and variable rainfall patterns each having 1.1 % (Figure 5).

The results are consistent with KIIs which indicated that droughts leading to crop/pasture failure and livestock migration and landslides leading to environmental degradation, loss of property, lives and livelihoods are the major events making the community to be vulnerable to disasters and hazards. Furthermore, the results agree with Kerelwa FGDs that revealed ‘‘Unlike in the past, rainfall in this area has reduced due to cutting down of trees. This has not only resulted to encroachment of forested, hilly and riparian areas as new cultivation lands are opened up but also caused erosion and/or landslides specifically in Koporoch and Kapkeser, destroying riverbanks and farm lands when it rains.

Furthermore, conservation (terracing) is no more caused by lack of enforcement of the Agriculture Act by the relevant government bodies as farmers don’t observe the regulation on land use e.g. river bank pegging’’

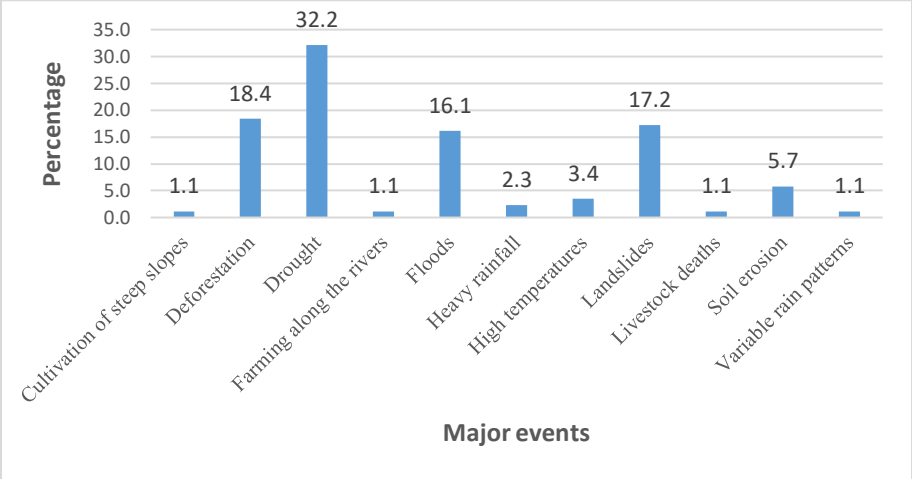

Figure 5: Household perception on major events that contribute to vulnerability in the agro pastoral community

This fundamentally means that the households are exposed to hazards associated with climate change and are most at risk to the adverse impacts of climate variability and change. The livelihood strategies for small scale agro pastoralists are grounded on crop farming and livestock rearing. Crop farming and livestock rearing are amongst the worst hit by climate variability through recurrent extreme events. Drought and flood events are frequent hazards reported by the households and are adversely impacting the scarce resources particularly pasture and water and the household livelihoods subsequently intensifying conflicts, insecurity and food insecurity. Extreme events such as drought and flood are already affecting communities in the ASAL areas increasing vulnerability among small scale agro pastoralists that rely upon climate conditions (Silvestri et al., 2012).

Deforestation is the other important major event reported by the households. It is the reduction or the loss of surface vegetative cover to other uses such as agricultural croplands and grasslands, settlement and mining activities (Rotich & Ojwang, 2021). Deforestation is greatly accelerated by anthropogenic activities threatening biodiversity that is declining at an alarming rate through mismanagement and inappropriate habitat conversion leading to loss of species (Petersen et al., 2021). This will not only disrupt the lives and livelihoods of the household and communities depending on forests as a resource for survival and agricultural purposes but also accelerate the conversion of forest land for agriculture increasing the risk of soil erosion. Soil erosion is also caused by water and wind, nutrient mining and rearing large number of animals leading to overgrazing. Deforestation for food can lead to low agricultural yields and food insecurity in the long run and consequently contributes to climate change through carbon emissions. Deforestation and forest degradation is responsible for 15% of all the greenhouse gas emissions contributing to increasing temperatures, changes in the patterns of weather and water and an increased frequency of extreme weather events.

Soil erosion is the other significant major event already taking root in the community as reported by the households. It is a serious problem that is peaking and emanates from the current agricultural practices employed by small scale agro pastoralists that leave the land soil bare. This is attributed to the slash and burn cultivation as small scale agro pastoralists expand into marginal areas that are highly vulnerable to erosion, the intensive cultivation of steep slopes and overgrazing leading further to land degradation to the extent that some of the land is abandoned due to high loss of fertile soils. The culminating effect is the continuous decline in the productivity of the soil further aggravating land degradation particularly in the face of changing climatic variations, the continued rise in population and diminishing sizes of the land coupled with the need to produce adequate food to feed the burgeoning population.

Lastly the other significant major event taking place in the community as reported by the households is landslides. It is increasingly occurring through the downward mass movement of rocks, debris or earth resulting to countless losses and damages to humans, agricultural land, crops and livestock, and critical infrastructure such as roads, bridges, power lines and market structures (Gichaba et al., 2013). It is caused by rainfall that saturates the land in addition to the unsustainable human activities including the communal

land tenure, deforestation, land fragmentation leading to land degradation driven largely by the high population pressure.

All these major events have a negative impact on the local ecosystems increasing the risk of land degradation and biodiversity loss. Climate change also will affect the length of growing seasons, and crop and livestock yields, and bring about increased risk of food shortages, insecurity, and pest and disease incidence, putting populations at greater health and livelihood risks.

Household Risks of the Future Climatic Variations

When asked about the risks of the future climatic variations (figure 6), it is apparent that deforestation (15.6 %), soil erosion (12.0 %, landslide (11.5 %) and food shortage (10.7 %) are serious household risks arising out of the future climatic variations (Figure 6). The other risks are drought (7.6 %), floods (6.8 %), varied agricultural production (5.7 %), no risks (5.2 %), drought and famine (4.7 %) and high temperatures (4.2 %), changes in rainfall amounts and patterns (2.9 %), famine (2.9 %) and those that don't know (2.9 %). The remaining risks were migration (1.6 %), shortage of water and loss of income (each 1.3 %), crop failure, livestock deaths and outbreak of diseases (each 1.0 %) and 0.3 % talked of risks of divine in nature (figure 6).

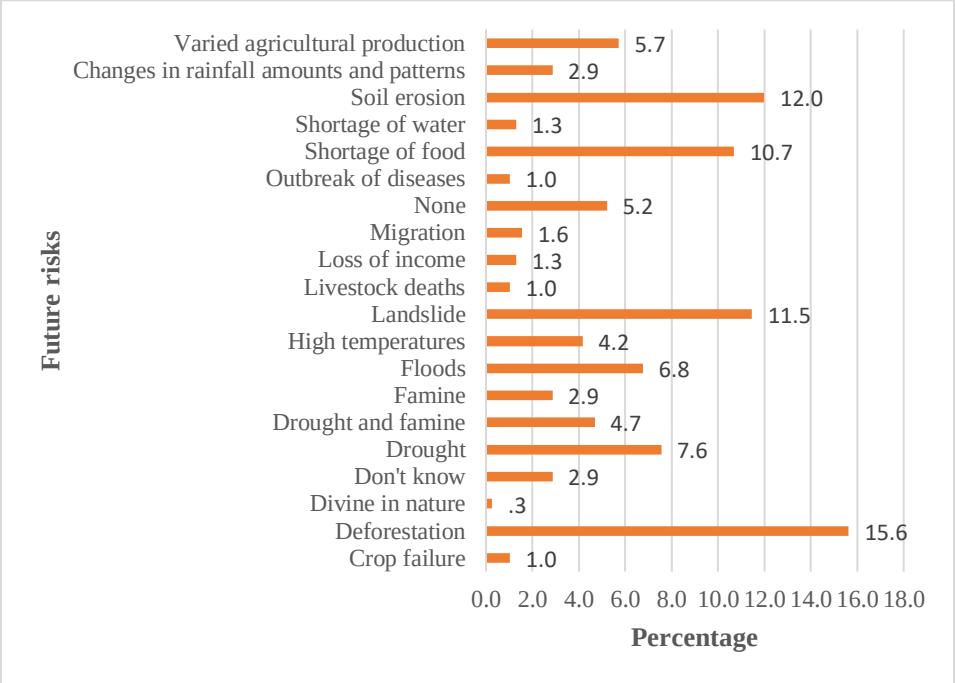

Figure 6: Household perception on the risks of future climate variations in the agro pastoral community

Household/Community Responses to Reduce Present Weather and Climate Risks

From figure 7, majority of the household responses to reduce present weather and climate risks are varied, with the major responses being tree planting (36.7 %), none (13.8 %), preservation of trees (8.3 %), alternative livelihoods (7.3 %), awareness creation on environmental conservation (5.5 %), planting early maturing and drought tolerant crop varieties (3.9 %), irrigation (3.4 %), soil and water conservation measures such as gabions, terraces, retention ditches and sisal planting (3.1 %), buying of food (2.9 %), reafforestation (2.3 %), migration (2.3 %) and avoid crossing flooded rivers (1.3 %). The other responses are praying to God (1.0 %), mixed farming i.e. growing of crops and keeping of livestock (1.0 %), livestock vaccination (0.8 %), and preservation of food (0.8 %). The results are consistent with KIIs where soil conservation measures, tree planting, drought tolerant crops and livestock resilient breeds, irrigation, water harvesting and input subsidy are some of the previous and current deliberate measures promoted to curb climate variability and change while crop and livestock insurance is a planned measure towards addressing climate variability and change.

Field observations revealed that the most common trees planted along land boundaries as live hedges by the households are Euphorbia tirucalli, Cassia siamea, Croton megalocarpus and Grevillea robusta. The other

important trees are the fruits such as Mangifera indica (Mangoes), Carica papaya (Pawpaws), Citrus sinensis (Oranges) and Persea americana (Avocado) which are planted by the small scale agro pastoralists. The fruit trees together with indigenous fruit trees such as Tamarindus indica L. enables the household and the community at large access fruits throughout the year and are a major source of vitamins and minerals. The trees preserved are Acacia spp, and Balanites aegyptiaca ('Tuyunwo'). This not only provides rich and nutritious forage for livestock through selective cutting of tree branches but also a platform to preserve maize stovers harvested for use during the dry season.

The households also response to the present weather and climate risks through alternative livelihoods (Table 1). This is through small scale businesses such as retail shops, hotels and maize grain stores mainly in trading centres; salaried and wage employment providing labour farm and construction activities; charcoal burning; and artisanal activities such as masonry, welding and plumbing. The other activities include government cash transfer programmes e.g. for the old members, gold mining and boda boda riding.

Planting of early maturing and drought tolerant crops is the other response practiced by the households. This includes the planting of maize varieties suitable and adapted to the various agro ecological zones such as maize varieties such as H624, H614, H513, H520 and H6213 mainly as seed purchased and also seed input subsidy from the County Government of West Pokot as confirmed from the FGD; bean varieties e.g. Kat B9, Nyota and Rosecoco; and sorghum varieties such as Gadam, Seredo, Serena and Kari Mtama 1 mainly as seed input grants from the County Government of West Pokot as confirmed from the KIIs. Crops such as maize, sorghum, beans and finger millet have the same seasonal calendar where it is planted during the long rains while crops such as green grams, bulb onions, tomatoes, vegetables (cowpeas, kales and manage) and watermelon are grown mainly during the short rains using irrigation water.

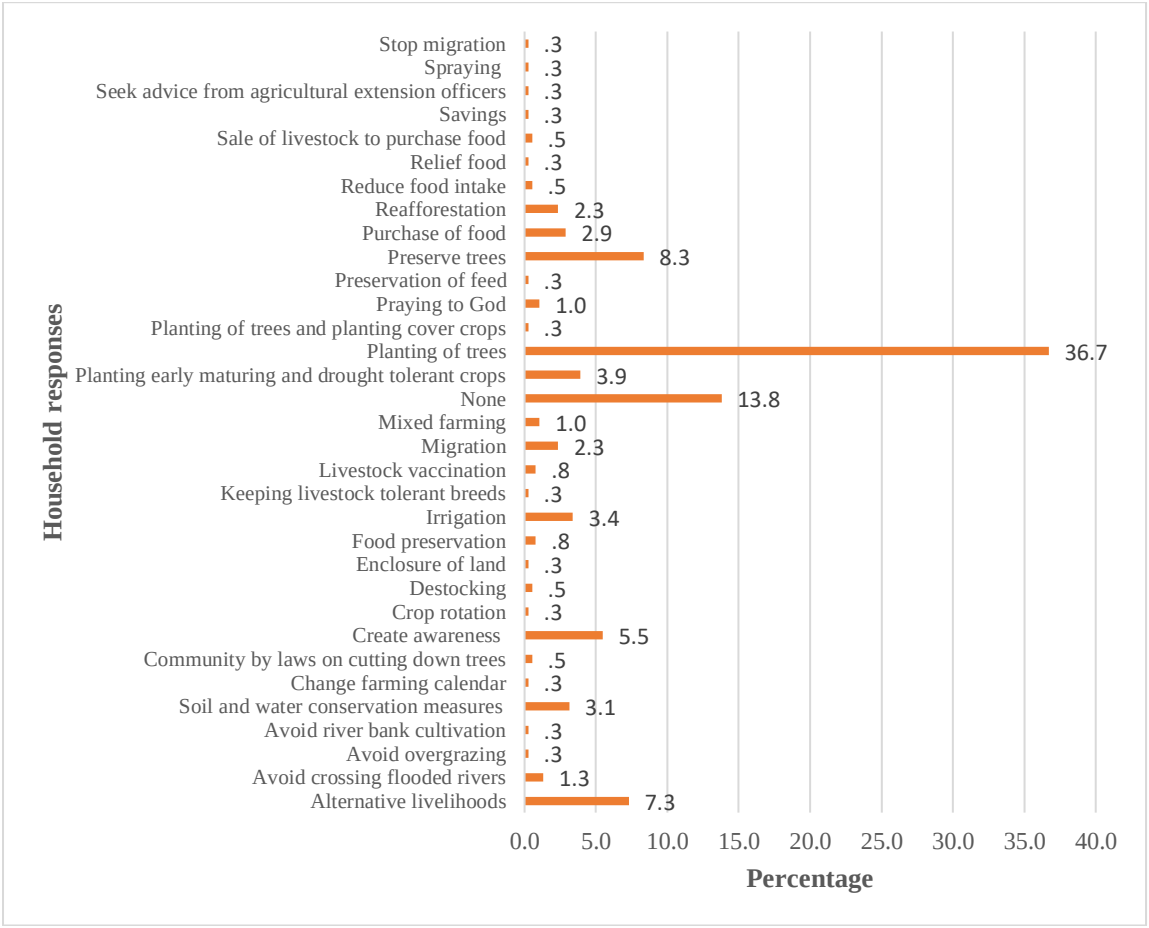

Figure 7: Household perception on the response to reduce present weather and climate risks in the agro pastoral community

The livestock tolerant breeds kept include Galla goats, Dorper sheep, Sahiwal, camels and improved indigenous chicken such as Rainbow rooster as they are hardy and can resist drought. Furthermore, migration of cattle in search of water and pastures normally starts early in the month of November andreturns back during the month of April when rains start as elucidated during Weiwei and Lomut FGDs.

Moreover, KIIs revealed that already the agro pastoral community is seeking the support of the County Government of West Pokot and other development partners in terms of timely provision of inputs such as locally adapted crop seed varieties (Maize e.g. Sungura, DH04, Duma and Tosheka varieties; beans; green grams; pawpaws; vegetables and high value crop seeds e.g. water melons, tomatoes and bulb onions) and locally adapted livestock breeds (e.g. Galla goats, Dorper sheep, Sahiwal and camels). The other equally important support is subsidized mechanized farming, generators for pumping water and pipes for delivering water to the farms; tree nursery establishment and management.

Household/Community Response Improvement to Future Weather and Climate Risk

Figure 8 shows the perceptions of the households on how to improve responses to future weather and climate risks in the agro pastoral community. The findings indicated that awareness creation (27.3 %), followed by planting of trees (23.4 %), adopting good agricultural practices (10.2 %), diversification of livelihoods (7.0 %), seek government support (6.0 %), irrigation (5.2 %) and adoption of soil and water conservation measures (4.9 %) are some of the most important responses that the households will adopt to improve their responses to future weather and climate risks in the agro pastoral community.

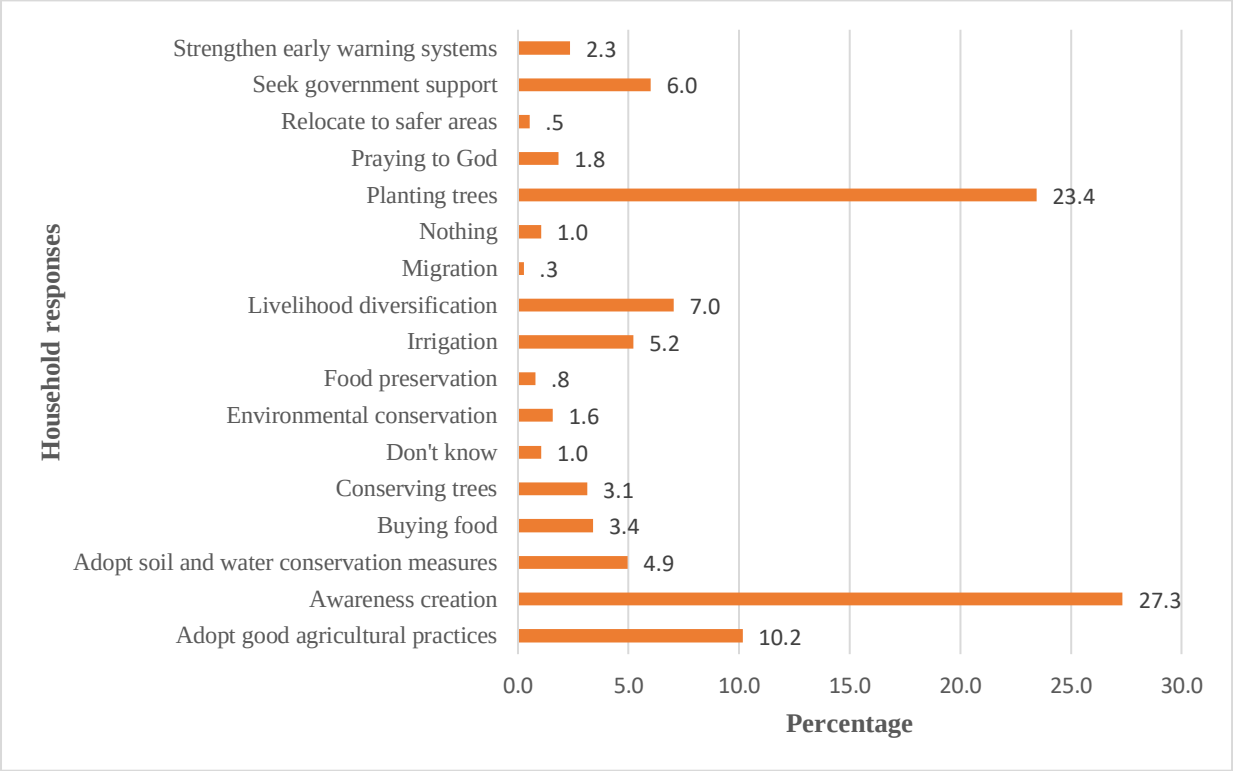

Figure 8: Household perception on the response improvement to future weather and climate risks in the agro pastoral community

VIABLE OPTIONS RECOMMENDED to REDUCE PRESENT and IMPROVE FUTURE WEATHER and CLIMATE RISKS for SUSTAINABLE CLIMATE CHANGE ADAPTATION

From the foregoing examination of the results on household perception on the response to reduce present and improve future weather and climate risks, the following current coping mechanisms, adaptation and mitigation options are recommended for adoption by the small scale agro pastoralists are discussed here below: –

Awareness Creation

Creating awareness in the agro pastoral community can reduce the negative changes emanating from the way the individual small scale agro pastoral farmers utilize their land and its resources (Figures 7 and 8). To

curb rampant land degradation and enhance environmental protection, there is need to continuously sensitize the community on issues of land degradation and how to tackle it. This calls for continuous improvement of the capacity of the small scale agro pastoralists as the users of the land with agricultural innovations and climate information through education and extension as well as improving their access to financial and social capital to enhance uptake of sustainable land management practices. In addition, since virtually all the households use firewood as the main cooking fuel as it is readily available, there is need to sensitize the community on energy efficient technologies such as improved cooking stoves, improved earth kilns for charcoal production and alternative energy sources like solar power and charcoal briquettes.

According to Cherotich et al., 2012, the other way of creating awareness and providing early warning systems is through climate information services (CIS). CIS entails the various ways in which climate information is availed to and utilized by the small scale agro pastoral communities in different timescales to manage risks associated with climate variability and change as well as protecting lives, properties, livelihoods and ensure attainment of food security. This can be achieved by integrating both scientific climate forecasts and traditional weather forecast to enhance the utilization of scientific seasonal climate forecasts (Ochieng et al., 2017).

Traditional weather forecast is attributed to indigenous or local knowledge that is acquired, accumulated and produced by individuals, communities and societies through continuous interactions with their environment over generations and centuries in their quest for livelihood sustenance particularly agriculture, natural resource management, medicine and management of climatic hazards (Ochieng et al., 2017; Kniveton, et al., 2015).

Focused group discussants in all the sites visited revealed that the community is aware of indigenous knowledge of weather forecasting and scientific seasonal climate forecasting. The small scale agro pastoralists use various indigenous strategies of weather forecasting such as wind direction, fire/smoke direction (‘Simar song sung’), gazing at stars, observation of goat (Capra aegagrus hircus L.) intestines (‘Kwanyan’), sound made by birds e.g. ground hornedbill – Bucorvus abyssinicus (‘Rindu/Wututu’) and animals e.g. rock hyrax – Procavia cavensis P. (‘Kener’) indicates rain while observation of animal behavior e.g. Crow (Corvus corax L.) building its nest on an open area indicates no rain and vice versa), in addition to getting seasonal climate forecasts from the Kenya Meteorological Department mainly through the vernacular radio,

CIS describes the scientific weather and climate forecasts at lead times from daily to seasonal forecasts and climate projections decades ahead. According to Muema et al., 2018; the delivery of CIS is largely carried out by public and private institutions with the Kenya Meteorological Department (KMD) being the national custodian for gathering and storing climate data and managing the provision of climate information. The channels for disseminating CIS exists ranging from mass (radio and television) and print media (newspapers and magazines) to the use of mobiles and information and communication technology. However, the channels advocated for and have high positive impacts in making agricultural decisions are those that broadcast through the local radio stations using the vernacular language, use of mobile phones to receive forecasts and increasing the frequency of sharing the information. At the same time, informal networks particularly the farmer groups, Savings and Internal Lending Committees in addition to the existing agricultural extension workers plays a vital role in dissemination of the forecasts. Traditional weather forecasts come in handy in those areas that are not easily accessible by channels (Onyango et al., 2014).

While access to and utilization of CIS in the Kenyan ASALs including West Pokot is still insufficient attributed to trust and reliability issues (Muema et al., 2018), the relevance of CIS in developing sustainable climate change adaptation is growing and the importance of the small scale agro pastoralists as the end users is at the heartbeat of CIS (Apgar, et al., 2017). Furthermore, climate change information must be accurate, reliable, timely, trusted, understandable and usable for small scale agro pastoralists to utilize it for climate change adaptation (Mudombi & Nhamo, 2014; Muema et al., 2018).

CIS has the ability to allow various pastoralists and agro pastoralists to access, use and learn as new and existing climate information is used over time to adapt their agriculture to the ongoing uncertainty that restraint making of choices in the farm against risks (Muema et al., 2018).

Tree Planting

This entails planting heterogeneous trees or shrubs among crops or pastureland to offer, diversify and sustain social, economic and environmental benefits such as increased biodiversity, enhanced soil structure and health, improved yields of staple food crops and livestock leading to enhanced generation of incomes and livelihoods for poverty alleviation by small scale agro pastoralists. Trees can be planted in areas that did not have (afforestation) or in degraded areas (reafforestation) to provide a wide variety of helpful and profitable products such as fruits (mangoes – Mangifera indica and pawpaws – Carica papaya,), medicines and wood (Figures 7 and 8). This is critical in increasing the income levels as small scale agro pastoralists access profitable market products in addition to curbing deforestation and land degradation. Tree planting provides opportunistic enterprises such as tree nurseries, timber production, fruits, fodder and fuelwood for sale. Planting trees are key in carbon sequestration and storage (Wamuongo et al., 2015), and triggers payment for ecosystem services through the sale of carbon credits which are a potential source of income streams by small scale agro pastoralists diversifying their agricultural activities and mitigating against climate change through reduction of greenhouse gas emissions in the atmosphere that would otherwise contribute to global warming (Kagombe et al., 2018).

Trees together with groundcover such as grasses are beneficial in protecting the soil against erosion by stabilizing the ground thereby restoring the land in addition to increasing the water retention capacity of the land and improving the water quality that is beneficial to agricultural production (IPCC, 2012). Trees can be increased in agricultural farmlands to supplement wood fuel through wood production and enhance sustainability (Githiomi & Oduor, 2012). Moreover, nitrogen fixing trees such as acacia species and legumes (Calliandra calothyrsus, Leucaena trichandra and Leucaena pallida) have positive effects on soil fertility and the sustainability of small scale agricultural production. They not only restore soil nitrogen fertility making it available for agricultural crops but improves the physical soil properties and increases the soil carbon content as well. They also increase livestock fodder leading to improved food and nutrition security, crop diversity and resilience to weather shocks for food crops.

Furthermore, with regard to rainfed agriculture that is majorly practiced and threatened by climate variability and change, tree planting can play a vital role in buffering small scale agro pastoralists against climate extremes through protecting water catchment areas while conserving the array of biodiversity and sequestration and storage of carbon that ultimately affect food and nutritional security.

In consideration of the small scale agro pastoralists with limited resource endowment, tree planting is regarded as a low cost practice to replenish soil fertility that is technically possible and socially acceptable. Over the long run, to reverse the low soil productivity brought about by the continuous cultivation of crops with little or no application of inorganic fertilizers, promotion of tree plantingy to reduce soil erosion, fight land degradation and improve soil fertility is equally important and sustainable. This will not only be beneficial to women to access fuelwood, fodder, vegetables and herbs but also dedicate the time saved in productive activities in the farm. It is therefore critical that reduction of emissions and restoration of tree cover is the most effective sustainable climate change solution to achieve the current target of 10 % tree cover in small scale farms.

Livelihood Diversification

Diversification of the available sources of livelihood is one of the feasible ways to respond to the effects brought by climate variability and change including competition over scarce resources and conflicts and

rising population pressure (Table 1, Figures 7 and 8). Farming is one of the major activities and a livelihood strategy for the majority of the small scale agro pastoralists. Rainfed agriculture is still the dominant kind of agriculture practiced thus exposure of farming to the vagaries of climate variability and change have far reaching effects to the livelihoods of the small scale agro pastoralists, as changes in climate have adverse impacts on food production, water availability, human health, natural resources and the environment. Small scale farmers have been shown to diversify their livelihood strategies from reliance on farming activities to off farm activities to generate incomes. More diversified livelihood strategies can lead to enhanced incomes and spreading the risks for small scale agro pastoralists. This is vitally important in the management of the current and future climate risks by the small scale agro pastoralists.

Good Agricultural Practices

This are practices that allow more efficient use of natural resources, mitigate the impact of agriculture on environment and strengthen capacity for adaptation to climate variability and change (Figures 7 and 8). This practices include crop management, livestock management and land management practices.

Crop Management Practices:

This is one of the most common strategies that can be used by small scale agro pastoralists to respond to climate variability and change. The strategies include the adoption and growing of diverse early maturing and drought tolerant crop varieties to increase yields such as maize, beans, cowpeas, finger millet, sorghum, green grams, tomatoes, water melons, bulb onions, vegetables, mangoes and pawpaws etc. The other strategies are diversification of crops in the face of uncertainty specifically incidence of pest and disease pressures; use of kitchen gardening to utilize the scarce water resources in improving household nutrition. The other important agricultural practices are avoiding river bank and steep slopes cultivation. Furthermore, there is need to intensify agriculture in the previously cleared land to stop the current extensive cultivation and reduce further conversion of forest land in search of fertile soils. This can be achieved through acquisition of inputs such as certified seeds, fertilizers and irrigation kits.

Livestock Management Practices:

These include practices such as the adoption of improved and climate resilient livestock breeds to increase livestock production e.g. Sahiwal, Boran, Galla goats, Dorper Sheep, improved indigenous chicken and camels. Destocking to avoid over grazing, land enclosures to allow regeneration of pastures, crop and livestock grazing rotation to relieve pressure on arable land. Forage establishment and conservation through hay and silage making, use and management of crop residues and supplementary feeding.

Land Management Practices:

Inadequate water supply is the major limiting factor of livelihoods particularly by small scale agro pastoralists in the ASALs of Africa including Kenya. The low rainfall status is made worse by losses due to surface run-off and the heavily degraded environment with least vegetative cover. During the rains, a lot of water is lost as run-off, percolation is minimal because of environmental degradation. It is therefore important to manage the land by constructing soil and water conservation structures to protect the soil and harvest this water for use during the dry periods for both domestic and irrigation. This can be achieved by constructing such structures such water retention ditches, terraces, gabions, negarims, trapezoidal bunds and water pans.

Furthermore, in addition to the relatively few soil and water conservation structures in place, there is need to train the local community on soil and water management technologies for adoption in areas already cleared for cultivation to stop further agricultural expansion and environmental degradation. Despite being capital and labour intensive during construction and maintenance, soil and water conservation is most effective in

curbing persistent soil erosion, improving the fertility of the soil and managing the overall productivity of the land.

The other land management practice is irrigation. It involves the application of controlled amounts of water to plants at needed times. This is coming against the backdrop of agriculture being mainly rainfed increasing the vulnerability of the small scale production systems to the vagaries of climate variability and change. Despite the importance of irrigation to the county's economy, the area under irrigation is still very low which is currently about 2,000 hectares and the existence of a huge potential of 10,000 hectares, majority of the small scale agro pastoralists practice canal and furrow irrigation, extracting water from rivers and streams particularly in Pokot Central and the lowlands of Pokot South Sub Counties. However, canal/furrow irrigation is wasteful as it is prone to seepage and evaporation losses in addition to being unsustainable over the long run.

The glamour for shifting from canal to pressurized irrigation such as sprinkler irrigation is already peaking up notwithstanding the acquisition costs and in consideration of sustainable use of the limited water resources. This is attributed to being highly efficient i.e. ensures no water losses, suitability in germinating many crops, ease of operation with minimal labour requirements, ensures relatively high and uniform water distribution, and is not sensitive to clogging as it is used with water of bad physical quality prevalent in the ASALs. Furthermore, irrigation eliminates dependence of crops on rain and assures production of various high value crops such as bulb onions, tomatoes, water melons, green grams, and beans etc., and their sustainability to accessible markets.

In the face of increased climate variability and change, the demand for irrigation water may exceed supply or the control over the access and allocation of water arises leading to water conflicts calling for continuous creation awareness of the small scale agro pastoralists on water catchment protection and farm water management to sustainably and efficiently utilize the available water resources.

Government Support

The unsustainable exploitation of land and water resources is the major cause of environmental degradation and a potential source of conflicts among the various resource users in the agro pastoral community (Figures 7 and 8). KIIs highlights lack of knowledge and skills on appropriate technologies to adopt, high costs of inputs, land tenure and inadequate market access and value addition as some of the challenges small scale agro pastoralists face in trying to attain sustainable climate change adaptation. To address such local community challenges associated with the exploitation of resources, it is imperative that the relevant and available stakeholders (national and county governments, private, civil society organizations, community) in natural resource management create synergies to address the identified challenges. KIIs highlights resource mobilization, capacity building, multidimensional approach to mainstreaming climate change issues and domestication of the relevant policies as some of the mechanisms that ought to be in place for sustainable climate change adaptation. This calls for natural resource management stakeholders to inclusively come together and collectively participate in the judicious use and conservation of the natural resources to ensure attainment of livelihood, food and nutrition security and reduction of poverty. This can only be achieved through focused coordination and implementation.

The coordination and linkages among the sectors concerned is weak and inadequate to support effective decision making calling for strengthening of the existing national and local institutions to support the adaptive capacity of the small scale agro pastoral community specifically in agricultural extension and information dissemination to adapt practices to local circumstances; provision of reliable, timely and equitable access to inputs in support of resource use efficiency; agricultural practices that generate positive spillover benefits; and comprehensive climate risk management strategies to manage extreme weather events. Furthermore, discussions among the various stakeholders in support of improved governance of tenure systems for land and water that consider women, poor and marginalized groups are potentially important and may result in the proper utilization and minimizing the expansion of agricultural land.

Policies and laws related to agricultural, environmental and climate change should be reviewed, updated and/or developed in an all-inclusive, consultative and participatory manner. There is also need for the local government to systematically strategize, plan and undertake capacity building to reduce the risk of disasters from climate change and enhance the resilience of agro pastoral communities to increasing extreme events such as droughts, floods and landslides. To reduce land degradation, policy interventions and well-grounded traditional rules that intensify the access and prudent management of the natural resources that are largely vital as a livelihood strategy are equally important.

Through public private partnerships, the government could facilitate alternative investments in agricultural water development in the catchment through groundwater abstraction and rainwater storage management. Moreover, the county and national efforts can be supported by international assistance to support climate change adaptation and mitigation for sustainable development, increased capacity building, development/transfer of technology, and sufficient/sustained public sector funding.

Agricultural Insurance

Agricultural insurance is a tool that can be used to manage climate related shocks arising from the unpredictable weather and changing climatic conditions. This can be achieved through risk transfer or spreading risk to foster agricultural investment and enhance community resilience against climatic shocks. In Kenya, agricultural insurance has been demonstrated with varying successes and challenges. The pre and post-independence Guaranteed Minimum Returns provided linkages to credit, insurance and marketing services; the indemnity based agricultural insurance of the early 2000 that locked out many small scale farmers to access agricultural insurance and the recently index based weather insurance that is a promising innovation that could be beneficial in terms of poverty reduction and invest agriculture for the future (Njue et al., 2018). Despite the efforts made to promote insurance, its uptake is still very low attributed to small scale agro pastoralist' perception, affordability and inaccessible insurance services (Njue et al., 2018). However, participatory farmer led approach to insurance can be the key in designing insurance products that consider the socio economic conditions of the small scale agro pastoralists and targeting economically viable enterprises to enhance acceptance and uptake (Njue et al., 2018).

CONCLUSION

It is evident that the households have a thorough knowledge and understanding of their environment. Household perceptions reveal that there is environmental degradation of the available natural resources such as land, soil, water and forests. This is attributed to deforestation associated mostly with agricultural land expansion. Drought, deforestation, landslides, floods and soil erosion are the major events increasingly perceived by the households that adversely affect crop and livestock thereby contribute to vulnerability both currently and in the future. The viable options recommended for adoption by the small scale agro pastoral community include awareness creation, tree planting, livelihood diversification, good agricultural practices, government support and agricultural insurance.

The study helps to examine the linkages between changes in environment and livelihoods, context specific adaptation strategies. The findings are relevant in guiding state and non-state actors together with the community in conservation and restoration of degradation hotspots towards sustainable management of agro pastoral ecosystems. This body of indigenous technical knowledge could form the basis for local level decision making pertaining to natural resource management, food nutrition and livelihood security.

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Table 1: The kind of agriculture, source of income, farming type and off-farm activities practiced by the household

Variable	Response	Percentage
Kind of agriculture practiced	Rainfed agriculture	77.6 %
	Both rainfed and irrigated	19.8 %
	Irrigated	2.6 %
Source of income	Farming	59.4 %
	Off-farm	40.6 %
Type of farming practiced	Crop and livestock farming	53.9 %
	Crop farming	39.5 %
	Livestock farming	6.6 %
Off-farm activities practiced	Small scale businesses	34.0 %
	Salaried/fixed employment	32.1 %
	Casual labour	18.6 %
	Mixed	3.2 %
	Charcoal burning	3.2 %
	Artisan	1.3 %
	Others	7.7 %