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## **The Agro-pastoralists' Coping and Innovative Mitigation Approaches to Impact of Climate Change in Arumeru District – Tanzania**

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### **Abstract:**

*The study investigated the agro – pastoralists' coping and innovative mitigation approaches to impact of climate change in Arumeru District. Data were collected using several methods. The methods were the household survey, Focus Group Discussion, interviews and field visits. The results indicate that the major revealed approaches used by agro-pastoralists in Arumeru District include; savings of money, feeds and food, the use of supplementary feeds, afforestation (planting of trees), dam construction, poultry production, livelihood diversification, the use of intercropping approach, building of strong houses, application of by-law, creation of awareness through education, the use of bottom – up participatory approach and use of fodder grasses and tree legumes approaches.*

**Keywords:** *Agro-pastoralists, Arumeru district, approaches, coping, mitigation, climate change impacts.*

### **1. Introduction**

Climate change is an issue of great importance for human rights, public health, and social equity because of its profound consequences and its potentially disproportionate impact on vulnerable and socially marginalized populations (Thomas, 2005; Joseph, 2017). Community vulnerability to climate change is determined by its ability to anticipate, cope with, resist, and recover from the impact of major weather events (Meena, *et al.*, 2006; Joseph and Kaswamila, 2017). Without proactive measures and investigations, climate change will likely reinforce and amplify current, as well as future socio-economic disparities, thereby leaving minority and low-income groups with fewer economic opportunities; and, additionally, health burdens and social conflicts on agro - pastoralists's livelihoods (Adger *et al.*, 2003; Joseph and Kaswamila, 2017). Whatever the effects of climate change will be (sea-level rise, increased floods, drought, disease), the most vulnerable groups will be the poor who depend on nature and whose ability to withstand against environmental shocks and stresses to their livelihoods is low (Adger *et al.*, 2003; Thomas, 2005). In this context, adaptation and mitigation is inevitable to address the impacts of climate change but coping efforts are impeded in many ways. Therefore, the objective of this study was to investigate the agro- pastoralists' coping and innovative mitigation approaches to impacts of climate change in Arumeru District found in northern Tanzania.

### **2. Materials and Methods**

#### **2.1. The Study Area**

The study was carried out in three villages, viz: King'ori, Ngongongare, Mbuguni, and Kisimiri Juu which are administratively in Arumeru District (See Fig. 1). Arumeru District is located between longitudes 35° 37' and 35° 47' East and latitudes 3° 17' to 3° 27' South. It borders Simanjiro District to the east, Hai District to the north-west, Kiteto District to the south, and Monduli District to the north. Mbuguni as one of the studied is found at 3° 34' 0" South, 36° 57' 0" East and King'ori is at 3° 17' 0" South, 36° 59' 0" East, while Ngongongare is located at 3°18'S and 36° 51' E is found in the east part of the District (Joseph, 2017).

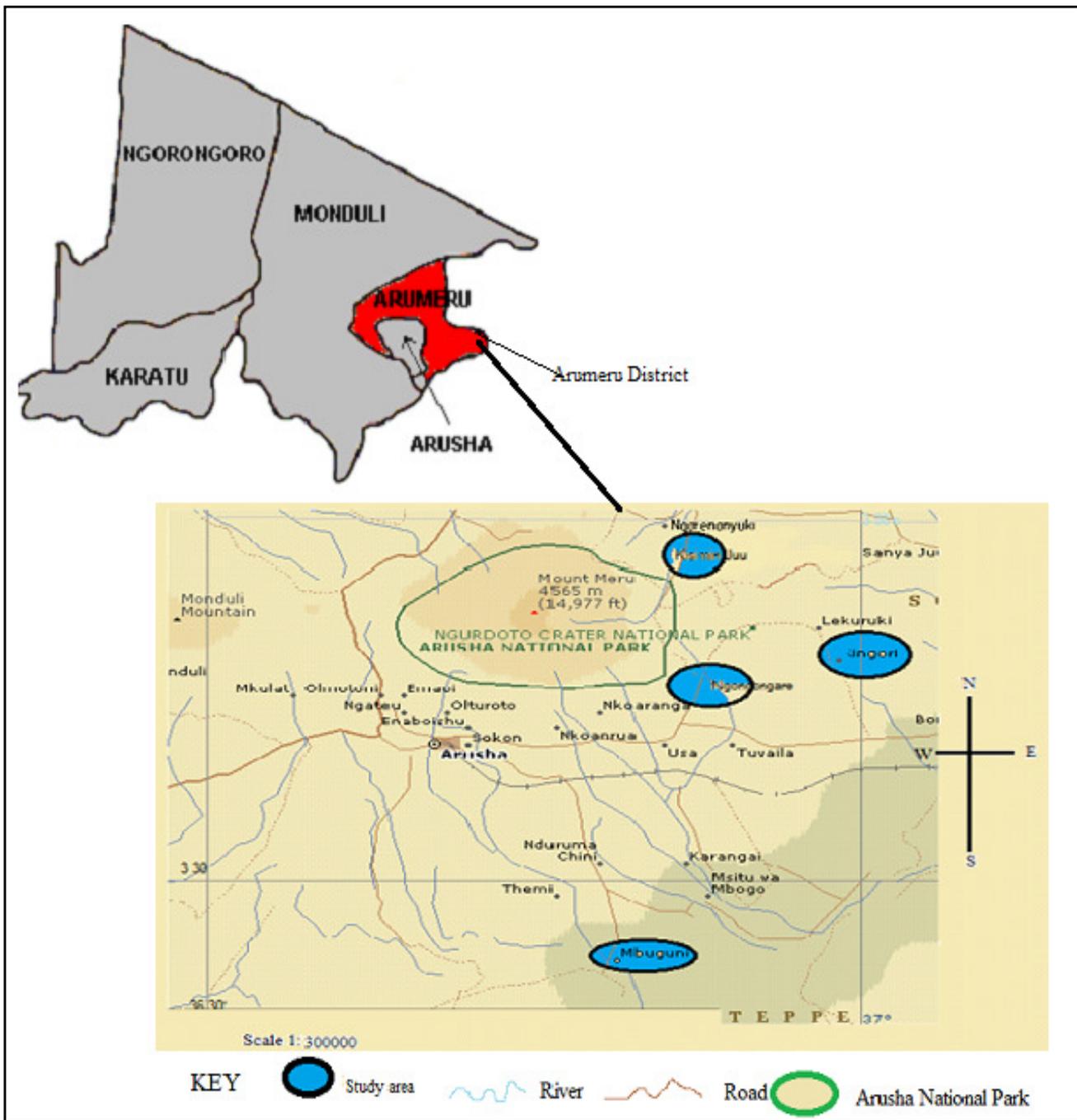


Figure 1: The Map Showing the Studied Village Source Authors 2015

### 2.2. Population

According to the 2002 census, the total population of Arumeru District was 516 814 (URT, 2003). The population annual growth rate between 1988 and 2002 was estimated to be about 3.5% and the life expectancy is 45 to 55 years whereby the average population density of the district is 110 people /km<sup>2</sup> (URT, 2002; Joseph, 2017).

The Maasai people occupy the north, the Arumeru occupy the central part and a mixture of Chagga, Massai, Mbulu and Meru occupy the south. Most people tend to concentrate on fertile soils in Meru area. They have small landholdings on which they manage to produce just enough to subsist. In lower – potential areas, population pressure has led to deforestation in the search for more land to farm and rapid soil degradation, exacerbated by inadequate social services such as education, health services and employment. On the other hand, the population in the study area vary. However, on average the population in each village range between 2,500 and 5550 people (See Fig. 2)

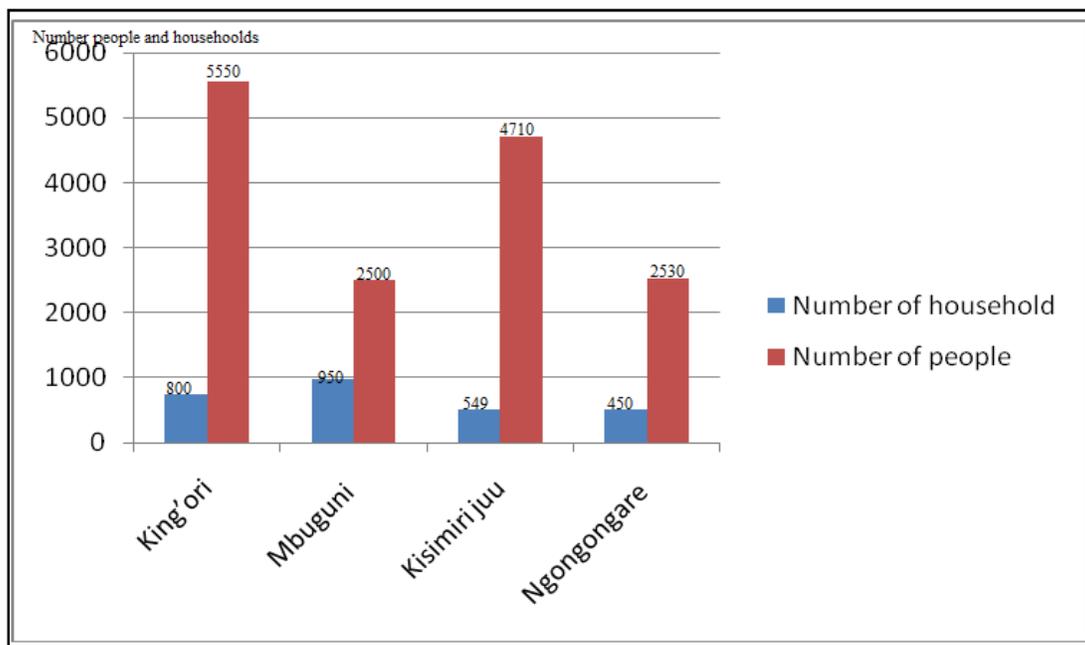


Figure 2: Total population and number of households in the study area  
Source: District Executive Office, 2016

### 2.3. Climate

The study area receives an annual rainfall ranging between 500 mm – 1,200 mm. The areas have bimodal type of rainfall for example short rains (*Vuli*) fall from November to January and long rains (*Masika*) fall from March to June (Thompson *et al.*, 2002). There is usually a long dry spell towards the end of January or early February. Two peaks of rainfall are experienced in December and in April (Kajembe *et al.*, 2005). The average temperatures range between 25<sup>o</sup> C and 15<sup>o</sup> C. Highest temperatures occur in October just before the start of the rainy season and fall gradually in December and remain relatively constant until May. Between May and August temperatures are at their lowest levels (Thompson *et al.*, 2002; Kajembe, *et al.*, 2005)

### 2.4. Economic Activities

Arumeru district has three agro-ecological zones namely: the high-potential areas; the medium-potential areas; and the low-potential areas (Nkonya *et al.*, 1991). Ngongongare and King'ori fall under high-potential area, Kisimiri juu fall under medium and Mbuguni fall under low-potential area. In the 'high-potential areas' Crops grown are mainly coffee, banana, fruits (avocado, citrus and pawpaw). Animals kept are mainly exotic and mixed breeds of dairy cattle, which are stall-fed because people living in these areas tend to concentrate on small family farms of about 0.8 ha (on average) and produce just enough food for consumption with a very limited surplus for sale. In the 'medium-potential areas' Crops grown are maize intercropped with beans, coffee, and banana with a semi-extensive livestock system (Joseph, 2017).

### 2.5. Data Collection Methods

Data were gathered through a questionnaire survey, FGD, key informant interviews, and field visits. The questionnaires consisted both closed and open-ended questions. An open-ended question gives respondents room to give their own views without being influenced by researcher (Kothari, 2004). On other hand, closed-ended questions give options to respondents and are good in collecting quantitative data, hence can simplify data analysis. The aspects covered in the questionnaires were the coping and mitigation approaches used by the agro-pastoralists against impacts of climate change in Arumeru District.

Before using the questionnaires, they were pre-tested for testing the questionnaire wording, sequencing and lay out (Bryman, 2004). The key informant's interview was conducted using interview guides. Eight Village Extension Officers (two extension officers from each village from the four selected villages - livestock and agriculture) and four District officers (two environmental officers and two District livestock officers) were involved hence made a total number of 12 key informants. Aspect covered during interviews was the coping and mitigation approaches used by the agro-pastoralists against impacts of climate change in Arumeru District.

Focus Group Discussion involved three groups in each village, youth, elderly and females. Each group comprised of 10 people, making a total of 80 group members. These two groups were involved in order to capture views as they are likely to perceive issues differently even for the same problem or issue (Creswell, 2012). During the discussion, the authors were mainly a facilitator and this had the advantage that participants were able to discuss issues at hand freely and without fear. The main subtopics discussed included the agro-pastoralists coping and mitigation approaches/strategies to impacts of climate change in the Arumeru District. Direct field visits were undertaken in study villages to observe different approaches employed by agro-pastoralists to cope and mitigate impact of climate change among the agro-pastoralists' communities. Through field study the authors were able to see the approaches used against impact of climate change in Arumeru District.

Data collected were qualitative and quantitative in nature. Therefore, the nature of data necessitated the use of qualitative and quantitative data analysis techniques. In this perspective both qualitative and quantitative information were analyzed separately to complement and supplement each other. For example, qualitative data collected from Focused Group Discussions were analyzed basing on themes and content. The themes were classified whereby every answer was patterned in relation to a theme in question. For Key Informant interviews, data was analyzed through themes and content analysis. Subsequently, quantitative data were collected through questionnaires, and were analyzed through statistical analysis where data were edited, coded, summarized, and analyzed using the Statistical Package for Social Sciences (SPSS) version 16.

### 3. Results and Discussion

#### 3.1. The Coping and Innovative Mitigation Approaches

The findings discovered that Agro-pastoralists in Arumeru District have been employing several strategies to cope and mitigate the impacts of climate change such as prolonged drought, heavier rainfall, temperature rise, disease outbreaks, and shortage of water. The coping and mitigation strategies ensure the rational use of the available natural resource base on which the agro pastoralists depend and also build strong social networks. Overall, the main coping and mitigating approaches/ strategies in order of prominence were livelihood diversification, poultry, savings, supplementary feeds/foods, use of traditional by-laws, afforestation, dam construction and use of (Table 1). Others were livelihood diversification, climate forecast and livestock production.

Mitigation Measures and coping Approaches	Villages				Average
	Ngongongare	King'ori	Kisimiri Juu	Mbuguni	
	%	%	%	%	%
Saving strategy	50.5	80.5	91.0	40.3	65.5
Poultry production	55.2	90.9	28.1	34.3	52.1
Dam construction	49.0	38.01	50.3	81.2	54.6
Planting of trees	90.03	71.2	18.0	51.3	57.7
Building strong houses	50.00	40.0	94.6	12.9	49.3
Supplementary feeds	47.0	88.0	31.0	77.0	60.7
Livelihood diversification	38.0	51.0	46.0	53.0	47.0

Table 1: Results perceived by households on Coping and Mitigation Approaches \*

\*=Multiple Responses

Source Field Data, 2016

At village specific level, the generic coping and mitigating approaches are mainly saving strategy, afforestation (planting of trees), dam construction and poultry production in which the frequency were 65.5%, 57.7% and 54.6% respectively. What is also apparent is that, precedence approaches varied from one village to another as shown in Figure 3. In Ngongongare the approaches were mainly planting of trees, poultry production, saving and building of strong houses. In King'ori the priority approaches were building of strong (permanent) houses, supplementary feeds saving, forest conservation as a way to conserve the environment which could in turn bring rainfall and water dam construction for use during critical dry periods and livelihood diversification of livelihood by switching to other socio-economic activities such as establishment of small scale businesses such as motor-cycle business popularly known as *bodaboda*, small shops, and establishment of small scale agriculture. In Kisimiri juu, the notable approaches were building of strong houses, saving and dam construction to allow collection of water for livestock and irrigation purposes while in Mbuguni the approaches/strategies were dam construction, planting trees and livelihoods diversifications.

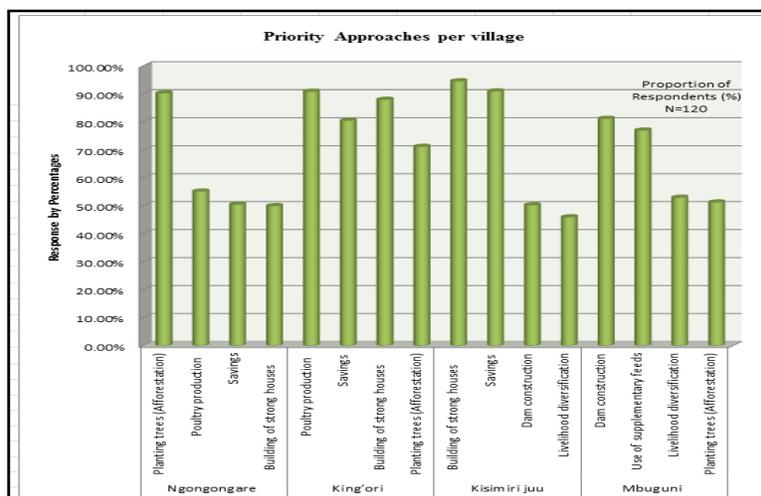


Figure 3: Approaches priority in each village

\*= Multiple Responses

Source: Field Data, 2016

### 3.1.1. Saving Strategy (Resources saving)

Results from the households (Table 1), focus group discussion and key informants indicate that agro pastoralists make savings of foods for their families and feeds for livestock as the strategy to reduce the impacts of climate change this was in line with Joseph and Kaswamila (2017). The saved food is used during dry season when there is less food and the price is very high, the major food saved is maize this were mixed with ashes to protect them from being destructed by insects. The other thing preserved was world vegetables which were dried up and kept into pots. According to the views of the households, saving is limited to food vegetables only. However, a study by Senbeta (2009) revealed that, there are two ways of saving: during impact saving - using less amount of available resource during climatic crisis; eating less food, using less feed and reducing purchases. The second type is pre-impact saving - households keep sufficient assets (crop, forage, livestock, money or other form of asset) that help them to bridge hardship times. In addition to managing household food consumption, to pay-off expenses and to fulfil household financial requirements the households could sell livestock instead of food crop.

### 3.1.2. Dam Construction

Results from the households (Table 1), focus group discussion and key informants indicate that the Agro – pastoralists in Arumeru District have been using dam construction approach as strategies to minimize the intense of climate change impact on water shortage. Overall results in four village combined indicate that, dam construction approach was perceived (54% N=120) the average of the four villages) by the households. During this study, it was revealed that the constructed dams (varying in size and depth) were used only by the community members in a particular village. For outsiders, they must ask permission from the village leaders who will provide permission.

It was revealed that most of the villages have dams which differ in terms of size and depth. Dams are ways of ensuring a year-round supply of water for the community and livestock. Water reservoirs/dams have been one of the strategies to mitigate water availability problems. These dams are normally constructed by the agro-pastoralists in collaboration with NGO's and or District Council. According to Joseph and Kaswamila, (2017) asserts that most of common dams are reinforced by building concrete walls across seasonal river beds to hold water. Sand dam is a new and preferred strategy due to several reasons: it protects water from extensive evaporation; acts as a slow filter for water resulting in potable water; limits some water borne diseases as mosquito parasites cannot breed in this condition, thus it reduces the threat of malaria; and they also act as saline water filters.

### 3.1.3. Afforestation

Results from the households (Table 1), focus group discussion and key informants indicate that afforestation have been by Agro – pastoralists to mitigate the impacts of climate change. It was discovered that planted trees in homesteads and elsewhere are regarded as a defense against wind and soil erosion and a water regulator. The afforestation approach has been recommended by various scholars such as Martin, Joseph as one of the strategies to cope and mitigate impacts of climate change. For instance, Martin (2012) argues that the role of forests in societal adaptation is becoming increasingly recognized and has led to the development of various initiatives such as the Congo Basin Forest and Climate Change Adaptation (COFCCA) project.

On other hand, Joseph (2011) argues that community afforestation can, for example, diversify incomes and improve social capacity, thus reducing the vulnerability to climate change impacts. During the interview with key informants in the district officers they stated that, "Forest play a great role in hydrology as it helps to protect water sources and rain formation. It also regulates climate (i.e. temperature) as it controls amount of Green House Gases (GHGs) which may contribute to rise in global temperature". However, this should be an integrated measure beyond local vicinity since the services provided by the forest in ecosystem cannot be limited locally. Furthermore, it is a long-term mitigation measure as it takes a couple of years for ecological restoration to take place.

Group	Village			
	Ngongongare	King`ori	Mbuguni	Kisimiri Juu
Youths	- Tree planting - Formulation of bylaws Use of bottom up approach Supplementary feeds/foods	- Intercropping strategy - Education to community - Growing soil cover crops Savings Use of supplementary approach	- Strengthening of household's roofs - Dam construction - Poultry production - Building strong houses - Tree planting	- Provision of funds by the government -Participation in local community in decision making
Women	-Borehole construction - Saving strategies	-	- Dam construction - Poultry production - Building strong houses	-
Adults	-	- Poultry production - Dam construction	-	- Saving strategy - Planting trees - Formulation of bylaws

Table 2: Perceived Innovative mitigation and coping Approaches by focus group discussants

Source: Field data, 2016

### 3.1.4. By-law Approach

Field results from group discussion with adults in Kisimiri Juu revealed that policies and bylaws reform are necessary for curbing the impact of climate change. It was noted that to have village bylaws which limit free grazing on cropland is very important. Bylaws should be reinforced through fines; the enforcement is to be done by community leaders by making sure laws are adhered when promoting zero grazing and reducing of size group of livestock. The tradition is to let animal graze after to harvest so as to protect soil from eroded at the same time protecting crops grown from being damaged by animals. Formation of by-laws is not only enough but also should accelerate policy formulation which a bid with local situation hence easy to curb impacts of climate change.

The findings concur with Watson (2001) who argue that policy lobbying and advocacy for integration of climate change in development planning and policy process at national and local levels is important as it can associate resources allocation to support climate change adaption actions at the local level. Therefore, formulation of by-laws would restrict local people within the localities to stop deforestation, reducing number of domesticated animals and omission of all ways that can lead to the increase of impacts of climate change in the area.

### 3.1.5. Education on how to Cope and Mitigate

The study revealed that the offering on environmental conservation education and how to curb climate change impacts was depicted as approach used. The education is offered freely by district environmental officers to villagers once in a month. The views of youth group discussants in King'ori is that education is important to the community on how to cope or mitigate the impacts of climate change. They (youth in King'ori) asserted that; i) education has awoken them to build strong and permanent houses which are resistant to wind and heavier rainfall, ii) education has made them aware on how to plant trees, iii) education has led them to understand intercropping strategies, iv) education has made them to understand the importance of restocking. In the same way, a study conducted by UNDP (2007) revealed that, the level of education influences the participation of an individual in development of mitigation and coping strategies. The more the individual is educated the more can participate effectively on issue with impacts of climate change. According to National Academy of Sciences (1992) the ability of human systems to adapt to and cope with climate change depends on technology, education, information and skills access to resources and management capabilities. Therefore, education to the Agro-pastoralists' is very important as it creates awareness and participation in the community toward solving climate change impacts in the area.

### 3.1.6. Intercropping Approach

As for intercropping, youths in King'ori perceived it as one of the coping mechanisms against impact of climate change. Although the strategy is common among the small-scale famers who maximize land with diverse crops (Mkenda, 1997), it was revealed that the approach could be used to minimize the risk of crop failure. These results are contrary to Gilley et al. (1999) who showed that intercropped crops can influence the microclimate and yield potential for adjacent crops. The authors also pointed out that a well-managed intercropping system could result in profitability and a greater soil and water conservation potential than most monocropping systems. In line with field data, a study by FAO (2002) showed that, Indigenous practices intercropping pigeon pea, soybeans, sweet potato and pumpkin, which act as cover crops after the main crop is harvested which provide a good canopy if densely planted. Therefore, the strategy should be applied by other communities impacted by climate change as the coping mechanism of protecting soil erosion in their farms at the same time as a strategy of improving food production in their households.

### 3.1.7. The Use of Bottom –up participatory Approach

The study results revealed that, the use of bottom – up participatory approach was among other approaches used built on local knowledge, innovations, and practices on how to curb impacts of climate change in the areas. The agro-pastoralists focus is on empowering communities to come up with appropriate strategies lineated with their existing environment in adapting and mitigating to impact of climate change. It was noted that the participatory spirit is encourage when dealing with all matters related to finding and planning strategies toward curbing impacts of climate change, as it influences awareness to the local community pertaining on causes of climate change, its impacts on agro-pastoralists' livelihood and what to be done to evacuate from impacts of climate change.

Dry	Wind	Flood
Plant drought tolerant crops e.g. cassava The use of supplementary feeds	Planting of windbreak trees around the houses	Temporary movement to other areas
Rainwater Harvesting, folder conservation practice	To construct strong houses	Set quarantine, local treatment using herbs
Practicing differed grazing clearing part of grazing area to be used during dry season referred as <i>ngitiri</i>	Planting of trailing crops e.g. sweet potatoes	Shifting of livestock, split of herds and selling.
Temporary movement to other areas	Additional of weight on top of roofs.	Reinforce river banks, drainage system maintenance
Sell the old livestock	Planting of trees Use of bottom up approach	Vaccination
Shifting of livestock, split of herds	Provision of education	Poultry production
Construction of dams	Improvement of participation	Planting trees
Planting of trees		Provision of education
Provision of education		Improvement of participation
Improvement of participation		Planting fodder grasses

Table 1: Perceived mitigation and coping Approaches by government officials.

Source: Field data 2016

### 3.1.8. The use of Fodder Grasses and Tree Legumes Approach

The study through interview with government officials revealed that, Fodder Grasses such as elephant grass or Napier grass and tree legumes such as *Leucaena leucocephala*, *Calliandra calothyrsus* and *Sesbania sesban* are planted along the contour to control soil erosion during heavy rain season as an approach used by agro – pastoralists to reduce the magnitude of climate change impacts on their land. In so doing the soil is protected at the same time agro - pastoralists gain food which is somehow sustainable to their livelihoods.

It was noted that, currently the agro – pastoralists especially those found around Mt. Meru are traditionally planting trees to provide shades, wind protection, fodders and fruits. Fodders grasses and tree legumes are now planted along field boundaries, particularly around homesteads, roadsides and badly eroded areas all this is done so as to protect soil from erosion and to protect the land for economic uses in the area. In the same way, Elijah et al., (2000) argues that soil conservation includes both physical measures to control runoff and biological measures. On the other hand, National Academy of Science (1992) suggests that adaptation strategies should give priority to proactive actions to reduce future risks to help vulnerable populations recover from unavoidable impacts of climate change.

### 3.1.9. Supplementary Feeds

Field findings indicate that maize barn, cotton/sunflower seed cake, maize stalks, sweet potatoes/beans leaves, and maize cobs were the mostly used supplementary feeds for livestock in the study area as coping strategies against climate change impacts in Arumeru district. These feeds are usually obtained after harvesting of farm products. However, for maize brans, hay, and seed cakes are normally bought from milling machines. Mbahuda area in Arusha is commonly known for the supply of maize barn while Kilimajanro region is the main supplier of maize stalks seed cakes. The prices of these feeds depend on the season.

### 3.1.10. Building of Social Networking

The building of social networking was argued by respondents as an adaptive strategy against the impacts of climate change in the study area. It was noted that many agro -pastoralists after 2008 – 2010 drought, formed social networks for sharing knowledge and experiences in relation to climate change and livelihoods sustainability in their areas. The network involves agro - pastoral Maasai, Meru and Chagga peoples within the country. The way the network works is that whenever agro-pastoralists sense anything related to livestock and crop production instability, they are supposed to communicate with their fellows whom they have formed a networking group on details related to pasture and water and the hosts are ready to accommodate their fellow.

## **4. Conclusion and Recommendations**

### *4.1. Conclusion*

Climatic change impacts in Arumeru district is a big problem and is associated with many challenges in relation to the livelihoods of agro-pastoralists in the District. It was found that the agro-pastoralists' livelihoods have been affected greatly by climate change and the main impacts are on human health, shortage of water, loss of land and human displacements, impact on agriculture and food security and failure of savings. However, to mitigate the situation agro-pastoralists have been using various innovative mitigations and adaptation approaches. The major ones include; savings, dam construction, use of supplementary feeds, and use of traditional by-laws. Others were intercropping, bottom –up participatory, traditional weather forecasting, herd diversification and building social networks. For agro- pastoralists to continue coping with climate change impacts, the study recommends the following:

- The District Livestock Officer should explore the options and benefits for mitigation approaches in both livestock and crop growing sector, particularly where there are opportunities to access carbon finance payments, and identifying synergies between productivity and environmental benefits, for example through reduced methanogenesis (lower methane reduction leading to increased feed conversion efficiency), reforestation of rangelands, manure management, or restoration of degraded rangelands;
- Agro-pastoralists' capacity building on climate change coping/adaptation and mitigation should be done by NGOs, CBOs, and the District livestock officials. The initiation and the establishment of programs intended to consolidate the adaptability and mitigation of climate change upon the agro-pastoralists will promote the techniques of how to buffer the impacts resulting from climate change.

### *4.2. Recommendations*

- i. The need to fully involve local communities in planning and decision making on how to effectively mitigate measure and application of coping strategies on climate change impacts on agro-pastoralists' livelihood.
- ii. Secondly, more capacity building efforts are needed to train climate scientists in Tanzania in the development and application of downscaling techniques as well as in the use of multimodal approaches.
- iii. Move from awareness raising to "proof of concept" With the climate change debate gradually moving from a focus on awareness raising about the problem to the development of actual adaptation responses, there is a need for developing so-called "proofs of concept" examples of agricultural decision makers that have successfully drawn on climate change projection data to make decisions that have improved agricultural productivity or human well-being.

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