

IMPACT OF CLIMATE CHANGE TO SMALL SCALE FARMERS: VOICES OF FARMERS IN VILLAGE COMMUNITIES IN TANZANIA

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LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|-------|--|
| CSO | Civil society Organization |
| DP | Development Partners |
| FGD | Focus Group Discussion |
| IFAD | International Food and Agriculture Development |
| IPCC | International Panel on Climate Change |
| NGO | Non Governmental Organization |
| TACRI | Tanzania Coffee Research Institute |
| TMA | Tanzania Medical Agency |
| UNDP | United Nations Development Program |
| UNFCC | United Nations Forum For Climate Change |
| WFP | World Food Program |

1.0 INTRODUCTION

Climate change is defined as a result of temperature variability due to emissions of greenhouse gases produced by human activities (Hope, 2009). According to Hope (2009:451) human activities such as ‘burning of fossil fuels, industrial production, cutting down of rainforests change the atmosphere’s composition by increasing the amount of greenhouse gases, which, in turn, traps heat in the atmosphere and thereby facilitating climatic changes’. Mubaya *et al* (2010), note that the impact of climate change is two-fold, bio-physical and socio-economic. Whereby bio-physical impact include rising sea waters, more frequent and intense storms, extinction of species, worsening drought, crop failure. As well as changes in cloud cover and precipitation, melting of polar ice caps and glaciers, and reduced snow cover (Mendelsohn and Dinah, 2005; UNDP, 2004; UNFCCC, 2007).

There is linkage between bio-physical and socio-economic impacts of climate change. The environmental degradation caused by bio-physical impacts creates socio-economic impacts. This is mainly on the agricultural sector where areas suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas are expected to decrease (Mubaya *et al.*, 2010:172). Consequently, affects small scale subsistence farmers in terms of productivity, food security and family income. However, in middle and higher latitudes areas the impact of climate change is to extend the length of the potential for growing seasons.

Although there are positive impacts the focus is on negative impacts of climate change because the positive impacts do not last as the climate continues to change. In addition the positive impacts are only in few areas and adverse effects are projected to predominate the world, especially in the tropics and subtropics (Mubaya *et al.*, 2010). For example, it is estimated that over 2.8 billion people in the world live in areas prone to more than one type of the physical manifestations of climate change which include; floods, storms, droughts and sea level rise ¹(FAO, 2005). The most vulnerable people live in the semi-arid dry land belt countries, Sub-Saharan Africa, South and Southeast Asia, Latin America, Small Island developing states and the Arctic.

Climate change is expected to have a significant impact on the livelihoods of the rural poor in developing countries. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that climate change is likely to have a significant effect on agricultural production in many African countries. Climate variability will increase almost everywhere. Effects of climate change and climate variability will continue to challenge vulnerable people. Droughts and dry spells will be more frequent, rain more inconsistent, and torrential downpours heavier, all phenomena that increase the risk of soil erosion and vegetation damage through runoff. Higher temperatures will increase the evaporation of soil moisture. Climate change will aggravate water stress, which the continent has already experienced; more people will be at risk of water stress (Boko *et al*, 2007).

¹ Climate change – The anatomy of a silent crisis (2009), Global humanitarian Forum

Africa is among the continents most vulnerable to climate change and climate variability. Socio-economic developments exacerbate the effects of climate change on ecosystems and humanity. Boko *et al* (2007) indicate that endemic poverty, poor governance, limited access to capital and global markets, ecosystem degradation, complex disasters and conflicts, and urbanization are factors that may undermine communities' ability to adapt to climate change. The economies of many African nations are dependent on sectors that are vulnerable to climate conditions, such as agriculture, fisheries, forestry, and tourism. Agriculture and natural resources provide the livelihood for 70% to 80% of the population, and account for 30% of GDP and 40% of export revenue in Sub-Saharan Africa (Toulmin and Huq 2006). In Sub-Saharan Africa agriculture employs 60% to 90% of the total labour force (Thornton *et al.* 2006). Tanzania is not different from the rest of Sub-Saharan African countries, agriculture is the dominant sector accounting for 75.1% of employed persons (National Bureau of Statistics, 2007).

In addressing the challenges of global warming and climate change, the focus for a while has been on reducing green house emissions. There has been little progress on reducing these emissions and the climate has continued to change affecting the agriculture sector negatively in many developing countries. Lately the focus has shifted to adaptation measures to reduce vulnerability to climate change impacts (Guthiga and Newsham, 2011). In Tanzania where 75.1% of the employed persons are in the agriculture sector, the continued impacts of climate change have and will continue to have devastating effects on the economy, food security and threaten the stability of the country.

It is crucial for Tanzania to invest in terms of financial resources and research on adaptation measures farmers could implement to cope with climatic changes especially in the agriculture sector. Guthiga and Newsham, (2011) argue that in recent years indigenous people have been recognised as powerful knowledge- holders on climate change and key actors for developing policy to cope with and adapt to its effect (*ibid*). Therefore using local persons is believed to lead to development of effective mitigation and adaptation strategies that are cost-effective, participatory and sustainable. Adaptation generally takes place at the micro and macro levels. There are different factors that determine the success and failure of adaptation. These include seasonal climatic variations, the agricultural production system, other socioeconomic factors; the government, NGOs, or private companies, and long-term changes in climatic, market, and other conditions (Nhemachena and Hassan 2007). Therefore, this research, through interviews managed to get the voices of small scale farmers who expressed their observations on climate change and its social economic impact experienced as well as adaptation strategies used to cope with it.

1.1 Rationale of the Project

There are many studies on climate change. This research report is not going into detail in discussing the history and background on climate change. After briefly explaining what climate change is and its impact on agriculture, the main focus of the discussion is on presenting the voices of small scale farmers in Tanzania indicating what they perceive to be the impact of climate change on agricultural production, different challenges they face and how they cope with the changes.

In Tanzania the form of agriculture practised is mainly subsistence farming consisting of

small scale farming communities. Like other developing African countries, climate change in Tanzania is predicted to impact negatively on these farmers who have no social security safety nets or resources to cope with the changes. However, the impact of climate change depends on the climatic zones of each area. This means farmers in different zones will experience the impact of climate change differently and will need different adaptation measures to cope with the changes. In addition to the different climatic zones, cultural and traditions also influence the adaptation strategies and their level of success. Therefore, in order to address these different aspects this study has covered different regions in Tanzania assessing different impacts from climate changes and different adaptation strategies farmers use to cope with these changes. It also establishes challenges farmers face and the strategies they use to cope with them. This helps to establish what more the government could do in terms of adaptation strategies and policies to assist small farmers in this regard.

The rationale of this project arises from the growing dangers stated above that necessitates a thorough understanding of the magnitude of the problem in the agriculture sector which is the backbone of the Tanzanian economy. Moreover, this study is important because the research recommendations on approaches and policies could be used to propose adaptation measures for farmers to cope with the effects of climate change and hence ensure food security in decades to come. Therefore these findings are useful to policy makers and other stakeholders who are responsible for agricultural development as well as the disaster management section of the government. That is, the President's Office (Disaster Management Section) and the Ministry of Agriculture and Food Security in particular.

Research findings will as well provide knowledge and awareness to the citizens who are employed in the agricultural sector and other stakeholders who are linked to agriculture, food security and poverty alleviation programmes for advocacy purposes. The findings could also be used by environmental CSOs to forge different agenda to reverse any undesired trend in the management of the environment in the country.

1.2 Objectives

The overall objective of this study is to assess the effects of climate change on small scale farmer in Tanzania in the past decade and recommend adaptation measures and policies to cope with climate change now and in the future. Specifically, this project:

- To assess the knowledge of small scale farmers on climate change and its impact.
- Assesses the variation in crop and livestock production due to climate change in the past decade.
- Assesses the direct and indirect socio-economic effects (e.g. impact on productivity) of climate change on small scale farmers in the selected regions.
- Identifies and assesses various traditional and modern adaptation and mitigation measures used by farmers to curb the effects of the climate change, and assess whether they are adequate.
- Identifies the type of population groups (women, children, widower, disabled etc.) have been more prone to climate changes.
- Suggest adaptation measures and policy recommendations.

1.3 Research Questions

- How small farmers understand and identify climate change?
- How small farmers identify impacts of climate change?
- To what extent has the climate change affected both production and productivity of small farmers?
- What socio-economic effects do small farmers face due to climate change?
- Which type of agricultural sub-sector has been more prone to climate changes?
- Which population groups have been more prone to climate changes?
- What traditional adaptation and mitigation measures small farmers use to cope with climate changes?
- What modern adaptation and mitigation measures small farmers use to cope with climate changes?
- What adaptation measures and policies could be implemented by the government?

1.4 Limitations

Views represented in the findings are from a small randomly selected sample of small scale farmers; this may limit the generalization of study findings. Notwithstanding the fact that the number of small scale farmers interviewed is small, the sample was selected scientifically, hence they may represent the true population of small scale substance farmers in the country. In addition, focus group discussions with government officials, Research Institutions, NGOs and other stakeholders were held to supplement the farmers' views.

2.0 IMPACT OF CLIMATE CHANGE ON AGRICULTURE

The agriculture sector especially in African countries has been worst affected by climate change. Hope (2009:455) indicated that 'majority of the African population derive their livelihood from agriculture which is the largest economic activity in the continent'. Hope (2009:456) further observed that in Africa small scale agriculture that is practised by many farmers 'relies heavily on rainfall for the provision of water for crops' and climate change creates havoc for African farmers. The International Fund for Agricultural Development (IFAD) data suggest that 50 percent of the developing-countries' rural population are smallholders farmers (farming 3 hectares or less of crop land); and 25 percent are landless, which may have included some agricultural labourers, non pastoralist livestock keepers, and poor people not engaged in agriculture (IFAD, 2000). The Sub-Saharan African countries mostly affected by drought include Burkina Faso, Mozambique, Rwanda, Somalia and Tanzania, Malawi, Kenya, Nigeria, Somalia and Sudan; while Mozambique and Tanzania are also prone to floods ²(IFAD, 2000). In addition, Thompson *et al.* (2010:2719) suggest that apart from projected warming or rainfall deficit the negative impact of climate change could also be due to vulnerability of the population in Sub-Saharan Africa. They further indicate that Africa is highly vulnerable to climate change due to 'social, economic and political constraints that determine the capacity of human systems to cope with external stressors such as climate change'. This is supported by Washington *et al.*, (2006:1355) indicating that poverty and underdevelopment in sub-Saharan Africa is partly due to 'difficulty in coping with climate variability in a continent subjected to frequent droughts, floods, high temperatures and land degradation'.

In Tanzania, climate change has also been observed. For example, a mean annual temperature increase of 1°C has been recorded since 1960 and rainfall decreased at an average rate of 2.8 mm per month and 3.3% per decade. More decrease in rainfall occurred in southern part of Tanzania (Mashingo, 2010). "It is predicted that extreme events such as drought, floods, tropical storms and cyclones are expected to become more frequent, intense and unpredictable in future. Other adverse effects will include negative impacts on food production, energy and water supplies, as well as a decrease in the population health, particularly in rural households which represent the majority of the country's inhabitants (Maclean, 2009)". In turn the negative impacts of climate bring about socio-economic impact on people especially in poor farming communities. There have been attempts to reduce the green house gases in order to reduce the negative effects of global warming and climate change. This has not been successful so far and the focus has shifted to ways of adapting to already negative impacts of climate change. There is little research on how processes and strategies of adaptation are unfolding in farming communities. In this respect this study covers this gap by looking at the impact of climate change on small scale farmers and effectiveness of adaptation strategies they use. Also to hear from them what adaptation strategies they think the government should introduce.

² Climate change – The anatomy of a silent crisis (2009), Global humanitarian Forum For instance in December 2011 floods killed more than 30 people in Dar es Salaam and left many people living in lowland homeless

3.0 CONCEPTUAL FRAMEWORK

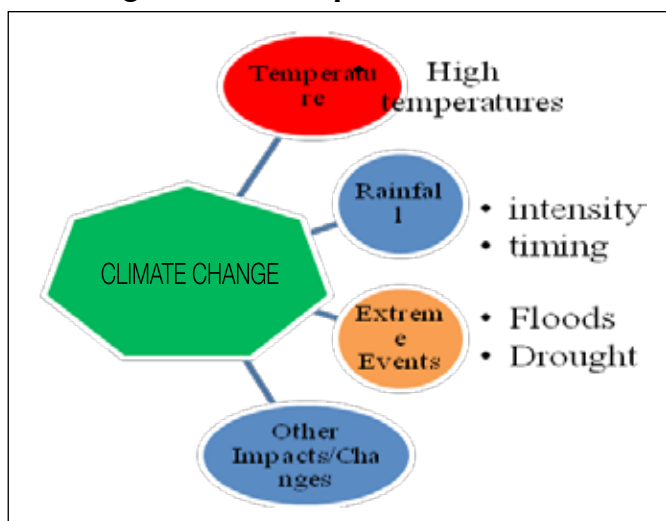
There is no doubt that the climate has changed and is continuing to change. Three of the resulting changes of the climate are changes in precipitation, temperature and extreme events such as droughts and floods. The impact of climate change is felt by farmers mainly in the “timing, frequency and intensity of rainfall events, and in the distribution of these events within a season of growth” (Blignaut *et al*, 2009). Annual average temperature and precipitation are important in assessing climate changes but do not provide adequate indication of the impact these changes have on individual farmers.

Therefore this research is not set out to establish the weather changes such as average rainfall, precipitation and temperatures in the different regions in Tanzania. This is because studies on the changes in rainfall and temperature have been conducted and indicate that there have been changes in rainfall and temperature as indicated above. For this research, fieldwork was conducted whereby twelve districts in eight regions were visited to hear the voice of farmers themselves on how they define and determine that there is climate change; how they determine its effects on their agricultural activities and livelihood and how they cope with these changes.

There is a strong negative relationship between temperature and precipitation. The declining rainfall and increasing temperature affect crop production. This negative relationship between these two variables implies that rain-fed field crop production and livestock keeping will become more and more vulnerable. To assess changes in temperature and rainfall and its impact on crop production, farmers, livestock keepers and government officials were interviewed. The interviews included questions on the changes in temperature and rainfall farmers and livestock keepers have observed and the impact these changes have on the crop production and animal grazing. In terms of temperature the changes anticipated were increased temperature. In most cases an increasing temperature will mean reduced crop production and reduction of pasture for animals.

Changes in rainfall patterns were assessed in terms of timing - whether there were changes in the rain seasons (time for start and ending), intensity of the rains – droughts and floods and frequency. Increased frequency and severity of droughts and floods may reduce crop and livestock production and changes in the seasons and timing of the rains create difficulty in timing the planting of crops which in turn result in reduced crop production and livestock products such as milk and meat. The resulting impact of these changes and

Figure 1: Conceptual Framework



variations in temperature and rainfall is food shortages, disruption of agriculture yields and productivity and reduced income for farmers. Consequently climate change may undermine the efforts of many developing countries including Tanzania for fighting income and food poverty and difficult to attain the MDGs.

4.0 METHODOLOGY

Exploratory case study methodology has been used in investigating the impact of climate change on small scale farmers in Tanzania. Case study application has been applied not to obtain statistical generalisation but analytical generalisation. Analytical generalisation is established using previous developed theories on climate change against empirical results of the case studies of the visited villages. The case studies are used to explain the perceptions in climate change impacts on small scale farmers and adaptation strategies being used to cope with the changes (Yin, 1994).

4.1 Type of Data

Primary and secondary data have been used to assess the impact of climate change in agriculture sector. Primary data collected include information on trends in crop production, changes of types of crops for the past ten years, information on livestock keeping, impact of changes in rainfall, temperature and extreme events such as floods and droughts, socio economic data such as income generating activities, employment and information on adaptation strategies farmers are using to cope with climatic changes. Secondary data has also been collected to complement the fresh information collected from the field. The secondary data collected include reviewing of the existing literature to supplement field work, food production and land productivity (comparative over time) in selected sample regions, yield, mean annual rainfall for at least ten years (start and end time-period), seasonality, mean temperature for 10 years), precipitation, occurrence of events such as floods, draught, heavy wind or storms etc.

4.2 Sources of Data

Primary data was obtained from interviews conducted with selected individuals, institutions as well as key informants. Necessary information as to how climate change impacts on agricultural sector has been captured from:

1. Agriculture research institutions using questionnaire about the changes in production due to the variation of weather (rainfall, temperature, extreme events).
2. Small scale famers and livestock keepers if they think there have been any changes in climate variables hence affecting their agriculture yield and animal products as well as their mitigation measures.
3. Agriculture professionals on whether there has been any climate variation and if any its impact on agriculture sector (crop production).
4. Government institutions whether there are any mitigation or adaptation measures to assist small scale farmers cope with climate change.
5. Weather bureau on climate changes in the country in general and specific changes in the regions and districts.

Secondary data has been collected from national surveys such as the household surveys, agriculture and food census, Food and agriculture statistics, weather reports etc. Other

relevant data and information was collected from the National Bureau of statistics (NBS), the Ministry of Agriculture and Food security, Ministry of Trade and Industries (export and Import data), Prime Minister's Office; Emergence Response Unit, Ministry of Land and Human Settlements, Food Security Department. Strategic Grain Reserves (SGR), Food and Agriculture Organization (FAO), Famine and Early Warning Systems Network (FEWSNET), WFP, UNDP, IFAD, etc.

4.3 Data Collection Methods

Data has been collected through field surveys where personal interviews and Participatory Rural Appraisal (PRA), a technique that emphasizes local knowledge and enables local people to make their own appraisal or assessments, analysis, and plans. Together with semi-structured questionnaires (flexible checklists), focused group discussions (FGD) were used to enable information sharing, analysis, and action among stakeholders. An assessment was done to see how farmers have been affected by climate change, their coping mechanisms, adaptation measures, and how government supports them.

4.4 Method of Analysis and Presentation

Research findings are presented using different themes. Tables, charts and diagrams have been used to analyse and present different themes from the data collected. The data collected has been processed using the Statistical Package for Social Sciences (SPSS) and analysed according to the study objectives.

4.5 Study Area

Tanzania has eight agriculture zones that are subdivided based on ecological and the existing farming systems. The zones include the western semi arid, central marginal rainfall, eastern mid humid zone, Lake Zone (semi arid cotton growing zone), Northern humid zone, southern dry land zone, southern highlands humid zone and Zanzibar islands. Due to resource constraints, only four zones were represented. Hence this study was conducted in five (8) regions, namely Arusha, Shinyanga, Mtwara, Iringa, and Mbeya, Kagera and Tanga (for Tanzania mainland), and Pemba for the Island section. Arusha and Tanga represented the Northern - Eastern Zones, while Iringa and Mbeya represented the Southern highlands and western zones while Mtwara catered for the Coastal and Southern areas. The Central zone and Lake Zone were presented by Kagera and Shinyanga region. Pemba as the most productive area in Zanzibar was selected to represent the Island.

Furthermore, the choice of Iringa region is based on the fact that, the region is among the major four food potential growing regions in Tanzania mainland; if these regions are vulnerable to climate change and variation the growth of our economy may be impaired. Moreover, Iringa region is a starting point for big rivers such as Ruvu and Rufiji, these rivers, vegetation and its valleys are the major sources for water for irrigation in the country and a potential source for hydro-electric power for the whole country. Kagera and Shinyanga are among the top cash crops potential regions in the northern and lake zone; negative effects may trim down the country exports. Since Pemba is the most agricultural potential area for Zanzibar Island, its selection is based on the fact that the island is the heart of the Zanzibar economy and agriculture is its main economic activity; negative effects to its environment

may have negative consequences to the Island's economy.

4.6 Sampling Procedure and Size

The regions for the survey were purposefully selected to represent the real ecological and farming systems that exist in the zones. However, from each of the eight regions, two divisions and districts were purposefully selected. From each division two villages were randomly selected. Hence 16 districts and 32 divisions were selected for the study. Finally, ten farmers from each village were purposefully and randomly selected. The selection of farmers considered two things; the type of agricultural activity they are doing and gender. Other sample selection criteria in the regions included geographical location, accessibility, availability and other socio-economic characteristics such as disabilities, age, and health status. Furthermore, two focused group discussions (FGD) were held in each region. The study area i.e. regions, districts, and sample size are shown in the below table 1:

Table 1: Data collection in 8 regions

| Region | Districts | Villages | FGDs with government officials | FGDs with farmers with 10 farmers | Individual interviews with farmers | Total number of farmers |
|--------------|-----------|-----------|--------------------------------|-----------------------------------|------------------------------------|-------------------------|
| Arusha | 2 | 4 | 2 | 2 | 34 | 52 |
| Iringa | 1 | 2 | 1 | 1 | 18 | 26 |
| Kagera | 1 | 2 | 1 | 1 | 16 | 26 |
| Mbeya | 1 | 2 | 1 | 1 | 16 | 26 |
| Mtwara | 1 | 2 | 1 | 1 | 16 | 26 |
| Pemba | 1 | 2 | 1 | 1 | 16 | 26 |
| Shinyanga | 1 | 2 | 1 | 1 | 16 | 26 |
| Tanga | 2 | 4 | 2 | 2 | 36 | 52 |
| Total | 10 | 20 | 10 | 10 | 168 | 260 |

5.0 DISCUSSION OF FINDINGS

The findings on the impact of climate change are presented according to the different themes arising from the discussion with famers, livestock keepers and government officials in the eight regions in Tanzania. The focus of the discussion is mainly on the social economic status of the farmers interviewed, land related issues, changes and challenges in crop farming and livestock keeping in relation to climate change, environmental management strategies and adaptation strategies farmers are using to cope with the changes.

There were 168 individual interviews with famers, 105 men and 63 women. Most farmers have lived in the area for over 20 years. The age range was between 30 to 60 years old. Out of the 168 individuals interviewed, 136 households had a man as a head of the house and only 18 households were headed by women. The average family size of each household was about 4 to 7 people. Table 3 below gives a summary of gender and education status of the respondents interviewed in selected areas. Surprisingly the table shows that 68.2% of men and 52.6% of women farmers interviewed had primary school education, while 13% of men and 10% of women had secondary school education and those without education accounted for 17.5% and 37.7% respectively. The table suggest that if the sample is the true representation of the small scale farmers in Tanzania, then most of the small scale farmers and specifically women have low level of education. With these levels of education there are few chances that these farmers could be employed in other non farming activities.

Table 2: Education levels of survey farmers

| Men | | | Women | | |
|-----------|--------|------------|-----------|--------|------------|
| Variable | Number | Percentage | Variable | Number | Percentage |
| Primary | 105 | 68.2% | Primary | 81 | 52.6% |
| None | 27 | 17.5% | None | 58 | 37.7% |
| Secondary | 20 | 13% | Secondary | 15 | 9.7% |

Sources: Field work 2011

The sample also indicated that an average family size is between 1 – 4 children per family. Majority of the children are in primary and secondary schools with very few familie in higher education level. Among the different income generating activities, majority of the household were involved in mainly two activities, crop production and livestock keeping (Table 4 and 5).Where secondary sources of income is mainly wage jobs and small scale businesses

Table 3: Income generating activities

| Main source of income | | | Second source of income | | |
|-----------------------|-----|------|-------------------------|----|-------|
| Crop farming | 137 | 89% | Livestock | 68 | 44.2% |
| Livestock | 8 | 3.2% | Crop farming | 23 | 14.9% |
| Wage job | 4 | 2.6% | | | |

Sources: Field work 2011

The regional analysis data indicate that agriculture is a dominating activity for almost 90% of the respondents in the sampled areas, other activities such as livestock keeping, wage job, businesses contributing very insignificantly; this indicate that the farmers sources of income are less diversified and may be vulnerable if any bad event (e.g draught) happens to their major source of income (agriculture). As shown in the table below livestock contributes more as a secondary income sources in regions such as Mbeya, Arusha, shinyanga, Mbeya and Kusini Pemba.

Table 4: Income Generating Activities Disaggregated by Regions

| Regions | Main Sources of Income | | | | Secondary Source of Income | | | |
|--------------|------------------------|-----------|----------|----------|----------------------------|-----------|----------|----------|
| | Crop Farming | Livestock | Wage job | Business | Crop Farming | Livestock | Wage job | Business |
| Arusha | 84.4 | 15.6 | 0.1 | 0.1 | 12.5 | 59.4 | 3.1 | 9.4 |
| Iringa | 93.8 | 6.3 | 0.2 | 0.1 | 18.8 | 31.3 | 0.1 | 31.3 |
| Kagera | 87.5 | 6.3 | 0.1 | 0.1 | 12.5 | 18.8 | 6.3 | 3.3 |
| Kusini Pemba | 68.8 | 6.3 | 0.1 | 0.1 | 31.5 | 50.0 | 12.5 | 0.01 |
| Mbeya | 99.2 | 0.7 | 0.1 | 0.1 | 25.0 | 62.5 | 0.1 | 0.1 |
| Mtwara | 99.3 | 0.5 | 0.2 | 0.1 | 25.0 | 12.5 | 0.1 | 18.8 |
| Shinyanga | 99.3 | 0.3 | 0.1 | 0.1 | 0.1 | 50.0 | 0.1 | 6.3 |
| Tanga | 84.2 | 0.1 | 0.2 | 2.9 | 2.9 | 41.2 | 0.1 | 5.9 |

Sources: Field work 2011

The regional analysis also indicate that remittances from friends or relatives do play a roles as a seasonal sources of income in regions such as Mbeya (12.5%), Kusini Pemba (6.3%), Tanga (5.9%) while in other regions its contribution is so insignificant.

5.1 Climatic Variations Affecting Crop Production

As noted in the beginning of the report, the aim of this report is not to establish whether the climate is changing or not. There is enough evidence from available literature indicating that the climate is changing. The common change related to climate change that has been experienced by farmers and affected crop production was mainly extreme events such as floods and drought and high temperatures.

Farmers indicated that they have observed changes in rainfall seasons and pattern, temperature are higher in some areas than they were before and incidences of extreme events such as floods and drought have increased. In some areas there are no more *vuli* rains, and when the rains come it is not at the usual time. In most cases rains delay and this result in crops drying out. Some farmers have observed changes in the rainfall pattern noting that in “*some areas rain was about 3 times a year but now only once or rarely twice a year and it is so unpredictable...It starts late and ends before end of rainy season... in the 1950 and 1970s we could cultivate and harvest twice but now we only harvest once*” (Muheza FGD, 2011). The interviews with farmers indicated that out of the 168 farmers interviewed 93 (57.4%) said that lack of rain has affected crops severely, 36 (22.2%) of farmers thought the impact was moderate and 27 (16.7%) of farmers thought it was minimal. Farmers indicated

that there was either no rain or very little rain and crops dried due to lack of rain during the drought periods. Farmers have also indicated that they experiencing frequent and severe floods for the past ten years.

Interview villagers also said that with the changes in the pattern of rainfall the past 10 years, they have designed various adaptation methods among other is changing the planting season. Unlike in the past when the planting period was well known, currently the planting depends on when the rains come. For example farmers indicated changes in planting maize, 131 (80.9%) farmers indicate there are changes in when they plant maize. These changes include lack of *vuli and Mchoo* rains, when there is no *vuli* rains, they don't plant *vuli* maize, there is also delay in planting and harvesting maize, when rains are late, it means they will plant late and harvest late.

Looking at the regional perspectives villagers in the interviewed region expressed their perceptions on whether they think there are changes in planting time or harvesting due to climatic changes.

Table 5: Perception on Changes in planting and harvesting Maize crops due to climatic changes in percentages of who agree

| Regions | Changes in planting time for maize (%) response | Changes in harvesting time and outputs for maize (%) response | Partial changes in planting and harvesting time for maize (%) response | |
|--------------|---|---|--|------|
| Arusha | 71.9 | 68.8 | Shinyanga | 36.3 |
| Iringa | 99.9 | 75.0 | | |
| Kagera | 81.5 | 75.0 | | |
| Mbeya | 81.3 | 81.3 | | |
| Mtwara | 62.5 | 56.3 | | |
| Tanga | 99.8 | 99.8 | | |
| Kusini Pemba | 87.5 | 87.5 | | |

Sources: Field work 2011

Almost all interviewed villagers in Iringa and Tanga (99%) agreed that they think that there are changes in planting and harvesting time for maize due to climatic changes , Kusini pemba (87.5%),Mbeya (81.3%), mtwara and kagera also reported almost the same observations. However respondents in Shinyanga (56.3%) felt that few change for maize crop was noted in their areas. Other crops whose famers felt that their harvesting and planting period has undergone changes include Paddy and Cassava; the changes for Paddy were noted in only by farmers from Kusini Pemba and Mbeya while other regions such a Arusha,Iringa,Kagera,Mtwara, Tanga and Shinyanga did not feel that there were significant changes. Many interviewed farmers from Kagera(56.3%),Kusini Pemba(62.5%) and Tanga(70%) felt that there were significant changes in terms of planning and harvesting time for Cassava. The data indicate that there were significant difference in the farmer's perception on where climate changes had affected the planning or harvesting time and therefore income. We could not find the reason for this situation, but we suspected that the regional difference in perception on the effects of climate changes among interview famers depended on whether the crops was a major crop or not; for

instance the perception for climate change effect for maize was low in Mtwara region and high in Mbeya at the same time for cassava the perception for climate change was high in Kagera, Mtwara, Kusini Pemba and Tanga and low in other regions such as Shinyanga, Mbeya, Iringa and Arusha. Surprisingly, almost all the interview famers in visited regions thought that there were no significant changes in respect of millet and sorghum while studies have established changes in almost all food crops including the drought resistant crops such as Millet, cassava and sorghum.

The regional analysis also provide surprising results as most interviewed villagers perceived that there were no significant differences in terms of planting time and harvesting for cash crops such as Coffee, cotton, tea, tobacco and even farmers from Kusini Pemba reported the same for cloves. However, majority admitted that crops harvest had declined due to many reasons: lack of rain and decline in soil fertility were among the reasons. Only interviewed famers in Kagera region who thought that there were significant changes in planting, harvesting time and yield for coffee compared to the past years such as in the 1960 and 70s.

Generally, Farmers also indicate that rain has become unpredictable in the recent year hence affecting their farming plans. Furthermore, interviews with farmers indicated that 55% of farmers feel that high temperatures affected the crop production and livestock negatively, 25% indicated that floods and 15% noted that drought affected their crop production and livestock keeping. In the case of drought, 128 (79%) farmers noted the impact of the drought was severe, 21 (13%) thought of it as moderate and 10 (6.2%) thought of it as minimal. An example of the severe impact of the drought was given by one farmer indicating that , “ *the drought dried up all crops, I got 8 bags of maize instead of the 60 which I was expecting, I got 20 bags of rice instead of the 100 bags I was expecting in 2010*”. Most of farmers said that these changes were experienced in year such as 2004/2005, 2007/2008 and 2010/2011. The worst changes were noted to be in year such as 1994, 1997, 1998, 2004, 2005, 2009, and 2010. Other bad seasons included 1974, 1984, 2003, and 2004 as seen on the table below. During the interviews in Arusha during the month of May, some of the farmers indicated that “we planted our maize in March and we have been waiting for rainfall and there is not rainfall yet. The maize is starting to dry up during the critical time, we don’t know what we are going to do now. It is raining in patches and the rain has not reached our area yet (Arusha region interview, 2011).

Table 6: Years of Extreme events (drought)

| Year | Number of Interviewed farmers who were negatively affected by drought |
|------|---|
| 1994 | 6 |
| 1997 | 6 |
| 1998 | 12 |
| 2003 | 8 |
| 2004 | 8 |
| 2009 | 36 |
| 2010 | 24 |

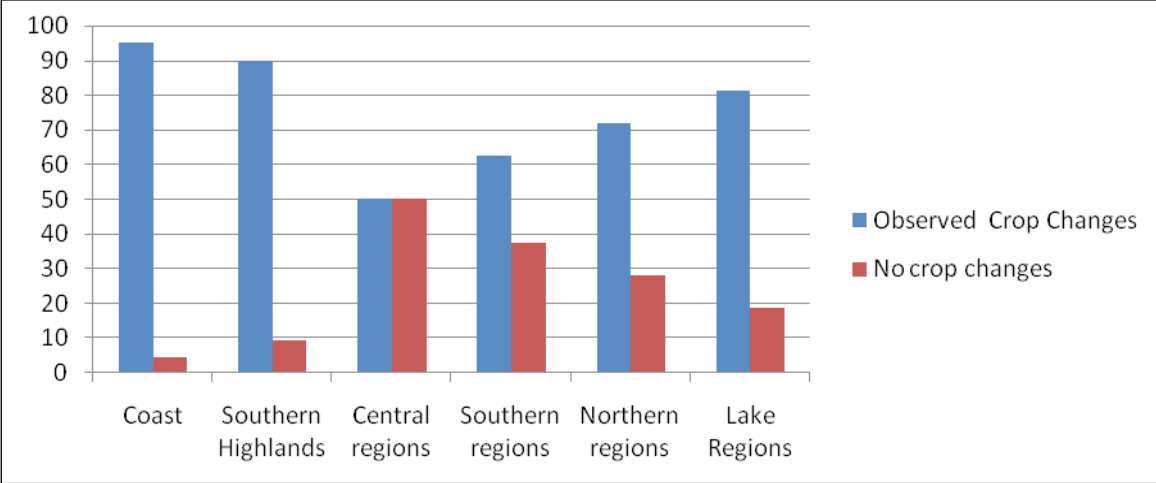
Source: Survey data

As the result of changes in rainfall and temperature farmers have noted the impact of these changes resulting in many other changes that affect crop production and livestock keeping. Farmers have noted reduction in livestock numbers and their products as discussed further under livestock challenges section. Farmers who also raise animals have indicated that one consequence of these changes is reduced areas for grazing, as availability of grass is reduced and this has affected the amount of livestock products such as milk. One farmer at Bhaghai village in Lushoto said that “*Mifugo imepungua kutokana na kupungua kwa malisho kulikosababishwa na ukame, mifugo mingi imekufa kutokana na kukosa maji*”, (“there is reduced number of livestock due to reduced pasture for feeding due drought, a lot of livestock have died due to lack of water”).

5.1.1 Reduction in soil fertility and crop yields

Some of the impacts of climate changes noted by farmers include reduction in soil fertility. In addition to the changes observed above that directly affect agricultural production in a negative way; soil fertility seem to negatively affect crop production to a large extent. Most farmers agreed that soil fertility has been reducing over the years. This has resulted in reduced crop production especially in high attitudes areas such as Lushoto district. Examples were given by farmers that compare to the past maize harvest has drastically declined, due to reduced soil fertility; hence, if they do not use fertilizer the harvest becomes so low. The figure below show villagers perceptions on climatic related changes in maize production; almost all zone in Tanzania agree on climatic effects on maize crops which is a major staple food in the country; surprisingly the central zone (represented by shinyanga region) seem to have a balanced perception on whether they did experience any changes in maize crop.

Figure 2: Zonal perception on climatic effects on Maize crop overtime

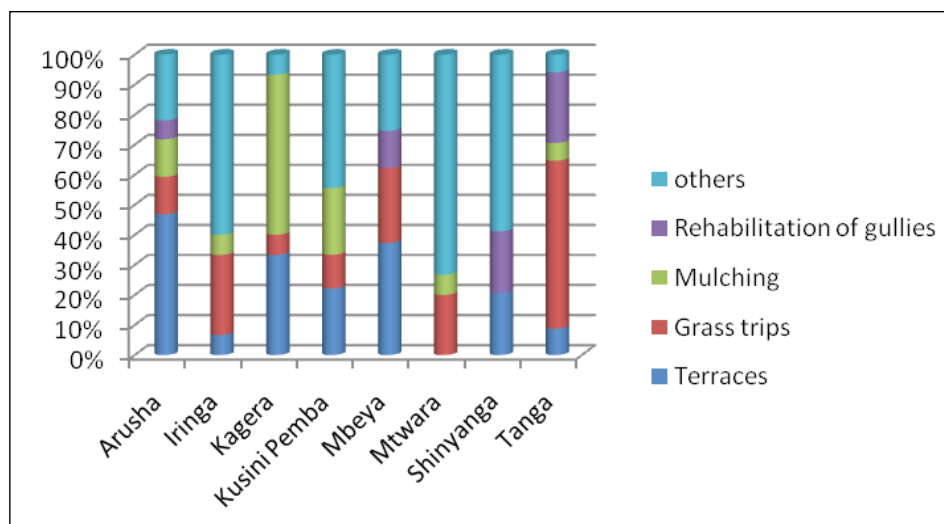


Source: Survey data

Some farmers indicated the sequence of yield decline as they said for instance “*in 2001 from 1 acre you could get 5 sacks of maize, in 2005 about 3 sacks and now even making one sack of maize can be a challenge*”. There is reduction in crop production looking at 3 and 5 years back crop production is not the same. There were more example of reduced crop production given by farmers, for example *one farmer indicated that “before from 1 acre you could get 25 bags of rice, 10 bags of maize, 15 bags of groundnuts but now you only get 10 bags of rice, 3 bags of maize and 4 bags of groundnuts”*(farmer in Mtwara region,

2011). In the group discussion one farmer indicated that “for the past 6 years samadi fertilizer has been used by people who can afford it”. Due to reduction in yields in maize and rice some farmers have opted to change the type of crops, now most farmers are farming vegetables, and other short term crops such as fruits. In the lake areas in year 2000 a boat would have up to 600kgs of fish now can hardly make it to 100kg”.

Figure 3: Soil Conservation Practices in Visited villages



Sources: Field data 2011

One can argue that soil fertility is not only influenced by climate change. Yes soil fertility can decline for a variety of reasons. Farming system may also contribute; Some common farming practices, including burning crop residues and leaving soil bare and unprotected from the sun and wind, are part of the problem. Excessive or insufficient use of fertilizers and improper crop rotations also lead to declining soil fertility. As noted in the discussions above, most farmers have mainly primary school education and live in rural areas. Livelihood choices for these farmers is limited, therefore decreasing crop yields is a serious challenge to their survival.

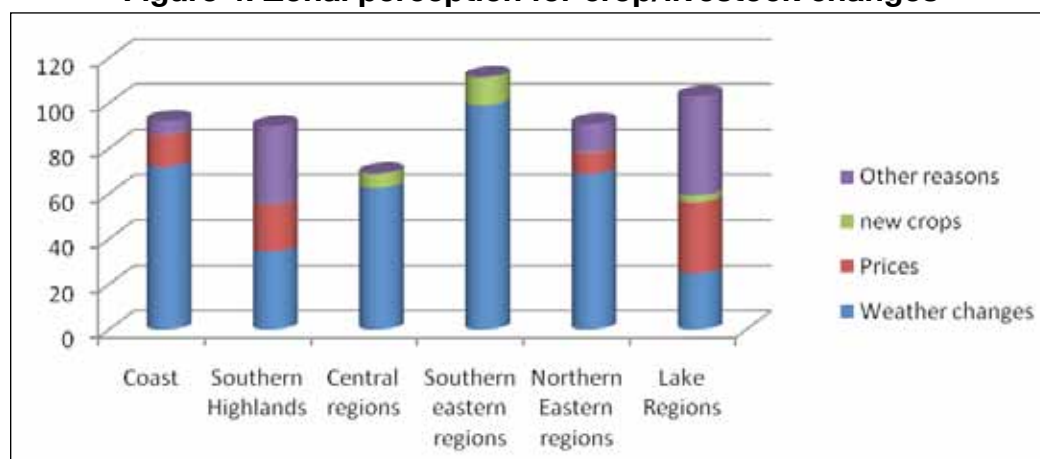
5.1.2 Disappearance of major crops, vegetable, forests, wildlife and water bodies:

Farmers have observed some changes in the type of crops that farmers prefer to farm now. Some crops are no longer grown or if grown its yields have declined such that farmers don't get equitable return. For instance farmers in Arusha region said coffee and tea has been replaced by sunflower and Irish potatoes because these are short term crops that mature within a short period and give good return to farmers. In another region, farmers indicated that some traditional crops such as cassava and bananas has disappeared due to drought, reduced soil fertility and increase in new diseases and pests. However, in a few regions some interviewed farmers said that comparing at the present and the past there are no changes as in their areas they are cultivating the same crops; but only difference they observed is that the crop production (yields) has been reduced overtime.

Others said that old types of seeds for crops have disappeared (maize, beans, banana, millet, mangoes, oranges), One old man in Korogwe during the discussion said that the “maize and potatoes we used to grow in the past was sweet but are not grown now....

things have changed at the moment ...the old crops are not the current crops, and even the farming ways have also changed, in the sixties we were not using chemicals or fertilizer but now if you don't use you will not get the better yields". In addition to the disappearance of major crops, there have also been changes in what is considered as major crops in different areas. Farmers interviewed noted that there have been changes over the past ten years on what is considered as a major crop. 85,2% of farmers interviewed indicated that there are changes in the type of crops they farm over the past ten years and 56.8% noted that these changes are frequent depending on the availability of rain. Although climate/ weather changes have been contributing significantly in farmers shift into new crops, prices changes, world demand for new crops have been contributing into crop livestock changes.

Figure 4: Zonal perception for crop/livestock changes



Sources: Field work 2011

The figure above show the zonal perception for the reasons for crop/livestock changes. Weather changes drives the changes almost all the zones, however prices seems to have some significant effects in the lake regions, southern and coast areas. As noted above farmers tend to diversify the crops they grow as well as their economic activities as a coping strategy for the climatic and other world wide changes.



In 2000/2001 main crops were considered to be Maize – 94 (58%), Rice – 23 (14.2%), bananas – 16 (9.9%) and cassava – 13 (8%), second main crops: cassava – 38 (23.5%), maize – 28 (17.3%), beans – 24 (14.8%) and cash crops: cotton – 14 (8.6%) and coffee – 29 (17.9%). By 2010/2011 first main crops: maize - 169 (67.3%), rice – 26 (16%), second main crop: beans – 24 (14.8%), cassava – 39 (24.1%), potatoes, maize, rice, third main crop: ground nuts – 11 (6.8%), cassava – 10 (6.2%), millet – 10

(6.2%) and bananas – 15 (9.3%). According to the interviewed farmers these changes in the type of crops is influenced by the changes in climatic conditioning especially availability of rain and changes in temperature, however the market conditions have also contributed to the change in crops grown, the market conditions include the demand and prices of the crops in the domestic and international markets. According to the farmers, cultivating crops such as vegetables, fruits, flowers provide more money (returns) when selling and they take a shorter time in and also cope well with short rain seasons that prevail at the moment. In general climate change has influenced the agrarian livelihood in terms of the type economic activities and genders roles in the families as will explained later.

Villagers who were interviewed also said that some wildlife that was available in the areas is not seen anymore. Animals such as pigs, rats, kanga, buffalo, and antelope were many in their areas but now they have disappeared. For supporting their livelihood People keep on destroying the forests and creating space for farms so animals move further away. Other reasons that have contributed to disappearance of animals include urbanization, drought, population increase and hunting. Big Forest that existed in the past in their areas has substantially reduced and disappeared in some areas due to population and economic activities increase and drought affecting growth of forests and water resources. Farmers also said that they have also observed changes in rivers/stream flow. There is reduced amount of water in the rivers and some small streams have dried up completely. When the study team visited the Longomba research institute the researchers managed to show how big the river that is passing near their centre was, but at the moment it is so small such that someone can cross by walking, something that was not possible in the past ten years. They also said that is the reduced amount of water in lakes and rivers has resulted in reduced number water bodies near their villages such as fish, reptiles, and other animals such as the hippos and crocodiles etc. In Muheza villagers also noted that one river that used to have water throughout the year in the past but now it is a seasonal river with little amount of water.

5.1.3 Proliferation of diseases, insects and obnoxious weeds:

In an interview farmers said that new diseases that have been observed include *mnyauko* bacteria in banana plantations, bana-By wival, Rice-By flora, these did not exist in the past. However, there is also an increase of some types of insects in some places such as *Viwavi Jeshi*, now they appear every year while they used to appear once in a while. Obnoxious weeds have been noted by farmers in some regions, some regions have not experienced an increase in weeds. Farmers noted that “some thorny weeds are new in the area they were not here before”. They have affected and reduced beans production. Farmers also noted that a reduction in palatable grass which has been overtaken by unpalatable grass (interview with a farmer in Arusha region, 2011). Due to the changes in temperature and rainfall some new weeds and insects are surviving and creating challenges for farmers. As new insects, diseases and weeds take over the farms, they affect the farm output and as a result threaten the livelihoods of farmers.

5.2 Challenges in Livestock Keeping

Tanzania is the third country in Africa after Sudan and Ethiopia for owning large number of cattle and the livestock industry contributes to around 4.7% of GDP in Tanzania. The statistics indicates that by 2009, there were 19.1 million cattle, 13.6 million goats, 3.6 million

sheep, 1.6 million pigs and 56.0 million poultry. In Tanzania there are three types of livestock husbandry systems in a form of pastoralism and commercialized intensive systems; 1) Pure Pastoralists – “Ufugaji asili”; 2) Agro-pastoralist “Ukulima na ufugaji” and 3) Intensive livestock keepers “Ufugaji shadidi” (Mashingo, 2010). In the surveyed areas, farmer practise agro-pastoralist and villagers keep the following animals cattle, chicken, pig, goat, and ship; while chicken and goat are most raised animals. When interviewed villagers were asked the reason why they keep these type of animals, more than a half (54.3%) said that livestock increases their income after sell of the animals and its products, while the other reasons included nutrition factors (for milk, meat, eggs etc). Respondents also said that raising animals provide some sort of safety nets- an insurance when faced with problems. The table below show the common animals kept by many villagers in the visited areas between the periods of 2005 -2010. The picture is that few villagers keep few livestock (3.4 -30.2% for pigs, goats, chicken ship and cattle) amounting to 1 and 9 and majority don’t own even a single animal (58-95% of the respondents).

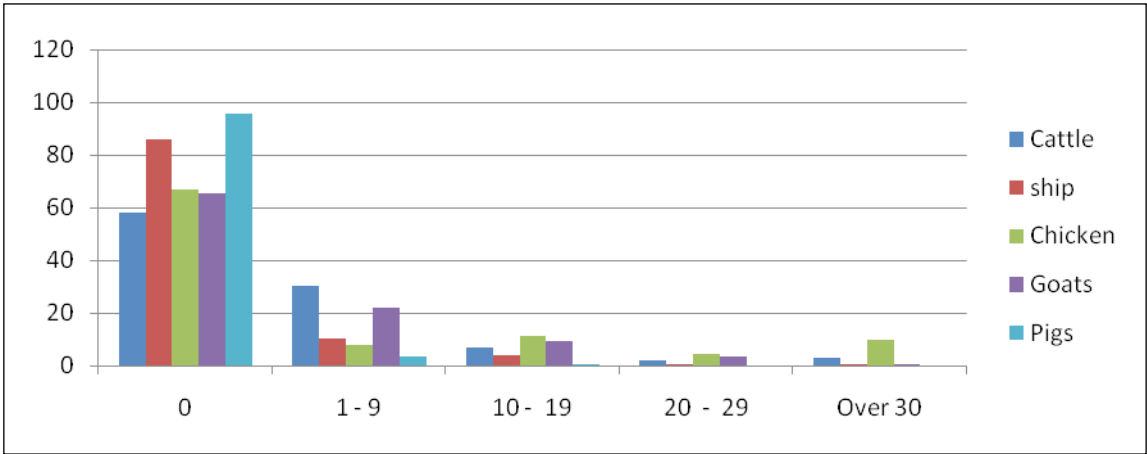
Table 7: Type of animals common raised in Families in Survey Villages (2005 – 2010), N= 162

| Amount | Percentages of Households Owning Animals | | | | |
|--------------|--|------------|------------|------------|------------|
| | Cattle | ship | Chicken | Goats | Pigs |
| 0 | 58 | 85.8 | 66.7 | 65.4 | 95.7 |
| 1 – 9 | 30.2 | 9.9 | 8.0 | 21.9 | 3.4 |
| 10 - 19 | 6.8 | 3.7 | 11.1 | 9.3 | 0.6 |
| 20 - 29 | 1.9 | 0.3 | 4.3 | 3.1 | 0 |
| Over 30 | 3.1 | 0.3 | 9.9 | 0.3 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 |

Source: Survey data

The figure below indicates animal ownership in visited villages. The figure clearly shows that many of the respondents don’t own livestock (74%), about 15% own 1 to 9 of all kept animals; while 6.3% own 10 to 19, 2% and 2.7% own 20 to 29 and over 30 animals respectively. Here the same message is depicted in the graph as in the table above.

Figure 5: Type of animals common Kept in Families in Survey Villages



Source: Survey Data

Several reasons were given by the interviewed villagers for keeping livestock they have. The interesting point from among the reasons for keeping livestock was that livestock is used as safety net during crisis; this has to be encouraged given the current price instability for cash and food crops in the markets, livestock helps to cushion income changes due market instabilities. Establishment for livestock raising projects at family level such as traditional chicken, goats, pork could be one way of getting out of poverty for many villagers. However, livestock keepers complained of lack market for animal products. In terms of reasons for expansion/decrease in livestock keeping, the responses were somehow divided as 80 (50.2%) agreed that they have increased the scale of animals kept while 79(48.8%) rejected, while the reasons for not expanding the livestock keeping included; expenses related with care, difficulty of feeding animals as pasture and water resources have declined other factors included; lack of price incentives for the animal products at the same time the cost of keeping livestock is escalating (medication) etc.

Among all the reasons draught was sighted as a major reason as one villager said “*due to draught many animals die as result many young people migrate to urban areas to look for jobs*”, this does not surprise as nowadays many young people and Maasa is who normally practices livestock keeping are now in cities doing other economic activities. This could be one social impact of climatic change. However, other villagers said that they increased their grazing as more income is earned from livestock keeping, prices for animal products in their areas has gone up and also livestock keeping provide safety net for unanticipated events in future.

The interviewed villagers also said that challenges related to shortages of land and pasture have led to changes in livestock keeping style, as more villagers practise zero grazing system now unlike in the past where majority of the pastoralist practised nomadic type of animal grazing. This was indicated in the study as 41.1% and 25.3% of the livestock keepers practice zero grazing and nomadic type of feeding animals respectively. Some studies have indicated that the distance to grazing and watering points increased with advancement of drought. In a particular a study carried out in Northern part of Tanzania indicated that over years the distance to water sources for livestock keepers increased from 5.5 to 16.4 km due shortages of rain and increase in drought, this is a big challenge for pastoralist and farmers who face difficulties to cope with climate related cost for their lives.

Other climate changes that have negatively affected livestock keepers included the increase or arising of new diseases attacking animals. However, few of the interviewed respondents reported facing new diseases, for example 52 farmers (32.1%) reported their animals being affected with new diseases while majority experienced almost the same type of diseases 109 (67.3%). They mentioned new diseases such as *Ndigana* and *Kizunguzungu* attacking cattle and bird flu attacking chicken. Most of them did not know where these new diseases come from but some thought that they are related to weather changes causing shortages of rain that makes land dry and dust that spread bacteria, migrating insects, while sometimes abnormal or heavy rains casing floods spreading virus and bacteria.

Climate change also has a negative impact to Tanzania's livestock as they reduce their outputs such as meat, hide and milk due to decline in pasture and water. This was also confirmed in this study as livestock keepers in Arusha, Lushoto, Arumeru and Mbalali said

that 'livestock keeping and its products³ declined due to reduction of pasture caused by drought and in some years many animals died due to lack of water. Other weather related impacts include increase in migration by pastoralist, leading to conflicts between farmers and pastoralists (for instance the recent fight between Maasai and Wasonjo in Ngorongoro District). Although some could not remember the worst years correctly, some mentioned years such as 1974, 2004/05, 2009 as they experienced bad drought weather condition, while years such as 1998 and 1999 had severe floods.

Figure 6: Land with no pasture and water due to drought



Source: Action aid

5.3 Socio-economic impact due to climate change

Many farmers in Tanzania depend of rain-fed agriculture and this means their crop production and livestock keeping depend on the weather. A good season means good output and bad season means compromised output. As farmers depend on their output as their main source of income when there is bad output it means many other aspects of the farmers life and family will be affected negatively.

5.3.1 A shift in Family and Gender Roles

One of the socio economic impact of climate change is related to changes in the gender roles. Women in visited villages in Lushoto and Muheza said that due to drought they spend more hours searching for water and pasture at the expense of other economic activities and sometimes have to get up at midnight to fetch water. Due to lack of water near the villages men are now helping women with water collection. Men participate in fetching water using bicycles and other means hence these changes have altered the gender distribution of family roles. They also said that due reduction of forests fetching firewood has been difficult hence men also have to take bicycles or carts for fetching them. Fetching water and fire woods in the past were the primary roles for women but with scarcity even men now do involve in these activities.

Villagers in places such as Lushoto and Muheza the attributed the rural urban migration by young people and men is seen as caused by decline in agriculture yield and livestock

³ In Muleba Villagers gave an example of prices increase for milk from Tsh 1500 to 2000 per 5 litres and from Tsh 2500 to 3000 per Kg of meet as an indication of scarcity of the animal products as a negative impact of changes in climate.

productivity, this migration is sometimes seasonal. This seasonal rural urban migration has been a primary cause of HIV/AIDS as when men leave their families behind and when in urban areas they get involved in extra marital relationship with other partners. When they return to their villages and wives they continue with life without realising they have contract HIV, hence climate change has in one way or the other associated with HIV/AIDS spread as they cause families separation.

5.3.2 Income Change

As interviewed farmers mainly depend on crop and livestock output for their income and livelihoods, occurrence for bad seasons due to lack of rainfall, floods or drought means the farmers' income will be reduced. Interviews with farmers indicate that, there are two factors that determine the amount of farm output. These are the size of the farm and whether the season was good, in terms of availability and frequency of rain. Most farmers have small farms and only able to produce enough for domestic use within the family. This is discussed further under the section on land issues.

The second reason for not producing enough for sale is when farmers are faced with a bad season due to lack of rains, high temperature and floods. When there are changes in the season that affect agriculture negatively; then they neither produce enough for sale nor for their own food. This means their earning capacity is impaired and their income for other needs such payment for social services which nowadays is literally not free such as health and education for their kids is compromised. When villagers were asked which group in the society they think is much affected with these changes, they thought that them as farmers do suffer a lot, and within the families children and elderly people are most affect as they have less coping mechanism for the adverse effects for climate changes..

Families indicated that, when they produce a lot they do sell the surplus food produced. This happens when the farmers get a good season -116 (75.3%) farmers indicated that on a good season they do sale the surplus produce. In most visited villages crops produced for sale were mainly beans, maize, rice, bananas and potatoes. However, when farmers are able to produce enough for sale there are still challenges they face in selling their produce (marketing challenges). Farmers indicated that, when it is a good year with enough harvest; it is not necessarily translate to good returns from the crops they produce. Other challenges they face include low demand and selling prices, there is no freedom to decide the price and markets are unreliable markets as they are sometimes highly regulated by the government sometimes bans exports hence killing the market for their crops.

5.3.3 Effects on Employment and Jobs

During the bad season due to climatic changes such as drought and lack of rainfall, the community suffers due to reduced economic activities that provide employment opportunities. This because rural areas agriculture have big multiplier effects and provide a main source of employment when there are no rains it means there will be no/little harvest for crops reading to low need for jobs in farms.

Although some agriculture related activities provide only temporally employment or seasonal, with decline in rains, wage workers that are being used during harvesting have will have no

or little employment. This chain for decline in economic activities with the decline crops output also affect crops middle men who buy the produce from farmers will have no work as there will be no crops to buy and sale. This results in reduced income for the agricultural marketing chain to include; farmers, the labourers, and the middle men who buy from farmers. This climate change related decline in agricultural output, employment and income has another negative consequence in food security as less food is produced. Moreover, due to reduced crop output, the little food harvested makes food expensive and this will affect negatively everyone in the community and country in general.

Farmers indicated the due to reduced crop production and reduced income in bad seasons, farmers face problems in paying school fees. In addition farmers have indicated other challenges they face include high cost of living due to high cost of food prices as they said *“we lack money to take our children to school, eye diseases have increased due to dust as a result of lack of rain, poor health and poor quality of life especially with children and food is not enough to feed the family, people suffer from hunger and malnutrition. In dealing with these changes young people have migrated to towns looking employment. Families get separated as parents especially fathers have to move and look for employment elsewhere”*.

When villagers were asked to rank among the population which one was more affected with the said climatic changes, ; as seen in the table 7 below; their perception was that comparing children ,men, women and elderly, the population group that has been mostly affected were the mainly women, young children and the elderly..

Table 8: Population groups mostly affected by climate change

| Group | Minimal | Moderate | Maximum |
|--------------|------------|------------|-------------|
| Below 18 yrs | 21 (13%) | 28 (17.3%) | 102 (63%) |
| 18 – 45yrs | 37 (22.8%) | 54 (33.3%) | 39 (24.1%) |
| Over 45yrs | 10 (6.2%) | 39 (24.1%) | 95 (58.6%) |
| Females | 7 (4.3%) | 17 (10.5%) | 117 (72.2%) |
| Males | 31 (19.1%) | 58 (35.8%) | 38 (23.5%) |

Source: Survey data 2011

Males between the age of 18- 45 years are less affected because they have the “ability to move from the severely affected areas to another and probably look for alternative employment options elsewhere, leaving the elderly, women and children behind with limited assistance. Apart from economic hardship associated with climate change that reduce farm productivity, women also suffer emotionally thinking (psychological effects) on how to feed their families with the children looking up to them to provide food which may not be available. *During the interviews women also said that “nowadays we walk very long distance to look for water and firewood and sometimes we have to get up midnight to go and fetch water. Fathers migrate to towns and turn into alcoholics while mothers and children suffer back home. Old people and children have no means to look for alternative ways to access food that is why they are badly affected especially those with no children to assist them”*. The elderly and children are dependants and tend to suffer more. They also said that “due to lack of enough foods in their families, children suffer from malnutrition and sometimes parents cannot pay for their school fees and other educational needs”.

Climate change has a massive negative socio economic impact on the farmers that depend on crop and livestock farming for the survival. As noted the climate has been changing and is continuing to change with increasing frequency of floods, droughts and variations in rainfall. Changes in rainfall and increasing frequency of extreme events impact negatively on crop farming and livestock keeping. When the crop farming and livestock keeping output is reduced, it results in reduced income, employment, spread of diseases and general suffering of poor families that depend on agriculture for survival. The question then is, how do we manage the environment to reduce the negative impacts of climate change and what adaptation strategies are being used by farmers to cope with the changes. In the next two sections i will explore environmental management in Tanzania in general and its application with the farming communities interviewed under the first section. The second section looks at adaptation strategies farmers are using to cope with climate changes they are facing and what more could be done to assist the farmers.

5.4 Environmental Management and Climate Change

Tanzania has several national programmes and strategies to address climate change. These programmes and plans are in line international agreements. Apart from these programmes and plans there is the Tanzania Development Vision 2025 strategy that is focused on addressing development, economy, environment and social issues. In support of addressing environmental issues there is Environmental Management Act (EMA, 2004). In addition to the act, there are several programmes that either focus 100% on the environmental management or have some aspects of environmental management in their objectives. These include the national strategy for growth and reduction of poverty (MKUKUTA I and II), Tanzania National Adaptation programme of Action (NAPA) 2006, Tanzania REDD strategy, The Tanzania Agricultural Sector Development programmes (ASDP), The National Forest Programme (NFP), 2001-2010, and Rural Development Strategy (RDS).

There are a number of institutions and actors responsible for environmental management from national to local levels. These include the National Environmental Advisory Committee, the National Environmental Management Council, Sector Environmental Section (in the Ministry), the Regional Secretariat, the Standing Committee on Urban Planning and Environment, the Standing Committee on Economic Affairs, Works and Environment, Village Development Committee and Environmental Management Committee. Their functions include providing links between different ministries, research, to enforce and ensure compliance of environmental management, environmental impact assessments, coordination and implementation of environmental plans. After discussing the programmes, plans and strategies and institutions that their main function is to implement these strategies, now the research project will present what had been observed on the ground during fieldwork on environmental management.

Interviews with farmers indicated that there are number of projects on environmental management. Some of the projects mentioned by farmers include crop diversification by different players such as IRA and Uyole Department of Natural Resources Project, -REKODA, TACRI, CARMATEC, HIMA (Environment Conservation) and DANIDA. These projects were being implemented mainly by government and funded by Development Partners (DPs). Farmers pointed out some of the activities they were involved in environmental management as seen on Table 8. These included controlling deforestation, indicate also indicated some

measures that are being taken to protect the environment. All farmers indicated the emphasis on planting trees. The tree planting projects implemented through DASIP. With the tree planting projects farmers expected that the rain will come and stop the long dry seasons. Another common activity was prevention of burning forests with the same expectation of receiving rains soon. Control of overgrazing and changing of farming systems was not common practise of environmental management in adapting to climate change. This will be discussed further under adaption strategies.

Table 9: Summary of measures to deal with climatic changes and poor environmental management practices

| S/N | MEASURES | PERCENTAGE |
|-----|---|------------|
| 1 | People have been stopped farming next rivers | 75% |
| 2 | Agreed that there has been preventing in burning forests | 90% |
| 3 | Controlling deforestation | 85% |
| 4 | Planting of trees | 100% |
| 5 | Introduction of new crops and animals that can with stand the drought | 75% |
| 6 | Control of overgrazing | 60% |
| 7 | Education on environmental management and information | 75% |
| 8 | Changing farming systems | 65% |

Source: Survey data

Although interviewed respondents appreciated the presence of the environmental management projects in the areas, they however, agreed that the current efforts to rescue the environment are inadequate to deal with the environmental conservation issues and thought that the private sector could be convinced to put more resources to assist the government as it is short of resources. Institutions such as Commercial Banks, Pension Funds, mining companies and other foreign investment firms could be approached for that matter.

When farmers were asked what were the cause of all the said environmental changes, farmers listed a number of factors such as: increase of population that also increase economic activities, destruction of water sources, deforestation that has resulted in reduced rain and drought. Other contributing forces included increased farming and urbanization taking up land and forests which were initially used for grazing. According to the villagers the primary causes for the events is the change in weather conditions happening in the world today.

The brief discussion about on environmental management in Tanzania shows that on paper there are limited strategies and policies on environmental management strategies. Apart from the limited strategies and policies, the planning and funding on the environmental strategies has problems. Most strategies on paper, apart for the international strategies on planting trees and reducing deforestation, there are limited tangible strategies on what poor farmers on the ground need to do to deal with climate change. The focus is on the management of the environment by planting trees and avoiding deforestation, issues on climate change such as frequent floods and drought need to be emphasized also in

environmental management strategies. In the next section, adaptation strategies will be discussed and in relation to environmental management and climate change.

5.5 Adaptation Strategies

As noted in the discussion above environmental management is mainly focused on preventing further damage to the environment. Yes this is a good strategy but there is need to also address the current challenges farmers are facing. Interviews with farmers showed that about 80 respondents or 49% admitted to have received support from the government for combating climate related disasters while 82 or 51% of respondents had not received any help from the government. The type of support received included food during drought seasons, seeds once in a while, extension services to some places and fertiliser. As such, most of the respondents i.e. 145 (89.5%) said this support from the government is still inadequate because even the food assistance they received was only enough for some few days and that some of the seeds did not grow. Apart from food and seeds, farmers also indicated that they do have seminars once in a while on climate change and environmental management with the emphasis on planting trees and noted above. Apart from the government assistance farmers also indicate different strategies they are using in adaptation to climate change. Some of these adaptation strategies are discussed below.

5.5.1 Coping strategies for livestock keeping

In order to cope with the effects of climate change at household level, some pastoralists diversify their economic activities by doing both agriculture and animal keeping; this confirms what the National Census statistics that had earlier indicated that 3% of the 3.7 million households in Tanzania are pastoralists and seven 7% are agro-pastoralist. Other coping mechanism for pastoralists included; involvement in petty trade, shifting from one area to another. Pastoralists from these drought prone areas usually moved with their animals from one place to another in search of water and pastures. These movements in most cases are not planned and not coordinated to negotiate resource use which sometimes results into conflicts between groups (farmers vs pastoralist, pastoralists vs government e.g. Ihefu, Rukwa, Mbalali cases etc). Other measures include change of new breed of animals that resist diseases and climate change impacts, construction of dams for water storage. In Muheza and Lushoto the interviewed livestock keepers said that they have abandoned the traditional cows that could not resist new diseases and also practise zero grazing that need more grass cutting along the river banks.

5.5.2 Livelihood Diversification

As a coping strategy people have diversified their economic activities; for instance they also altered their lifestyle and switched to other income generating activities such as: Young people have established for motorcycles driving business-Bodaboda(Figure ..below), selling of oil and petrol, saloon, petty shops and business, small scale poultry keeping, selling food items across the roads and shops as a new income generating activities. There have been some changes in population dynamics, in some areas people have been migrating seasonally or permanently from one area to another especially from rural areas to urban areas, there is a need to conduct a thorough research for this climate change

related migration in the country. Such dynamics has resulted in some negative social and economic impacts as noted in the discussion above on the social economic impacts of climate change. For instance the discussion with some villagers in Muheza district indicated that one of the effects of such climate change is seasonal migration that cause HIV/AIDs spread as partners engage in other sexual relationships with other partners when they are away from their families.

Figure 7: Boda boda transport (new economic activities)



5.5.3 Soil Conservation

In order to preserve soil fertility, farmers use various ways: out of the interviewed villagers some use terraces (30.2%), mulching (14.8%), grass strips (11.1%) and other traditional methods (20%). However, some farmers still do not use any methods to preserve soil fertility as seen in Table 9 below. Although the percentage of those who do not practice any conservation methods seems small, there is a need to encourage this group to at least use one of any means to preserve their soil to preserve for its fertility.

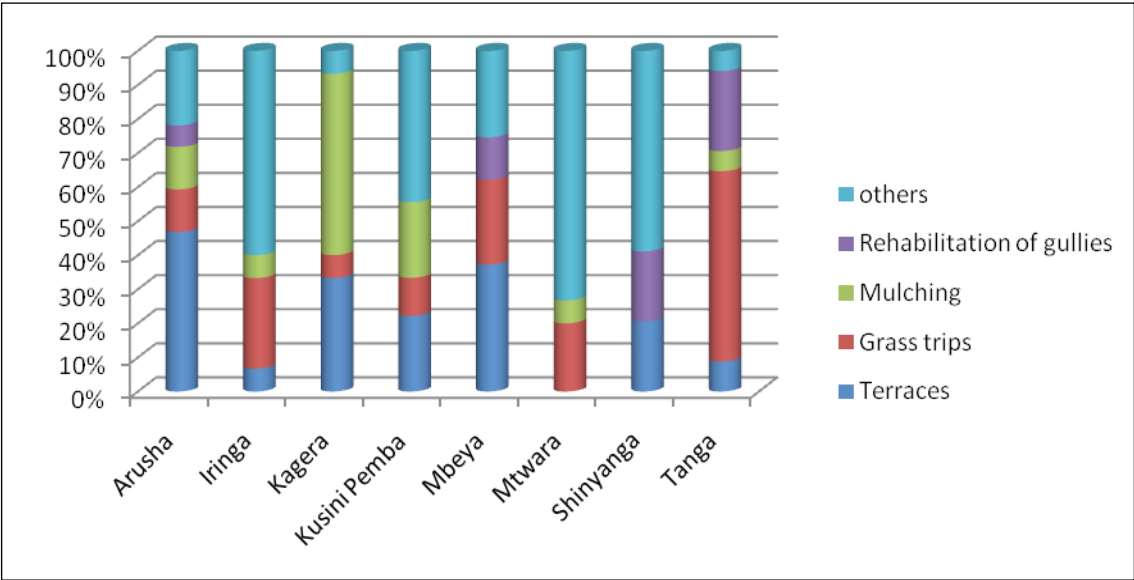
Table 10: Soil Conservation

| S/N | Soil conservation | Number of farmers | Percentage |
|-----|---------------------------------------|-------------------|------------|
| 1. | Terraces | 49 | 30.2% |
| 2. | Mulching | 24 | 14.8% |
| 3. | Grass strips | 18 | 11.7% |
| 4. | Other | 39 | 20% |
| 5. | do not practise any soil conservation | 23 | 14.9% |

Source: Survey data

Shifting cultivation is one of the soil conservation practised by farmers. Out of 154 farmers who responded to this question, 48 farmers (31%) agreed that they do practice shifting cultivation while majority of them 106 (69%) do not practise shifting cultivation. Farmers indicated that, they normally leave some farms empty for sometime before using them again, so that the land can recover its fertility. Crop rotation is another method mentioned by farmers as one of the means they use to preserve soil fertility and ensure soil conservation. Farmers in Arusha indicated that, they use crop mixing as a method to ensure soil fertility. They mostly mix beans and maize. Shifting cultivation, crop rotation, crop mixing are some of the traditional methods that have been used for years to preserve soil fertility and are still being used during these times of high climate variations as some of the adaptation strategies. The conservation application in the selected region is indicated in the figure below

Figure 8: Soil Conservation Practices in Visited villages



Sources: Field data 2011

Mulching is applied extensively Kagera, Kusini Pemba and Arusha, while grass trips in Tanga, Mtwara, Mbeya and Iringa. Rehabilitation of gullies in Tanga, Shinyanga, Mbeya, while terracies in Mtwara, Shinyanga, Iringa and Kusini Pemba. However, as stated above few farmers do apply modern methods for soil conservations; there is a need to sensitize famers on the need for soil conservation.

5.5.4 Fertilizers

The major reason for shifting cultivation as revealed by these farmers was to restore soil fertility that is normally lost from excessive farming and soil erosion. In addition, farmers use different ways to manage their farms. About 100 farmers or 67.5% of all who were interviewed use local manure from livestock commonly known as samadi. Apart from this, others use industrial fertiliser, pesticides, certified seeds and pesticides. Although the chemicals applied in these crops, are said to have positive impact to crop production; the challenge is how to minimize their associated negative effects and cope with environmental management aspects. The summary is provided in Table 10 below:

Table 11: Farm coping strategies

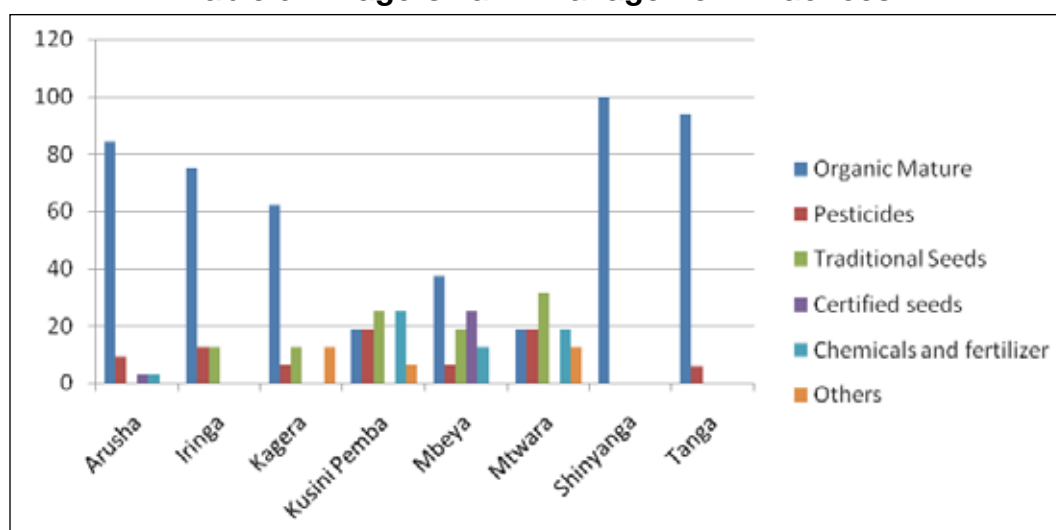
| S/N | FARM MANAGEMENT PRACTICES | NUMBER OF FARMERS | PERCENTAGE |
|-----|---------------------------|-------------------|------------|
| 1. | Use of local fertilizer | 100 | 67.5% |
| 2. | use pesticides | 15 | 9.3% |
| 3. | certified seeds | 15 | 9.9% |
| 4. | chemical fertiliser | 10 | 6.2% |

Source: Survey data

The data from the table above clearly show that most farmers cannot afford buying industrial fertilizer, seeds, pesticides as these inputs prices are too high for them. Instead farmers said that they use traditional inputs such as local seeds, fertilizer (manure) from livestock and non industrial chemicals such as Muarobaini and other trees as a pesticide. In addition there are other traditional methods and modern practices which can help boost soil fertility, and assist farmers in making their farms more resilient and resistant to the changing climate. These include micro-dosing of fertilizer, using rather than burning crop residues and other organic matter, planting nitrogen-fixing crops and trees, making good use of compost and manure, and taking steps to prevent wind and water erosion. Although these traditional inputs are believed to be environmentally friendly; it is not very clear how effective they are or how many farmers use these methods. There is limited research on their applicability. Some farmers indicated that, they would have also liked to use fertilisers but they cannot afford to buy. So they normally just plant the seeds and hope for the best which does not work in most cases.

Most famers in the visited villages rarely use modern farm management practices such as organic mature,pesticedes, traditional and certified seeds, or chemical fertiliser. The figure below show the farm management practices for the interviewed villages in visited villages

Table 9: Villagers Farm Management Practices



Source: Field data 2011

The message we get from the above figure is that few villagers do apply modern agriculture techniques in their production as few villagers do apply pesticides, certified seeds, modern chemicals and fertilizer, instead they use traditiona seeds.The inability of most farmers to

apply modern agriculture explains the low productivity and food insecurity problem in some parts of the country. Few regions record comparatively higher rate in the application of certified seeds, fertilizer, agrochemicals and modern seeds these include: Arusha, Mbeya, Iringa and Kusini Pemba. There is a need to find ways to assist farmers to apply modern methods for agriculture inputs, however such applications require huge investments in terms of agricultural input subsidies, extension services and capacity development and so on.

5.5.5 Drought resistant crops/seeds

A few farmers have indicated that they use new types of maize seeds that produce maize within a short time and do not require a lot of rain. Therefore, farmers are trying to adapt to the changing climate by changing the type of seeds they use. This change has been noted by farmers in Bukoba and Arusha indicating that there is a change in the type of bananas they plant now compared to before, banana plants are called FIA. As the amount of rainfall is reduced they tend to plant types of bananas that can resist drought. In Mtwara farmers indicated that there was a new type of cassava that has been introduced but farmers are not so keen on it. They indicated that, yes it does produce a lot of cassava, but the cassava is not very tasty and people do not like to use and therefore no market for it.

5.5.6 Irrigation farming

Irrigation farming is being used in some areas. In Arusha, a small group of women who are mainly farming vegetables indicated that there was a project by an NGO on drip irrigation where they were taught on how to use drip irrigation on the vegetables. Since the project they have been using it and it has worked very well for them. Before they were farming maize, but now they have stopped and mainly farm vegetables because they take a short time and they can do up to three seasons in one year. This project seems to have been helpful to a few farmers. With the success of this project, possibilities of implanting it in different areas need to be explored and funding as an adaptation strategy to farmers. There are other forms of irrigation that are being used by farmers, but this is done on a very small scale when compared to the demand for irrigation. Irrigation has a lot of potential for farmers in Tanzania but most farmers do not use it because of lack of resources. Many small scale farmers do not have financial means to install an irrigation system in their small farms. As a result many tend to farm near the rivers and create more environmental problems.

The discussion above indicates that farmers are using different methods as adaptation methods in coping with climate variations. Although there are attempts in adapting to the changing climate, these are not enough and more needs to be done. More needs to be done in cases of extreme events such as floods and droughts which have become more frequent than experienced before. The government and communities have and need to work together and find ways to deal with these extreme changes which threaten food security.

Other coping mechanisms which are in place also need to be implemented more effectively. For example some farmers indicated that they cannot afford to buy the modern seeds or fertilizer to improve their crop productivity. Although seeds are meant to be subsidized by the time they get to farmers there are some costs involved that makes it difficult for very poor farmers to have access to the seeds. This is the same with fertilizers.

Irrigation is another coping strategy that has a huge potential as a coping strategy but it is very expensive and majority of small scale farmers who are far from water sources cannot afford. There is need for government and other sectors to come in and assist farmers with irrigation projects such as the one which has been done in Arusha. There is need to explore different irrigation projects that are cost effective and easy to maintain that could be implemented in poor farming communities.

Another coping strategy that could be implemented more effectively is early warning system on changes in temperature and rainfall. Farmers complained that the warning system that is used now is now adequate. The warnings come late, sometimes incorrect and after the warning the government does not suggest what farmers could do to cope with the coping changes. Farmers noted that, they normally get this information from TVs and radios as supplied by the Tanzania Metrological Agency (TMA) and sometimes from extension officers or political leaders. Climatic information and early warnings need to get to farmers on time and farmers should be advice or provided with strategies on how to deal with them.

Interviewed villagers also agreed that the information is normally from media sources, the information however covers many areas, it is too general for them to understand what it implies for farming and other economic activities. Their request to the government was that the information provided need to be area specific. Weather early warning and strategies should get to farmers early enough to make a difference in farmers. To supplement what is provided by TMA, Information such as provided by FEWSNET need to reach farmers early for making informed farming decisions.

5.5.7 Conclusion and Policy Recommendations

The overall objective of this study was to assess the effects of climate change on small scale farmer in Tanzania in the past decade, explore the environmental management that are being used and adaptation measures and policies to cope with climate change. Eight geographical regions were selected and from these regions interviews were conducted from 12 districts and 20 villages. From the interviews the aim was to explore certain factors related to the impact of climate change including challenges factors face in terms of crop production and livestock keeping related to climate change and how farmers were dealing with these changes.

Farmers indicated that both crop farming and livestock keeping has been affected negatively by climate change. There has been an increase in the frequency of extreme events such as drought and flooding which has reduced soil fertility and yields from crop production and livestock keeping. There has also been disappearance of major crops in some areas as farmers are trying to farm crops that are able to survive short or no rainfall. These changes in turn has resulted into socio economic challenges such as spread of diseases such as malaria in areas where there was no malaria before, reduced income, lack of employment (which in turn affect people's health, access to education and food) and conflict between livestock keepers and crop farmers among many other problems. Mostly children, women and the elderly are mostly affected by the resulting impact of climate change as they have limited resources and mean to cope with the changes. Men would migrate to urban centres and look for casual employment and women, children and elderly remain in the village facing the problems alone with no support.

In coping with the impact of climate change, environmental management and adaptation strategies that are in place are not adequate to cater for challenges small scale poor farmers are facing in Tanzania. The current environmental management that are emphasized on are on planting trees and combating deforestation. These are good strategies in addressing climate change and environmental management. During interviews farmers indicated that, yes they have been planting tree but are still waiting for the rain which is not here yet. Farmers understanding is when they plant trees next season they will get rain and the problem of drought will go away which is not necessarily the case. This idea is mainly from the many environmental strategies that are based on international convention. In addition to these strategies it is important for individual countries like Tanzania to focus on international challenges of climate change and find ways of addressing these challenges to fit the local situation. There is need for climate change adaptation strategies that will assist farmers more directly especially poor farmers who cannot access some of the coping strategies such as fertilizers and seeds. There is also need for better early warning systems and coping strategies for droughts and floods.

As a recommendation, respondents argued that they need more education on how to deal with climatic changes and if possible, the government could help with machinery and other farming equipment. In addition, they also requested the provision of loans, to assist them diversify their economic activities in other sectors as climate changes affects farm and livestock products.

The climate changes and variations have always been occurring and in recent years the change has been happening at a higher rate than observed before. These changes are predicted to continue at an even higher rate in future. With 80% of Tanzanians depending on agriculture for survival there is urgent need to explore various coping strategies, safety nets and policies that will prevent farmers falling into poverty due to lack of food and income from agriculture activities and livestock products. There is also a need of having consistent strategies and improved institutional capacity and planning within different ministries and other stakeholders to address different challenges farmers face due to climate change.

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