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Climate Change Adaptation Practices for Sustainable Food Production in Rombo District, Tanzania

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Abstract

Although various studies on climate change and food production have been conducted, information on how households in Tanzania respond to climate change for sustainable food production is scarce. This paper investigates climate change adaptation practices in enhancing sustainable food production in Rombo District, Tanzania. The study adopted a cross-sectional research design. Quantitative data were analysed by using the Statistical Package for Social Sciences software, while the qualitative data were analysed through factual and logical interpretation of the findings. Results show that drought was the main effect of climate change as reported by 65.7% of the respondents in the study area. Furthermore, the findings show that 81.4% of the respondents applied artificial fertilizers to their farms in efforts to adapt to climate change. Study results also show a significant association between the education level of the respondents and use of improved seeds (P = 0.08) and soil water conservation (P = 0.09) as adaptation measures to climate change. In adapting to the changing climate, respondents also experienced some challenges such as lack of resources in terms of financial, material and human labour. Proper knowledge on the adaptation measures is recommended to be given to farmers through various methods.

Introduction

The world is facing multiple crises such as hunger, poverty, economic crisis, climate change and other environmental crises. The destruction of the environment, including climate change, is the biggest long-term threat against the possibilities to end poverty, especially in aspects of hunger and malnutrition as stated in one of the targets of the Millennium Development Goal (MDG) One (UN, 2009). According to the United Nations' panel of climate experts, Africa is highly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and over-dependence on rain-fed agriculture (IPCC, 2001). FAO (2008) observed that in the tropical countries like Tanzania, food production is

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affected mainly by climate change impacts such as rainfall scarcity and high temperatures. Other factors include low soil fertility, poor technology, low levels of input use and poor mechanization. Normally, climate change affects food production in most developing countries that engage in the cultivation of crops in rain-fed systems. Thus, one of the great challenges of the 21st century is on how to increase food supply to accommodate the world's growing population while mitigating climate change (Easterling, 2007). Likewise, reduced food production in developing countries remains a challenge towards attaining MDGs, of which the foremost is to eradicate extreme poverty and hunger by 2015 (UN, 2008; Gregory et al., 2005).

Some studies have predicted the levels of climate change that are expected to occur in Tanzania in the coming years. For instance, according to a study commissioned by the government of Tanzania, climate change is expected to raise mean annual temperatures by 3-5ºC, and average daily temperatures by 2-4ºC by 2075 (Yanda & Moshy, 2007). It has been proposed that developing countries will be hit harder than developed countries, and the most food-insecure regions -- Sub-Saharan Africa (SSA) and South Asia -- will be hit hardest. FAO (2009) reported that by July 2009 the global total number of undernourished people surpassed 1 billion for the first time. In Tanzania specifically, out of more than 75% of people who depend on agricultural production for food and other household needs, 44% are undernourished (FAO, 2007). Due to this problem, all the development strategies conform to the commitment of the government to reduce the vulnerability of the agricultural and food security sectors to the adverse impacts of climate change (Kilembe et al., 2013). According to Yanda and Moshy (2007), the government puts a lot of efforts for adapting to climate change at both national and local levels for livestock-keepers and crop farmers.

Several studies have been conducted on relationship between climate change and crop yield (Gregory et al., 2005; Morton, 2007; Sultana et al., 2008). Despite all these studies on climate change and food production, information on how households in developing countries like Tanzania respond to climate change in order to sustain food production is still scarce. Unfortunately, food production in Tanzania, and particularly in Rombo District, is highly dependent on rain-fed agriculture, which makes the district vulnerable to the adverse impacts of climate change on crop production. This study, therefore, aims at finding out climate change adaptation practices for sustainable food production in Rombo District, Tanzania. The study specifically sought to: (i) describe the background characteristics with respect to adaptation to climate change; (ii) determine the effects of climate change; (iii) find out the adaptation practices used in the study area; and (iv) to determine the challenges experienced in

adapting to climate change. The findings of this study are expected to provide useful information to policy makers and development planners in suggesting practical tools to develop implementable policies, programmes and technologies that minimize households' vulnerability to food insecurity.

Conceptualization of Climate Change and Adaptation

Climate change and adaptation are inseparable because adaptation measures are normally taken as a remedy to changes in climatic conditions. Phillips (2006) define climate change as regional or global-scale changes in historical climate patterns arising from natural and/or man-made causes. The concept is often used synonymously with global warming and the greenhouse effect, although the concepts have different meanings. While global warming refers to any change in global average surface temperature, greenhouse effect is a natural system that regulates the temperature on earth. Global climate change facts include: increasing temperatures, melting polar icecaps, uncontrolled forest fires, and annual average increase in sea level. It is assumed that African countries that depend on natural resources and rain-fed agriculture for their economy are more vulnerable to the risk of climate change.

Adaptation has been described by Lambrou and Piana (2006) as changes in processes or structures to moderate/offset potential dangers, or to take advantage of opportunities associated with changes in climate. It also implies various actions taken to help communities and ecosystems deal with changing climate conditions. Such actions may include the construction of flood walls to protect property from sea level rise, or the planting of agricultural crops and trees more suited to warmer temperatures and drier soil conditions (Skinner, 2011; Skinner & Brody, 2011).

Methodology

The study was conducted in Rombo District, which is located in the Eastern part of Kilimanjaro Region, Tanzania. The study covered two villages, Kirongochini and Ikuini from Usseri and Mkuu divisions, respectively. The study villages were selected based on their semi-aridity conditions, and how they contribute to the district's vulnerability to food shortage. Food shortage results from crop failure due to inadequate and unreliable rainfall (URT, 2000). The study employed a cross sectional research design, which allows data to be collected at single point without repetition from a study sample. The design is also flexible in terms of data collection and less expensive in terms of time and funds (Kothari, 2004).

Multistage sampling technique was adopted whereby the sampling stages included division, village and finally the household. According to Fowler

(1993), this technique is convenient for studying large and diverse populations in which the list of actual individuals to be studied is not available, as was the case in this study. Usseri and Mkuu divisions were selected based on their climatic conditions, followed by a selection of one village Kirongochini and Ikuini from each division. Thereafter, a sample of 70 households was randomly selected from a sampling frame constructed from the village register books. This sample size was relevant according to Bryman (2004) who suggested sample of 30 units to be a minimum sample size that can be statistically tested. The respondents comprised of heads of households and some key informants: one agricultural extension officer, district agricultural and livestock development officer and four elderly people from each study village. Two focus group discussions, made up of five people, were also conducted for each study village.

Primary data were collected by using various methods such as questionnaire administration, in-depth interviews and focus group discussions. The instruments included a questionnaire, interview guide and a checklist of questions. On the other hand, secondary data was collected through documentary review of various documents on climate change, adaptation strategies and food production. Quantitative data was analysed by the Statistical Package for Social Sciences (SPSS) computer programme. Descriptive statistics such as frequencies and percentages were determined. Further analysis involved cross tabulation with Chi-square test to show association between adaptation measures and respondents' background characteristics. A qualitative method was used in the analysis of qualitative data where the use of factual and logical interpretation of the study findings was employed.

Results and Discussion

Respondents' Background Characteristics

It is important to analyse the background characteristics of a study population as it helps in data interpretation. The background characteristics involved under this study include sex, main source of income, income status, size of household and level of education.

Sex

The study findings show that 57.1% of the respondents were men, while women comprised 42.9%. This is contributed by the fact that the society in the study area is patriarchal in nature, thus the majority of households heads are men. Due to the nature of the society, it was however expected that the proportion of female respondents could be lower than what is found in this study. This was not so due to the fact that some respondents

were widows, and in some household men were not available at home during data collection, hence women had to respond on their behalf.

Main Source of Income

The study findings show that more than half (57.1%) of the respondents in the study area used both farming and animal keeping as their main source of income. The types of animals kept were mainly poultry, sheep and goats. Only 35.7% of the respondents depend on farming alone as the main source of income. The rest, 4.3% and 2.9% depend on off-farm and small business, respectively. This result shows the real image of any rural Tanzanian community, which mainly depends on farming for livelihood. This engagement of large proportion of the population in agricultural sector reflects the outcome of low education level of the rural people that denies them other alternatives for survival. It has been explained in the 2002 Household Budget Survey that 80% of the poor are rural; and 81% of the same belong to households where the main economic activity of the head of a household is agriculture.

Table 1: Distribution of Respondents by Background Variables (N = 70)

Variable	Frequency	Percent (%)
Sex		
Male	40	57.1
Female	30	42.9
Main source of income		
Crop farming and animal keeping	40	57.1
Crop farming only	25	35.7
Crop farming and off farm activities	3	4.3
Crop farming and small business	2	2.9
Income status		
Low	45	64.3
Medium	25	35.7
High	0	0
Household size		
1-3	8	11.4
4-6	43	61.4
7-9	17	24.3
10 and above	2	2.9
Level of education		
4 years in primary schooling	10	14.3
Completed std. Seven	45	64.3
Completed form four	4	5.7
Never attended school	11	15.7

Source: Field survey, 2010

Tanzania has recently recognized that agriculture plays a pivotal role in the reduction of poverty through increased food production. This recognition made the government in 2009 to embark on agricultural production improvement by its famous slogan of *Kilimo Kwanza,*[1] to realise a green revolution. Among the activities in pillar number one of the ten pillars of Kilimo Kwanza is to modernise and commercialise agriculture for peasant, small, medium and large scale farm producers (RAWG, 2009)., Under *Kilimo Kwanza,* farmers expect to get subsidies that will assist them in cash crop production. However, the practise of subsidising farmers had been in existence in Tanzania for some years, but was abandoned in 1980s and 1990s due to policy reforms, introduced in the form of Structural Adjustment Programmes (SAPs). Specific measures were taken in 1993/94 when prices of cash crops were decontrolled by the government to allow private traders and institutions to participate in the marketing of the crops (Ponte, 2001).

Household Income Status

According to the results of this study, there were only two categories of income status; low (less than TZS50,000 per month),[2] and medium income level (between TZS50,000 and 150,000 per month), which comprised 64.3% and 35.7% of the respondents, respectively. The findings show that there was no respondent with high level of income status (more than TZS50,000 per month). This portrays the actual situation of the rural poor who depends on peasantry farming as a source of income. The low levels of income forces households of poor peasants to consume less. For instance, the Poverty and Human Development Report of 2009 puts it that almost 98% of households spend less than TZS58,000 per month per adult equivalent on food and basic necessities according to 2007 prices, and approximately 80% spend less than TZS38,600 per month. This situation is a result of too much dependence on agriculture, which is the least remunerative sector in the economy (RAWG, 2009).

Household Size

Study results show that 61.4% of the respondents had a household size with a number of people ranging from 4 to 6 members. On the other hand, only 2.9% of the respondents had a household size above 10 members, while the remaining 11.4% and 24.3% had a household size ranging from 1 - 3 and 7 – 9, respectively. This finding deviates from the district average household size, which is 4.4 according to the national census (URT, 2013). This could be due to the small sample size used. Large household size is expected to contribute to increased food production by working together in household economic activities. However, this could be possible when almost all of the household members take part in the production process.

[1] A Swahili name meaning Agriculture first

[2] 1USD was equivalent to approximately TZS1500 during the study time

Level of Education

The study findings show that 64.2% of the respondents had completed primary education, while only 5.7% had gone beyond primary education. Of the rest (14.3%) had stayed in primary school only for four years, and 15.7% had never attended school. These results depict the actual situation in most rural areas of Tanzania, where the majority have never attended secondary education. However, since the majority had formal education, this implies that they were literate enough to learn and use various adaptation measures provided through different sources such as mass media, agricultural extension agents and publications.

Education is expected to provide knowledge to people on how to adapt to climate change for sustainable food production. It is believed that educated people have greater access to information on climate change, improved technologies and higher productivity techniques. It has been argued by Kilembe et al. (2013) that if efforts are made to ensure that the young generation is well educated, there will likely be increased capacity to deal with the challenges of climate change to the agricultural sector. Despite the significance of education in adapting to climate change, it has been revealed that secondary school students do not understand the interconnections among the components of the climate system (Shepardson et al., 2012). This knowledge gap is a significant stumbling block for understanding not only the causes and effects of climate change, but also the adaptive and mitigation strategies that can be developed.

Effects of Climate Change

The study results show that 65.7% of the respondents mentioned drought as the main effect of climate change in the study area, followed by unreliable rainfall, which was reported by 30% of the respondents. Other effects were storm waters and outbreak of pests and diseases as reported by 2.9% and 1.4% of the respondents, respectively (Table 2).

Table 2: Distribution of Respondents by the Effects of Climate Change (N = 70)

Effect	Frequency	Percent (%)
Drought	46	65.7
Unreliable rainfall	21	30.0
Storm waters	2	2.9
Outbreak of pests and diseases	1	1.4
Total	**70**	**100**

Source: Field survey, 2010

From these findings, drought is the major effect of climate change due to the fact that people in the study area perceives climate change as reduction in amount of rainfall, together with the changes in duration of rains. In this respect, people had the idea that droughts in recent years are more severe than in the past. The respondents claimed that droughts repeat after 2 to 3 years, while in the past it could repeat after 6 to 10 years. They further claimed that droughts are usually accompanied with severe food shortage as majority of households' food consumption depends directly on what they produce from their farms.

With regard to unreliable rainfall, respondents were highly food unsecured in the study area as narrated by one key informant in Box 1.

BOX 1: RELATIONSHIP BETWEEN RAINFALL AND HOUSEHOLD FOOD AVAILABILITY

When there is enough rainfall, household food is also sufficient but the crops are sold at very low prices. The reverse is also true; when there is insufficient rainfall, household food availability becomes an issue and the food prices boom. In my case for example, I put all my efforts in agricultural production but lack of rains lets me down. Nowadays it is not possible to have assurance of harvesting in order to have enough food for the household consumption and surplus to sell to meet other needs. As a farmer I do not have anything else to sell in order to meet my basic needs. So I found compelled to sell the food I produce even if it is not enough for household consumption. Consequently, my household always suffers from frequent food shortages.

Although outbreak of pests and diseases was mentioned by one respondent only, it also came out during focus group discussion. The group participants claimed that banana production has been affected by the outbreak of insect pests such as black ants, which destroy roots and stems of banana plants. It is possible that food production can be affected by other factors like deteriorating soil fertility due continuous use of the same land for cultivation, low use of inputs, destructive animals and small farm size due to population increase. However, in the case of this study rain shortage is the more striking factor that threatens maize production in the area. All these effects of climate change make farmers to adapt to some practices to ensure sustainable food production as discussed in the next section.

Adaptation Practices towards Climate Change

The study results show that farmers in the study area were forced to change their traditional way of crop production due to climate change. By so doing, they sought to adapt to some practices as shown in Table 3.

Table 3: Distribution of Respondents by Adaptation Practices (N = 70)

Practice	Frequency	Percent (%)*
Use of fertilizers	57	81.4
Use of improved seeds	43	61.4
On-farm rain water harvest	33	47.1
Crop diversification	13	18.6

Notes: *Percentages add up to more than 100 due to multiple responses
Source: Field survey, 2010

According to the results, a majority (81.4%) of the respondents mentioned the use of fertilizers as the main adaptation practice; followed by the use of improved seeds, which was mentioned by 61.4% of the respondents. Other practices were on-farm rain water harvest and crop diversification, which were mentioned by 47.1% and 18.6% of the respondents, respectively.

Use of Fertilizers

According to focus group discussions and key informant interviews, the use of fertilizers was not practiced in the past. This was because the farms were fertile enough to support plant growth and obtain sufficient crop yield. Application of fertilizers is one of the inputs that enhance crop productivity when appropriately used and supported with sufficient soil moisture content. However, the use of fertilizers, although mentioned by the majority of respondents as one of the measures to adapt to climate change, is not easily affordable especially for the poorest farmers. Although the government introduced a voucher system through which fertilizers were sold at cheaper prices, farmers were just buying some small amounts of fertilizer that they could afford, but not sufficient for their farms.

It has been argued in RAWG (2007) that the cost and availability of fertilizers and other agricultural inputs have been the major hurdles in agricultural production in Tanzania. Although the use of manure as an alternative to artificial fertilizer could be cheaper, it was unfortunate that the respondents in the study villages (Kirongochini and Ikuini) could not opt for it. They were poor farmers in the low land area of Rombo District, who mostly keep poultry and very few animals like goats and sheep, which were not capable to produce enough manure.

Use of Improved Seeds

The respondents argued that this practice was used after they had noted that there are some changes in the duration and amount of rainfall in their area. They also decided to use improved seeds after they had observed that households that use modern seeds tend to have high chance of harvesting

than those that use traditional seeds. Improved seeds are essential components in increasing productivity in agriculture. The seeds include two categories: (i) higher yields with greater resistance to pests and diseases; and (ii) shorter crop duration varieties. This practice is especially important in countries like Tanzania, where the agricultural sector is dominated by small subsistence farmers who cannot afford other more costly practices. However, the cost element also appears here again, thus not all farmers were able to apply this practice, unless assisted by the government.

On-farm Rain Water Harvest

Rain water harvesting was done either by directing run-off water from roads to farms, or by the use of terraces as a mechanism to retain rain water in farms. The use of terraces helped to reduce the speed of run-off water and allow rain water to penetrate into the soil for plant use instead of wastage in the form of storm water. The two traditional practices were developed by farmers as a response to rain shortages and frequent droughts. They involve harvesting surface run-off water and increasing water infiltration into their farms. The intention was to increase soil moisture content, and at the same time reduce flash floods that occur during heavy rain seasons.

Crop Diversification

Crop diversification as an adaptation measure to climate change by the respondents involves cultivation of a variety of crops like cassava, pigeon peas, groundnuts and sunflower, which were not traditionally grown in the study area. Cassava, for instance, was believed to be poisonous in the past, thus people were not using it as food. Rarely, it was dried up during food shortages and used as flour for stiff porridge by some very poor families. The study further discovered that people in the study area had changed their staple food from banana based meals to cereal based meals, mostly maize, for a long time. This was attributed to the fact that banana production has been affected by climatic change such as decrease in rainfall and frequent prolonged drought. Thus, other crops were introduced after discovering that maize production alone was not sufficient in dealing with the problems of food shortage. The respondents reported that they currently concentrate on the production of cassava and maize as alternative staple crops to banana. This is in line with Orindi and Eriksen (2005) who found out that crop choice is climate sensitive, and farmers adapt to changes in climate by switching crops.

Association between Adaptation Measures and Background Characteristics

It was also revealed from cross tabulation that there was an association between the level of education of respondents and taking measures for adaptation to climate change. The Chi-square test results indicated that

there was significant association between the education level of the respondents and the use of adaptation measures to climate change such as the use of improved seeds (P = 0.08) and on-farm rain water harvest (P = 0.09). This implies that education increases climate change awareness and the likelihood of taking some adaptation measures to enhance food security. Thus education is an important asset in enabling poor people to come out of poverty, especially in the face of climate change. It is expected that the impact of climate change on people's livelihoods will require people being innovative, for example, by adopting modern production technologies for higher food crop productivity in agricultural. However, the Chi-square test results revealed no significant association between the adaptation measures and other background variables.

Challenges in Adapting to Changes in Climate

The results in Table 4 show that 51.4% of the respondents reported that households fail to adapt to climate changes primarily due to the lack of resources. These resources include financial, material and human labour. Lack of financial resources in terms of households' own cash, or in the form of credit, was claimed by the respondents to hinder household's ability to adapt to climate change. This is due to the fact that many adaptation activities involve the use of money, especially in buying some inputs like fertilizers and improved seeds to enhance crop productivity.

Table 4: Distribution of Respondents According to Challenges In Adapting to Climate Change (N = 70)

Challenge	Frequency	Percent (%)
Lack of resources	36	51.4
Lack of awareness	22	31.4
Irresponsible behaviour	9	12.9
Others	3	4.3
Total	**70**	**100**

Source: Field survey, 2010

Furthermore, 31.4% of the respondents said that the lack of awareness about climate change was the challenge in adapting to changes in climate. These respondents said that they lack information on climate change impacts and adaptation options. Due to this, some people get satisfied with the changes and claim that these are according to God's will, as revealed by one key informant who claimed that the solution for adverse climate changes is to pray more to God for His mercy. Another key informant further said that in the past they were used to offer sacrifices to the ancestors, asking for forgiveness and favour and they were heard; but currently they have stopped performing such kinds of rituals due to interventions from religious people who preach that the performance of the rituals are against God's will.

Additionally, about 13% of respondents mentioned irresponsible behaviour as one of the challenges. This is the tendency of some people to ignore things in their surroundings even if they interfere with their livelihoods. In this case it means some people have noted that there are some changes in rainfall in terms of onset and distribution but they may not take any initiative to cope with the changes.

Other challenges such as small size of the farms, old age and superstition were mentioned by 4.3% of the respondents. They claimed for example that they fail to plant variety of crops because their farms are small. This is the problem in the study area that land fragmentation is very high due to population growth and low mobility of the poor households. Consequently, high population pressures force farmers to intensively farm small plots of land, making it difficult to adopt adaptation practices, such as planting trees, which require more land. Old age as another challenge was mentioned in the sense that some of the adaptation measures involve intensive land management, for example making terraces for rain water harvests is laborious work for the aged ones.

On the side of superstition it was lamented that some people associate the shortage of rains with some beliefs that some people have the power to inhibit raining. As a result they take no action of adapting with the expectation that when those people in power are pleased with some offerings then the rains will fall as usual and they will have good harvests. This shows that people are not aware with the climatic change that is why they tend to associate the changes with some beliefs. It implies that these people need to be informed of the climatic changes.

The challenges identified under this study are common, not only to the study area but in most developing countries. For instance, Kilembe et al. (2013) in a comprehensive analysis of East African agriculture and climate change identified challenges commonly faced that limit adaptation to climate change such as weak infrastructure and economies; the dependence of food security on rainfall; severe poverty and deteriorating livelihoods; limited reliable, accurate, and updated statistical information; only to mention a few. The author added that a major challenge is increasing agricultural production among resource-poor farmers without exacerbating environmental problems and simultaneously coping with climate change.

Conclusion and Recommendations

Climate change results in large losses in productivity of food crops in various parts of Tanzania. Hence, communities need to adapt to climate change in order to attain sustainable food production at both local and national levels,

notwithstanding the various challenges they experience. The occurrence of climate change in Rombo District has made people to change their traditional food production practices as one of coping measures.

Since adaptation measures are associated with literacy level, it is important to ensure that proper knowledge on the measures is given to farmers through various methods such as the use of radio, television or provision of seminars. Knowledge can also be imparted to students at various levels of education by incorporating in the syllabus a topic on climate change. Furthermore, the government, through sectoral policy formulation, should give sufficient account on climate change adaptation practices. This can be achieved through conducting site-specific studies to facilitate the attainment of relevant information on how the community responds to the situation of low food production as a result of climate change. The government should also give enough support to the agricultural sector, especially in assisting poor farmers through the provision of subsidies.

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