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Enhancing Food Security for Smallholder Farmers in a Changing Climate Environment: A Case of Ismani Division, Iringa District - Tanzania

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Abstract

Climate change presents significant hurdles to food security, particularly for smallholder farmers and vulnerable populations in developing nations. Consequently, responses to climate change and variability play a crucial role in ensuring their food security. While smallholder farmers in Ismani Division, Iringa District, have implemented various adaptation strategies, there remains a gap in understanding their effectiveness amidst changing climatic conditions. This study aimed to analyze the adaptation strategies employed by smallholder farmers in Ismani Division, Iringa District, to mitigate the impacts of climate change on food security. Specifically, the research sought answers to the following questions: Do smallholder farmers perceive climate change? How does climate change affect smallholder farmers? What adaptation strategies do smallholder farmers employ to address the impacts of climate change? How effective are these strategies in enhancing food security for smallholder farmers? Ismani Division was purposefully selected for its semi-arid characteristics, which render it particularly vulnerable to climate change effects. Employing a cross-sectional research design, the study utilized a multistage sampling technique to select divisions, wards, villages, and households. A total of 120 respondents were randomly from selected wards, villages, and households. Quantitative data were collected through household surveys, while qualitative data were gathered through key informant interviews. Data analysis involved descriptive statistics using the Statistical Package for Social Sciences (SPSS) for quantitative data, and content analysis for qualitative data. The findings underscored the significance of small-scale livestock keeping as a key adaptation strategy against the impacts of climate change, contributing significantly to improving food security among smallholder farmers in Ismani Division. The study recommends that the government and other stakeholders provide support to smallholder farmers in implementing effective adaptation strategies to enhance food security. This study sheds light on the vital role of adaptation strategies in bolstering food security for smallholder farmers in the face of climate change. By understanding

and promoting effective adaptation measures, stakeholders can work towards ensuring sustainable food security for vulnerable agricultural communities

Key words: climate change adaptation, smallholder farmers, food security

1. Introduction

1.1 Background Information

Evidence shows that, while the world is exposed to climate threats, Africa is the most affected region (WMO, 2023). The consequences of climate change for agriculture and food security in developing countries are of serious concern, and agricultural development in Africa is more challenging in many places. Weather patterns are becoming less favourable in most instances, increasing the volatility of crop and livestock yields. The frequency and severity of extreme events are increasing as temperatures are projected to continue rising, and rainfall patterns are expected to shift more than they have already (Woetzel et al., 2020). The African continent's agricultural productivity growth has declined by 34% since 1961 due to climate change (WMO, 2023). The decline in agriculture challenges the farmer's quality of life and is thus a significant factor in poverty as the food and water supplies are critically impacted by climate change (Ortiz et al. 2021; WEF, 2023).

The African continent is marked as the most food-insecure region in the world because it relies on climate-sensitive and vulnerable economic sectors (Sirba and Chimdessa, 2021). Food security is being affected by rising temperatures, changes in precipitation patterns, drought conditions and extreme weather events associated with climate change (Mbow *et al.*, 2019; Kumar *et al.* 2017). FAO (2001) defined food security as "a situation that exists when all people at all times have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life".

Food security is a growing concern globally, with two billion people being subjected to moderate to severe food insecurity in 2019 according to the UN's Food and Agriculture Organization (FAO 2019). The number of people suffering acute food insecurity increased from 135 million in 53 countries in 2019 to 345 million in 82 countries by June 2022, FAO stipulates this increase in large part to be attributed to climate change (WB, 2022). Climate change has a direct and significant impact on food insecurity. All four dimensions of food security: Food availability, food accessibility, food utilization, and food systems stability are being affected by the changing climate (Rao, *et al.*, 2017; FAO, 2018). As global temperature rises, food production becomes more difficult and uncertain due to

changes in weather patterns, extreme weather events and other environmental disruptions (WEF, 2023). However, the changing climate is already affecting food security through increasing temperatures, changing precipitation patterns, and greater frequency of extreme events (Mbow *et al.*, 2019).

Agriculture is a dominant sector in the Tanzanian economy providing livelihood, income and employment to over 80 per cent of the population. In Tanzania, climate change is manifested through the increase in atmospheric temperature and uneven distribution of rainfall to most of the areas in the country (Mang'anya, 2016; Mary and Majule, 2009). The country experiences vulnerability in terms of a decrease in crop production of different crops exacerbated by climatic variability and unpredictability of seasonality (URT, 2007). Climate change and variability threaten the livelihood of smallholder farmers who depend on subsistence agriculture, which is almost entirely rain-fed. However, rain-fed agriculture is particularly sensitive to climate change (Lyimo and Kangalawe, 2010; Boko *et al.*, 2007). Therefore, dealing with climate change is an economic necessity to avoid serious disruption to global and national socio-economic development, and adaptation is an overriding priority for developing countries like Tanzania (URT, 2012).

Adaptation strategies to climate change have the potential to reduce the adverse impacts of climate change on agriculture and other sectors (Smit and Plifosova, 2001). Adaptation strategies to climate change also help farmers achieve their food, income, and livelihood security objectives under extreme weather conditions such as drought and floods (Hassan Nhemachena, 2008). However, it is important to understand which adaptation strategies are effective in reducing the negative impact of climate change (Dinshaw *et al.*, 2014). Investing in wider adoption of best practices for mitigation in the food and agriculture sector could therefore have multiple pay-offs for food security, contributing to the stability of global food markets and providing new employment opportunities in the commercial agriculture sector, as well as enhancing sustainability of vulnerable livelihood system (Kumar *et al.* 2017).

Although smallholder farmers in Ismani Division, Iringa District, have implemented various adaptation strategies, there remains a gap in understanding their effectiveness amidst changing climatic conditions. Empirical evidence on how adaptation strategies for immediate climate variations and change can transform into long-term adaptive capacity was relatively limited. Therefore, there was a need to understand how adaptation strategies applied against the current impact of climate change could be used to build capacity in

addressing a future changing climate. This study addressed this gap by identifying the current adaptation strategies used by smallholder farmers against the impacts of climate change, in overcoming the current food security situation and their effectiveness in building capacity to ensure food security in future changing climate.

This study is in line with the National Adaptation Programme of Action (NAPA) (URT, 2007), which calls for the identification of immediate and urgent climate change adaptation actions that are geared toward long-term sustainable development. This study also is in line with the Sustainable Development Goal relating to food security (Goal 2). Therefore, the study contributed to identifying effective adaptation strategies to enhance food security in a changing climate hence ensuring food security among smallholder farmers.

2. Methodology

The study was conducted in Ismani Division Iringa District, Tanzania. The District is one of the four Districts of the Iringa Region. Iringa District has six administrative divisions. One division namely Ismani out of six was selected for the study based on its climatic condition. The area (Ismani) is semi-arid with low mean rainfall ranging from 500 – 600 mm. The temperature in Ismani is between 20 and 25°C (Mussei *et al.*, 2012).

The rationale for choosing Iringa District for the study is twofold. First, the Iringa District was one of the Districts in the Iringa Region that used to produce surplus maize, the Ismani division being one of the major producers. Currently, the area (Ismani) Division experiences recurrent drought conditions, making it more vulnerable to the impact of climate change than other areas in the region. Secondly, like other smallholder farmers in semi-arid areas of Tanzania, smallholder farmers in Ismani divisions practice rainfed agriculture, the impact of climate change is often felt hardest by subsistence farmers who become less self-sufficient and forced to buy their staple foods. During low-yield years, food may become too expensive for them, pushing poor households into a food insecure situation.

A cross-sectional research design was used. The design was suitable because it allowed the collection of multiple cases at a single point in time (Babbie, 1990; Bailey, 1998). A multistage sampling procedure was applied to select divisions, wards, villages, and then households. This procedure allowed more than one sampling method to be used. Ismani division was purposively selected based on its climatic condition (semi-arid). Wards and villages in the Ismani division were selected randomly. A total of 120 respondents based on Cochran's formula were

drawn randomly so that each household had an equal chance of being selected (Cochran, 1977).

Quantitative and qualitative data were collected. Quantitative data were collected through a household questionnaire survey. A tool for this method was a questionnaire. The questionnaire was pre-tested in Lwang'a village, Ismani Division, and revised to produce the final questionnaire that was administered to heads of household smallholder farmers. Information on climate change and food security was gathered through this method. Qualitative data on climate change and food security were gathered through the key informant interview informant method, this method involved experienced smallholder farmers in terms of years of working on farms. A multiple response and descriptive analysis was carried out using a Statistical Package for Social Sciences (SPSS) in the analysis of quantitative data. Qualitative data were analysed using content analysis whereby qualitative data coding and conclusions were drawn based on themes of the study.

3. Results and Discussions

3.1 Perception of smallholder farmers on the Changing Climate

Understanding the smallholder farmers' perception of the changing climate is critical to knowing how to adapt and increase resilience against climate change (Antwi-Agyei and Nyantakyi, 2021). The study revealed that smallholder farmers are aware that climate change is happening in the study area. All respondents perceived a decrease in rainfall. About 97% of respondents perceived that there was an increase in temperature, while 53% perceived there was an increase in dry spells (see Table 1). These results are similar to the study done by Gandure *et al.* (2013) in South Africa which showed that the community perceived climate change through increased temperature and decreased rainfall amount.

Table 1: Respondents' Awareness of the Changing Climate

Climate change	Frequencies	Percentage
Increased dry spells	64	53
Increase in temperature	116	97
Decrease in rainfall	120	100

3.2 Community's Knowledge of the Causes of Climate Change

Several human activities contribute to climate change, some are industries, transportation, agriculture, deforestation and livestock-keeping activities. The findings revealed that 80% of respondents said deforestation contributes more

to climate change (see Table 3). These findings were complemented by one of the key informant interviewees who said:

“In the 1970s and early 1980s there were so many trees and in those old days there was a lot of rain. We were harvesting a lot and we never experienced food insecurity. But we started experiencing low harvest after cutting most of the trees to increase farmland and other uses”

Forest plays a major role in moderating the climate, and also absorbing atmospheric carbon dioxide. Therefore, removing forests leads to the accumulation of atmospheric carbon dioxide and also affects the macro climate of an area where the forest has been removed. However, climate change happening in the study area is not a result of deforestation only but a combination of different human activities because the atmosphere is dynamic, it keeps on moving.

Table 2: Causes of Climate Change

Overcome	Frequencies	Percentage
Deforestation	116	97
Do not know	4	3
Total	120	100

3.3 Impacts of Climate Change on Small Holder Farmers

3.3.1 Low harvest

Low harvest is among of impacts of climate change whereby 85% of respondents said that there is a decrease in harvest (see Table 3). The findings are similar to the study done by Mang’anya in Kilosa Tanzania (2016) in which farmers have reported declining crop yields due to unpredictable climatic conditions. These results were complemented by key informant interviews whereby, one key informant said;

“We used to harvest up to 16 bags of maize per acre, but nowadays we harvest less than ten bags per acre. This is due to the decrease in rainfall and exhaustion of the soil fertility. Low harvest has an impact on our livelihood. We depend on harvest for our basic needs and income, so when we harvest little our livelihood is jeopardized”.

Low harvest means low income, this implies that climate change jeopardizes efforts on poverty alleviation done by smallholder farmers.

3.3.2 Drought

Drought conditions and famine are among of impacts of climate change facing smallholder farmers in the study area. About 15% of respondents said there was an increase in drought conditions (see Table 3). These findings are similar to the study done in Ethiopia by Ardalan (2019) that Drought is partly caused by climate change and could create famine and health problems. These results were complemented by a key informant interview whereby one of the key informants said:

"Usually, the rainy season used to start in November and end and the end of May, but nowadays rainy season starts in late December or sometime in January and ends in early May or sometimes April. There are also prolonged dry spells in February which sometimes lead to drying of crops before reaching their maturity"

Table 3: Impacts of Climate Change on Smallholder Farmers

Effects of farmers	Frequencies	Percentage
Low harvest	102	85
Drought	18	15
Total	120	100

3.3.3 Food Insecurity

The findings revealed that smallholder farmers are experiencing food insecurity in the study area. About 72% of respondents did not harvest enough food crops to sustain them around the year (Table 4). Considering that the main economic activities carried on in the study area is farming specifically rain-fed agriculture. These results are similar to those done by Antwi-Agyei in Northern Ghana (2021) who showed smallholder farmers in Northern Ghana were experiencing food insecurity, they even sometimes skipped meals as a coping mechanism.

Table 4: Availability of food around the year

Food available	Frequencies	Percentage
1-3 months	10	8
3-6 months	30	25
6-9 months	46	39
year around	34	28
Total	120	100

Farming is a major source of income in the study area, therefore, having low harvest means they will have not enough food to sustain them throughout the year and income hence, food insecurity. These findings are complemented by key informant interviews conducted in the study area, one of the key informants said:

"When we have a good harvest, we usually sell some and use the money to buy other basic needs, but if the harvest is low, how can you sell while it cannot even meet the needs of food for the household? We struggle a lot, sometimes we skip meals so as the little we have could sustain us longer".

3.4 Adaptation strategies carried to overcome impacts of climate change in the study

The findings revealed that smallholder farmers adapt to the changing climate using various strategies. About 85% of respondents said that they keep livestock to rescue against the impacts of climate change (see Table 5). These findings are similar to those from the study done in Northern Ghana by Antwi-Agyei *et al.*, (2021). Those findings showed that smallholder farmers were keeping livestock and selling them to buy food so that they could feed their families. Selling livestock to buy food helped them to keep on going till the next harvest. These results were complemented by key informant interview conducted in the study area whereby one of the key informants said that:

"Without livestock keeping how can you survive? The small number of livestock I am keeping is very helpful, if any member of the family becomes sick, I sell some of them so that I can get money for hospital bills and afford other basic needs. Livestock keeping also helps in case you have harvested low on food crops that cannot sustain you year-round, for that case, you will have to sell some of your livestock or their product like eggs and use the money to buy food. Therefore, livestock keeping in our area is very important because the climate is not predictable, and you cannot depend only on farming"

Livestock kept in the study area were cows, goats, pigs, and chickens. However, most of the livestock kept were cows and goats which were facing challenges in grazing due to prolonged drought conditions, sometimes they ended up dying due to lack of food as one of the key informants said:

"However, livestock keeping like cows and goats is challenging because

of drought conditions in the area, if you do not take your cows and goats to the mountains where they can get food during the dry season you may end up losing them (they die of hunger due to drought condition)”

Other adaptation strategies were planting a variety of types of crops in the same plot of land, petty business, and casual labour. Using fertilizers also was among the adaptation strategies applied by smallholder farmers in the Isimani Division (see Table 5).

Table 5: Adaptation strategies to overcome impacts of the Climate change

Overcome	Frequencies	Percentage
Livestock keeping	102	85
Application of fertilizer	14	12
Others	4	3
Total	120	100

4. Conclusion and Recommendations

Climate change presents significant threats to rain-fed agricultural systems, and this hampers the attainment of the Sustainability Development Goals, particularly the goals relating to food security (Goal 2). This study explored the coping practices for short-term climate variations and the adaptation measures used by smallholder farmers to address the impacts of climate change in the Isimani division Iringa District. This study determined smallholder farmers’ perception of climate change, the study also explored the impact of climate change on households. The adaptation strategies used by smallholder farmers to address climate change were also examined.

However, these adaptation practices to address the impact of climate change such as livestock keeping, planting various types of crops, application of fertilizers, and casual labour are not enough to build the capacity of the smallholder farmers to ensure food security in future climate changes. This is because most of the adaptation strategies applied in Isimani are climate-sensitive. There is a need for transformational adaptation strategies that are more sustainable and can withstand the current and harsh climate changes projected to occur in the future.

The study recommends that the government of Tanzania specifically the Ministry of Agriculture and other stakeholders provide support to smallholder farmers in implementing effective adaptation strategies identified in this research to

enhance food security. In conclusion, this study sheds light on the vital role of adaptation strategies in bolstering food security for smallholder farmers in the face of climate change. By understanding and promoting effective adaptation measures, stakeholders can work towards ensuring sustainable food security for vulnerable agricultural communities.

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