



REGULAR ARTICLE

## THE RAMIFICATIONS OF CLIMATE VARIABILITY IN AGRICULTURAL FOOD CROPS PRODUCTION AMONG THE SMALLHOLDER FARMERS IN SOUTHERN HIGHLANDS, TANZANIA

BROWN GWAMBENE\*

Department of Geography, Faculty of Social Sciences and Entrepreneurship, Marian University College,  
P. O. Box 47, Bagamoyo, Tanzania

### ABSTRACT

Implication of climate variability and changing environment potentially subvert agricultural crop production of subsistence and smallholder farmers in the developing countries. Ensuring food security during increasing environmental changes and climate variability constitutes one of the greatest adaptation challenges. Understanding the complex nature of food security and emphasis on increasing food crop production and distribution provide substantial adaptation option and an opportunity for spearheading, generating of information, developing of innovative and improving technologies to adapt to anticipated situations. This paper employed survey to collect information. The study results ascribe that the heavy reliance on rain-fed agriculture, shortage of land and the use of poor technology renders many smallholder farmers vulnerable to the effects of climate variability resulting in the decline of agricultural production, hence food insecurity. The trend is likely to worsen if no measures are put in place to redress the situation. In addressing such challenges, substantial efforts are needed to improve farming practices and the development of adaptation measures that include diversification, climate smart farming practices and improvement of extension and veterinary services. For effectiveness of adoption this will need to include promotion of appropriate and inclusive, environmentally-sound technologies and an enabling policy environment that reinforces actions at the all levels.

**Keywords:** Climate variability, Smallholder farmers, and agricultural production

### INTRODUCTION

Agriculture is extremely sensitive to climate and weather extremes, especially changes on temperature, rainfall and wind. For example, the increased potential for droughts, floods and wind strength pose challenges for farmers and the enduring changes in weather condition, water supply and soil moisture affects farm productivity and makes it reduce viability to continue crop production or some of the crop varieties in certain area [1, 2]. Further, changing rainfall patterns will affect the amount of water available for crop production. Such effects significantly threatened food security and livelihoods of people who depend on small-scale production specifically, crops, livestock, fisheries and natural resource extraction [3, 4]. Additionally, climate variability and environmental change alter the abundance and distribution of beneficial and pest organisms that are ecologically important [6]. These will further increase the burden and vulnerability to poorer livelihood and jeopardize poverty alleviation efforts and affect food security strategies.

Climate variability and environmental changes is already frightening survives and is anticipated to have substantial

impacts on subsistence rural livelihoods in Sub-Saharan Africa [7]. Heavy dependence on those livelihood activities that are highly exposed to environmental change and weather conditions, for instance farming and natural resource extraction increase vulnerability to the changing environment [3, 8, 9]. About 80% of the population in rural area of Sub-Saharan Africa involve in, Agriculture and natural resources as the main livelihood. Agriculture sector account for around 30% of GDP, 40% of export revenue and is the dominant sector that employs about 60% to 90% of the total labour force in most Sub-Saharan Africa [10, 11]. Conversely, such sector is particularly vulnerable to climate variability and environmental changes.

Climate change and variability has exhibited by the incidence of more intense fluctuating rainfall patterns and increased temperature that threaten sustainability of food crop production [12]. According to Aydinalp and Cresser [13] climate variability has a negative impact on the agricultural sector and it is expected to alter, crop production and productivity due to changes in temperature, rainfall, wind and changes in patterns of pests and diseases. It distresses food crop production and

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\*Corresponding Author

Brown Gwambene

Department of Geography, Faculty of Social Sciences and Entrepreneurship, Marian University College, P. O. Box 47,  
Bagamoyo, Tanzania

Email: gwambene@gmail.com

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affects water resources [9, 14] that are vital for livelihoods in farming activities in rural area. In response to environmental changes a suitable land for cultivation of key staple crops anticipated to undergo geographical shifts [15]. The question is about how farmers respond to such changing environment, rainfall patterns, temperature, and wind strength. It is the aim of this study to establish the challenges, opportunities and implications in response to climate variability impacts in agricultural production and food security. To address such challenges, enabling environment to sustain adaptation measure is imperative.

### **Methods**

The study was conducted in three villages located in three agro-ecological zones namely Kapula-mpunguti (lowland zone), Kikota (midland zone) and Mbeye 1 (highland zone) of Rungwe district in the southern highland of Tanzania. These zones differ in terms of type of produce, climate conditions, soil characteristics, terrain and biophysical environment. To understand the challenges and opportunities in smallholder farmers, this study used both primary data (through surveys) and secondary data (in libraries and documentation Centre). Primary data were collected through participatory research approaches (PRA) including focus group discussions, key informants and household questionnaire. This was complemented by, field observations by physically looking at and confirming and solicitation of some of the information on agricultural production and climatic variability. The interviews involved consultations with key informants, including agricultural and natural resources officers at district, ward and village levels in selected zones, including local government and elderly persons found in the study area. For effectiveness, these methods were used in such a way that they complemented each other.

The data were organised and edited and analysed using different qualitative and quantitative methods. The qualitative data from different sources and methods were processed and analysed using trend, content and situational analysis. The analysis was conducted during and after data collection. Quantitative data were analysed by using Statistical Package for Social Sciences (SPSS).

## **RESULTS AND DISCUSSION**

### **Implications of climate variability on food crops production**

The long-term mean climate condition, knowledge and technology significantly, influence the nature and practices of any particular agricultural production [17]. The results indicate that crop varieties produced under the current climatic condition and are particularly known to be produced are generally appropriate for communities. However, changes in mean climatic condition may affect the current situation and production patterns. Such changes may require adjustments of the current practices and change in crop varieties [18, 19].

The decline in crop production were associated with higher temperatures [6, 11]. Yield of the most important agricultural crops is expected to decline and it was indicated to increase production cost and result in additional price for crops such as rice, wheat, maize, and

beans [18]. Among the potential cause of the decline in crop yields include shortening of the growing period, decrease in water availability and poor adaptation capacity [1]. In the long run, climate variability and environmental changes affects land productivity and agricultural production [4, 21].

### **Vulnerability in agricultural crop production**

Smallholder farmers suffer from locally specific and hard to predict effects caused by climate variability and environmental changes. The complexity nature of the impacts aggravated by variety of crops produced at household and their interactions of subsequent adaptations, relative to commercial farms with more restricted ranges of crops. Decrease in crop production and poor harvest for different crop types/varieties is among the main vulnerable elements in the agricultural sector. The study indicates that the impacts of climate variability, seasonal variations aggravated situation. Erratic rainfall, uncertainty in crop production together with shifting in agro-ecological zones and prolonged dry spells beyond the normal patterns amplified vulnerability of food crop production.

It was further revealed that ecological changes that favour weeds, pests and diseases, together with climate variability, shortage of land and exhaustion are expected to increase vulnerability in crop production. Decline in yields for the main food crop will further affect the national food security. A similar situation was suggested by Bisanda and others [22] in which food crop at a national level was predicted to decline by 33% due to temperature rise and frequent occurrence of drought. The main challenge is about the capacity to adapt to the impacts of climate variability and changing environment among small farming household.

A compressive land management measures, integrations of local adaptation measures in education and mainstreaming climate and environmental change in agricultural and natural resource development plans are prerequisite in reducing vulnerability. Specifically, in the study area there is a need to find the alternative land for smallholder farming within or outside the study area so as to increase crop diversification and productivity.

### **Change in food crop production and adaptation challenge**

Among the influences of climate variability and changing environmental in agricultural activities is the reduction of productivity, which results on production instability and food shortage [23, 24]. Most of the smallholder farmers in the southern highland attributed the changes in production to climatic conditions, poverty and land factors. Under the rain-fed agriculture, rainfall and temperature are a major determinant of agricultural production, whereas poverty and availability determine the intensity of production, method, type of crop and practices. Drought, erratic rainfall, temperature change, land exhaustion, lack of water and crop pests and diseases were perceived as the major challenge in agricultural production. Table 1 below indicates the challenges in agricultural production.

**Table 1: Challenges of agricultural production in southern highlands**

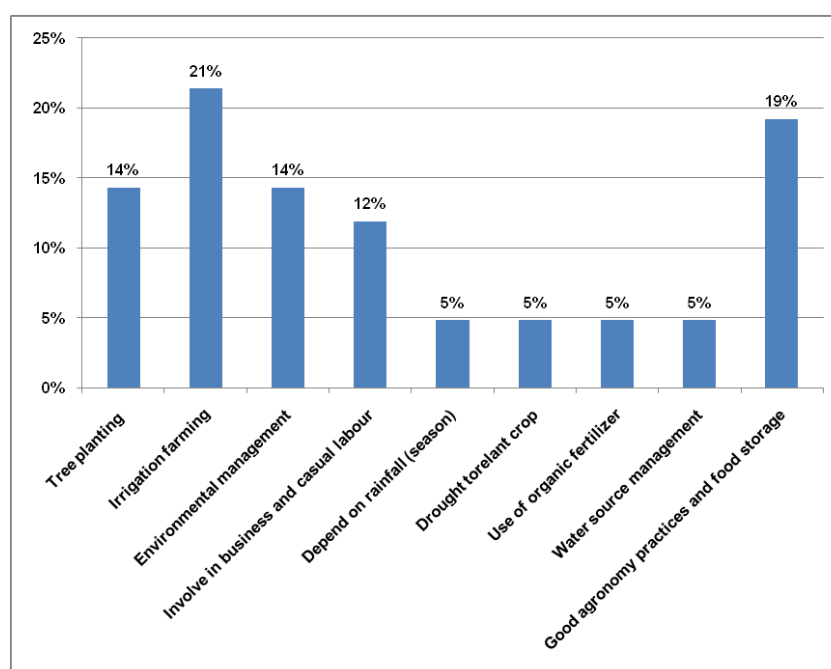
Challenges of agricultural production	N	Percent	Cases percent
Drought	23	37.7	39.0
Climate change	6	9.8	10.2
Erratic rainfall	5	8.2	8.5
Pest and diseases	5	8.2	8.5
Ice and fog	2	3.3	3.4
Land exhaustion	8	13.1	13.6
Low production	7	11.5	11.9
Food shortage	3	4.9	5.1
Weeds	2	3.3	3.4
<b>Total</b>	<b>61</b>	<b>100.0</b>	<b>103.4</b>

Climate change and variability increase challenge of agricultural production among the smallholder farmers in developing country. The dependent on subsistence farming and climate sensitive livelihood subvert their adaptive capacity and increase vulnerability. The result in table 1 above indicates that most of the perceived changes were associated with climate variability, including drought, 13.1%, climate change 9.8%, fluctuating rainfall 8.2%, pest and diseases 8.2% and ice and fog 3.3%. Other mentioned challenges are land exhaustion 13.1%, low production 11.5%, and food shortage 24.9%. The low yields are linked to shortage of rainfall that results in lack of water and small land holdings that limits mechanization and adopting alternative activities. The impact of climate variability and environmental changes are likely to increase unless, proper adaptation measures are developed to improve agricultural production and food security.

**Measures to reduce vulnerability and improve crop production**

Among the suggested measures to reduce vulnerability and enhance resilience of the smallholder farmers are the improvement and reduction of input price (31.4), improvement of market for the produce (14.4), improvement of extension services (6.4) and production knowledge and fertilizer use (20.3). Other measures are improving of input subsidy mechanisms (6.3), provision of adaptation education (4.3), water source management (3.2), improve irrigation farming, crop diversification and access to land (3.7). Fig. 1 indicates the measures used to reduce negative effects of climate variability and environmental changes.

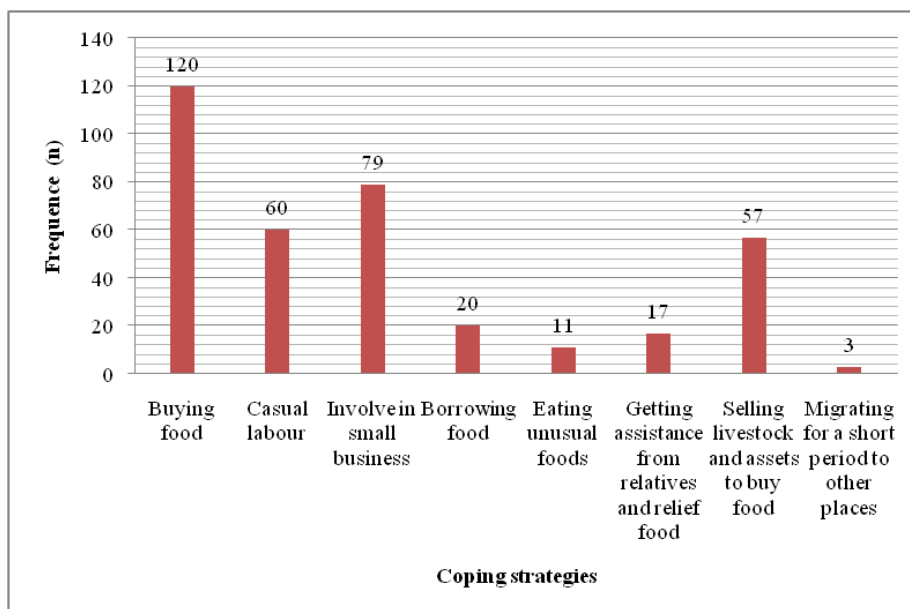
Reducing the adverse effects on well-being, and take advantage of the opportunities is among the important strategies in reducing vulnerability and increasing resilience in smallholder farming communities. Under the changing environment smallholder farmers develop adaptation measures to reduce the impacts and increase agricultural production and food security. Table 2 The suggested effective adaptation strategies for smallholders farmers



**Fig. 1: Reducing vulnerability to food shortage and increasing production**

**Table 2: The suggested effective adaptation strategies for smallholders farmers**

The suggested effective adaptation strategies	N	Percent (%)
Improve and reduction of input price	59	31.4
Improve crops market	27	14.4
Improve extension services	12	6.4
Improve Production knowledge and fertilizer use	38	20.3
The government should improve input subsidies	11	6.3
Education on climate variability	8	4.3
Water source management	6	3.2
Improve capital and implements	5	2.7
Tree planting and natural trees conservation	6	3.2
Involve drought tolerant and Improve maize seeds	6	3.2
Produce for business	2	1.1
Improve irrigation farming and crops diversification	4	2.1
Improve access to land group work	3	1.6
Garden farming and early mature crops	2	1.1
Total	188	100.0



**Fig. 2: Coping strategies to reduce food shortages in Smallholder farmers' community**

Developing innovative and improved technologies for adapting to the current and future situations, and enhancing the resilience of smallholder farmers is an important adaptation option. Doing so, farmers developed coping strategies to reduce the impact (fig. 2). Among the mentioned coping strategies for reducing food shortage include buying food (n =120) 31.6%, casual labour (n =60) 15.8%, involve in small business (n =79) 24.2%, borrowing food (n =20) 5.3%, and eating unusual foods (n =11) 2.9%. Other strategies are selling livestock and assets to buy food (n =57) 15.0%, and Migrating for a short period to other places (n =3) 0.8%. For the effectiveness of the strategies efforts to spearhead the generation of information and dissemination among smallholders, farmers and other key stakeholders are needed. In addition, there is a need for promoting understanding of agricultural production, climate

variability, and adaptation measures, interactions between social/political structures and functions as well as ecosystem attributes.

The study revealed that most smallholder farmers produce for subsistence with limited extension services and mechanization. In such environment the use of modern agricultural technology is not a common practiced, whereas improving productivity and crop production practices are highly pronounced. Majority of smallholder farmers developed coping and adaption measures that helped them to survive the shocks and persistence environmental changes. Such measures are affected by subsistence agriculture within an ever more dynamic nature and competitive livelihood activities. Whereas, adaptive capacity is affected by social differences (due to age, gender, status, wealth, political influence and education level) not only influence perceptions and

actions, but also access to and control of resources [24]. These differences have to be taken into account in developing effective measures to reduce vulnerability and increase smallholder farmers' resilience.

## CONCLUSION

Ensuring food security among smallholder farmers under increasing environmental changes and climate variability constitutes one of the greatest adaptation challenges. This needs focus on improving production, distribution and use of food crops, and understand the complex nature of food security. Awareness of climate variability, the environment and agricultural production provide an opportunity for spearheading the proper adaptation measure, innovative and improved technologies for healthier anticipated situations.

The heavy reliance on rain-fed agriculture and natural resource extraction renders many smallholder farmers vulnerable to the impacts of climate variability and environmental changes resulting in the decline of agricultural production, hence food insecurity. The trend is likely to worsen if no measures are put in place to redress the situation. In addressing such challenges, substantial efforts are needed to improve farming practices and the development of adaptation measures that include diversification, climate smart farming practices and improvement of extension and veterinary services. For effectiveness of adoption this will need to include promotion of appropriate and inclusive, environmentally-sound technologies and an enabling policy environment that reinforces actions at all levels.

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