Exploring Factors Affecting Agricultural Productivity in Tanzania: Policy Implication for Climate Change

By

MUSSA, Mariamu Abdallah

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

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TABLE OF CONTENTS

LIST OF TABLES

APPENDIX

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ABSTRACT

Change in climate becomes as much as big challenge indifferent sectors including the agriculture to the whole world and mostly to the countries with small economy (developing and mid income countries) this happen because there some factors that drawback the improvement of this sector like government support, financial problems, and skills of using improved agricultural techniques. Tanzania as a developing country faces the same problem which hinders even the growth of the economy by considering that agriculture is the major economic activity and employs many people. The government of Tanzania has been tried to push this sector through different ways but still is not performing better as farmers depend on whether condition which mostly keeps on changing these days due to increase of human activities that pollute the environments and have adverse effects to the ozone layer and cause climate change. Therefore, this study aims at identifying better strategies (adaptation factors) for the challenges caused by climate change towards the agricultural productivity as drawbacks of Tanzania's economy. The study has been conducted quantitatively while a random sampling method to get respondents has been used and primary data have been collected through a survey that is distributed online by using Qualtrics. The data analyzed by using simple linear regression and techniques like the use of irrigation systems, crop diversifications, greenhouse farming, and crop rotation identified to help in improving this sector. To adopt these techniques if difficult for the farmers as they need huge capital while most of the farmers in Tanzania are poor but, the government can help through different measures like policies, subsidies, and loans to the farmers. Hence, this study provides advice to the farmers, government, and NGOs concerning the better method to address this problem as well as to give the theory that change in weather condition does not always lead to a decrease in agricultural productivity but there techniques that can help to improve the agriculture sector by considering the social, economic, and geographic conditions of Tanzania.

LIST OF ABBREVIATIONS

ANOVA – Analysis of Variance

CO2 – Carbon dioxide

FAO – Food and Agriculture Organization

IPCC – Intergovernmental Panel on Climate Change

IPRCC – International Poverty Reduction Center in China

MAFAP – Monitoring African Food and Agricultural Policies

HEHA – National Environmental Health Association

OECD – Organization for Economic Cooperation and Development

UNFCC – United Nations Framework Convention on Climate Change

URT – United Republic of Tanzania

I. INTRODUCTION

1.1 Climate Change

Inadequate attention to climate lead to the disturbance of human life, disturbs economic activities, and destroy the whole system of ecology and brings huge changes to climatic condition which results to the big destruction and brought in danger different aspects including the use of land, access of water, health, food production, natural and physical capital (Château, Clapp, Dellink, Lanzi, Magné, Marchal, Vliet, &Vuuren, 2012). Despite of all these suffering that human being pass through but it is proved that human activities contributes a lot to climate change as most of human activities emit dangerous gases (greenhouses gases) where by carbon dioxide being the first gas to be produced in huge amount and is expected to cause the global average temperature to increase up to 4° C (IPCC, 2007).

Hence, the occurrence and magnitude of extreme events like heavy rainfall (floods), droughts, hurricanes, and typhoons anticipated to increase at large regardless of the amount of the temperature increase (Meehl, 2007). According to the IPCC (2013), change in climate projected to end in the future whereby rate of increase in temperature, floods, typhoons, hurricanes, and sea level to continue to speed up. While it is projected that in 21st century there will be global temperature change especially in Asia in both seasonal and regional variations (Cruz, 2007).

1.2 Agricultural Activities and Climatic Change

According to Gautam and Kumar (2014), to depend on the weather in agriculture is dangerous because any possible increase in temperature and carbon gas concentration affects crop growth and hence food production will be low. Parry and Rosenzweig (1994) in their model of agronomy said that change in temperature make land less productive and it has huge impacts in developing countries because they depend on productive land for their survival and getting income. According to Agbola and Fayiga (2016) climate change is all about disaster

which includes floods, extreme heat, and drought which cause soil degradation at the end will result in low crop yields. That is why in recent years agricultural productivity has been decreased due to the climate problem which has discouraged agricultural progress to the great extent (URT, 2007).

The effect of climatic change in China expected to last into the future on agriculture and livestock farming in such a way that the productivity of crops like wheat, rice, and corn will decrease, which will result to the decrease of Chinese agriculture by 5~10% by 2030 and it is expected that, in the late 21st century the yield of these three crops will decrease by up to 37%, which will affect food security (Winkel, 1997). Cereals affected much with absence of rain when flowers begin because it is the period where cereals need much water and if the temperature increase to 30 °C at this time will lead to sterility (Saini & Aspinall, 1982). For example, for the rice and wheat there is 35 -75% decrease in cereal productivity because drought disturbs fertilization process of cereals (Sheorn & Saini, 1996).

The analysis of climate change shows to have a huge impact in Tanzania with significant risks. For the past 30 years Tanzania show to have decrease in average rainfall and increase in average temperature whereby extreme drought which hits many areas in Tanzania almost the whole country experienced during 1994-1996 and 2005-2006 that lead to food insecurity and hunger because there were no agricultural activities (Kangalawe & Lyimo, 2013)**.** The increase in temperature (global warming) for some decades overwhelming natural disaster which also affects agriculture sector and becomes a serious threat because agricultural activities depend much on conducive environment like availability of water and moderate temperature hence any adverse decrease productivity (Fazal & Wahab, 2013). According to Komba and Muchapondwa (2015), Tanzanian farmers perceive climate change to have occurred over the past two decades in the sense that 528 (98.9%) out of 534 farmers experience changes in precipitation and temperature, and mostly controlling by planting drought resistance crops, changing planting seasons, planting short season crops, use irrigation.

1.3 Agriculture Activities in Tanzania

The United Republic of Tanzania is one among the 49 developing countries in the world found in East Africa (United States, 2014). Based on the Population census of 2012 the country expected to have a population of about 60 million by 2020 and composed of Tanzania mainland and Zanzibar while depending on agriculture as the major economic activity (URT, 2012). Agriculture in Tanzania started so many years back before colonial rule whereby people use poor tools and it was just for their food still there were famine and food shortage (Little, 1991). During the colonial rule, there were changes including the introduction of cash crops, trainings as well as there were research institutes whereby studies to different crops and farming techniques conducted (Manda, 2002). After independence (1961) Tanzania remains as the agrarian economy and in 1980s the country started to support agriculture sector by increasing the budget, introducing agriculture institutes as well as investing in agricultural extension services and research (Isinika, 2016). While in these days' agriculture is characterized by globalization and use of technology that restructuring the agricultural sector whereby farmers use science and technologies as well as different modern agricultural tools/inputs and practices (Mkonda, 2018).

Tanzania is one of the developing countries and hence, it is facing the problem of economic crises which lead small increase on the government expenditure while the demand of foods increase (United State, 2014). Despite that, the government of Tanzania does its best to help the agricultural sector that faces a lot of challenges including changes in climatic condition which is mostly caused by human activities as the world development and when doing other economic activities like industrialization lead to the drought of the land become dry and lose its fertility as the result even crops and graces also dry (IPRCC, 2011).

In Tanzania, farmers participate in agriculture for both domestic and commercial purposes (Manda, 2002). “Tanzania is among the African countries whose people are a mainly small scale for both food and cash crops” (Hieronimo & Kimaro, 2014). Mostly who participate in

agriculture for their self-sufficient use local ways like hand hoes, and depending in weather condition in such a way that their cultivations depending on the seasons to favor a certain type of crops also they do not know the access of information of weather and climatic change in general, they rely on what they always do and those who deal with commercial agriculture there are of two kinds small and large scale farmers (FAO, 2013). For small scale farmers, only one-third of the grain produced within the country might reach the commercial market so most of them not benefiting from these activities (Amani, 2005). For the large-scale farming use modern techniques like mechanization, financial services like loans, irrigation systems, extension services, research institution, market information, fertilizers, vaccine, and fertilizers (URT, 2015).

The most common food crops in Tanzania are sweet potatoes, maize, rice, wheat, bananas, cassava, and sorghum while the cash crops are tobacco, coffee, cotton, sisal, tea, and pyrethrum and farmers choose the type of crop depending on: (i) physical factors like the quality of soil and availability of water; (ii) economic factors, like seed prices; (iii) personal preferences of the household; (iv) crop profiles, including crop yield and pest resistance; (v) resource availability such as machinery and fertilizer (Marandu & Mitawa, 1995). Traditionally, farmers may have different farms for different crops but over the last few decades' systems shifted due to land pressure and farmers mixing their crops especially food crops and mainly legume crops like beans and other crops like maize. (Hieronimo & Kimaro, 2014).

1.4 Problem Identification/Statement of the Problem

Developing countries depend on agriculture as a primary sector of its economy, since they do not have other major economic activities like industries which needs high investment in capital, technology, and skills that is why they put much effort in agriculture hence, they tried much to ensure that their agricultural productivity increase year after year so as they can have surplus for exportation which is the best technique in the economy (Cervantes-Godoy & Dewbre, 2010). This is because exportation increases foreign exchange that will help in

financing the importation of basic and essential capital goods for the investment of other economic activities like mining not only that but also to increase foreign exchange as a result increases the economy of the country. Also, they put much look at the quality of their products to have an assurance of internal and external market as it is known many industries depends on agricultural products for raw materials. For example, the flour mills, rice shellers, oil and similar mills, sugar factories, wineries, textiles, leather mills including pharmaceutical and numerous all these factories most of their raw materials are from the agricultural sector (Levira, 2009).

Tanzania like other developing countries, large number of people live in villages where their major source of income depends on the agricultural sector. Other activities people participate are mining, factories, engineering and constructions, forestry as well as service provision activities like in health (doctors and nurses), education (teachers and professors), and other professionals like carpenter, garage service providers as well as for transportation (owners and drivers) but agriculture employs a large number of people (MAFAP, 2009). Agriculture is the main source of income in Tanzania that it employs more than 75% of the workforce and has the contribution of 26.7% in GDP, 30% in exportation, 95% of food consumption, and 65% as raw materials for an industry (URT, 2009). that's why the government makes efforts to ensure that this sector is performing better by providing some of the agricultural inputs for free and other inputs subsidized also farmers are encouraged and trained for free also, the government of Tanzania establishes farmer's bank whereby farmers can be organized in groups of about ten people and get a loan with a small interest rate of about 7 % - 12 % while other microfinance has the interest rate of about 16% - 24% (Daudi, Laing, Mponda, Okor & Shimelis, 2018).

Despite these efforts and initiatives still agriculture in Tanzania is not doing well, this is because farmers depend on weather conditions which are very dangerous as nowadays the weather is not constant because of different economic activities like industrialization which

produce greenhouses gases that affect the earth's horizon. According to the results of IPCC (2013), the concentration of greenhouses gases causes a climatic change that will lead to heavy rainfall, extremely hot, floods, droughts, cyclones, and recession of glacier. These conditions are not favorable for agricultural productivity, because when there is heavy rainfall may result in floods which will destroy crops and even animals may die due to hunger as they may not have enough food. Likewise, when drought happens crops will die, and even animals will die either because there will be no food for them to survive or water for drinking. According to (Levira, 2009) the agricultural sector as the backbone of the economy in Tanzania is expected to drop as the impact of the contemporary issues of climatic change which underpin this sector that employs the majority of Tanzanians.

This problem leads Tanzania to have an unstable economy because climate change has a great impact on agriculture. After all, this sector mainly depends on seasonal rainfall which is vulnerable. The effect of climatic change causes severe problems to crops as it also changes the seasons in the sense that, rainfall and drought (high temperature) may occur unexpectedly and sometimes the rainfalls when the crops have already been damaged due to drought. In recent years agricultural productivity has been decreased due to the climate problem which has discouraged agricultural progress to the great extent (URT, 2009). According to the Ministry of Agriculture, Forest and Fisheries of Japan (2008) global warming lead to the low level of production on Japan's agriculture, that there was a decline in rice productivity, destruction of productive areas for fruits, increase in sea level and extreme drought. Also, intense weather events, associated with climate change cause land to become unsuitable for production that leads to sudden reductions in agricultural productivity (Wheeler, 2013).

1.5 Purpose of the Study

The climatic change caused by human activities like industries and deforestation, nowadays becoming a big challenge for agriculture. According to Agbola and Fayiga, (2016)

climate change is all about disaster includes problems like floods, extreme heat, and drought which cause soil degradation at the end will result in low crop yields. But this problem can be addressed by several policies and strategies. For example, according to the Indian Agricultural Research Institute (2005), India uses policies like soil and natural resource conservation, water, and environmental protections; as well as policy for technology revolution whereby the productivity in 2018 double the one of 2016. According to Huang, Rozolle and Wang, (2010) China use strategies like improving agricultural infrastructures such as water-saving irrigation projects and encourage researcher conduct more studies on crops that resist drought, diseases, pests and waterlogging also farmers encouraged to plant crops according to local climatic conditions which helped their agricultural productivity to increase for example soybeans increase from 5.04 million tons in 2016 to 15.83 million tons in 2018.

Tanzania's government helps Farmers in terms of inputs and knowledge and farmers by themselves strive to ensure that their agricultural products are in large amounts with high quality. Regardless of these efforts still agricultural sector does not perform well since it depends on weather conditions. Therefore, this study aims at identifying better strategies (adaptation factors) towards the impacts caused by change in climate as it affects agricultural productivity in Tanzania. The recommended goal is to provide advice to the farmers and government concerning the better method to address this problem as well as to give the theory that change in weather conditions is not always lead to a decrease in agricultural productivity.

1.6 Research Questions

This research aimed to address the following six questions:

1. Farmers in Tanzania are willing to adopt new strategies like the use of greenhouse farming, irrigation, crop diversification, and crop rotation to increase their productivity?
2. The use of irrigation system will help to increase agricultural productivity in Tanzania?

3. The use of crop diversification will help to increase agricultural productivity in Tanzania?
4. The use of greenhouse farming will help to increase agricultural productivity in Tanzania?
5. The use crop rotation will help to increase agricultural productivity in Tanzania.
6. The help from the government like policies, subsidies, and loans will help farmers to cope with climate change?

1.7 Significance of the Study

The study is significant to all agricultural stakeholders including farmers, NGOs and governments as it will clearly show how the people who engage in agricultural activities depends on weather condition have mostly been affected by climatic change and hence will help to come up with better solutions on how to deal with this challenge to enable modern and sustainable agricultural activities.

II. LITERATURE REVIEW

2.1 How to Improve Agricultural Productivity

According to Komba and Muchapondwa (2015) the problem of change in climate towards agricultural activities can be solved by using different techniques like crop diversification, irrigation and planting drought resistance crops depending on the socio-economic and geographic condition of the area and considering availability, accessibility, and affordability because specific variables may have positive or negative affect towards the choice of particular adaptation methods. Also, the problem of climate change can be solved in various ways like Cultural Methodologies through cultivation of new crops; plant adaptability; and the use of fertilizer. Other ways are Conventional Techniques and Genetics and Genomics Strategies (Raza, 2019).

According to FAO (2015), climatic change in Tanzania leads to vulnerability like heavy and random rainfall, unstable of agroecological zones, high temperature beyond normal, weeds and crops compete for moisture , increase in pests and diseases which result to decline in food production. Farmers must use techniques like irrigation, use of fertilizer, controlling pests and diseases, extension services, crop diversification and greenhouse farming (UNFCC, 2007). Also, it is proposed to use other techniques like crop rotation, planting drought resistance crops and farmers must use data from meteorological authorities (Gu, Omambia & Shemsanga, 2010).

According to Bakari (2015) the problem of climatic change can be solved by long-term adaptations like land used the use of technology like greenhouse farming, land management techniques and proper use of water. Also, it is proposed to use techniques like changing in planting seasons, use of irrigation systems, crop rotation, greenhouse farming and silviculture practices (Levira, 2009).

2.1.1 Technology Factor

Technology has a great role in solving problem of change in climate and enables farmers to have a conducive environment for their agricultural activities to increase productivity. Climate change caused by human activities which mostly use non-renewable energy in transportation, electricity production, industries, residential and commercial, agriculture, land use, and forestry whereby they release gases like carbon dioxide in sufficient quantity to change the composition of the atmosphere resulted in increasing of heat referred as global warming (Trenberth, 2018). But can be solved in different ways. For example, electricity can be produced by using hydro, wind, and solar energy; in industry, residential and in commercial green energy such as solar and wind can be used (Major, 2018). Technology is vital in developing agricultural productivity due to the following reasons;- improving agricultural infrastructure like irrigation systems; secure output market due to innovations; improving agriculture inputs like seeds as well as fertilizer; and enable effective input supply system (FAO, 2018).

2.1.2 Irrigation Factor

The adoption of planting drought resistance crops can reduce the risk of shortage of food but the use of irrigation system maximizing and extending the growing season hence increase the production resulting to increase in the availability of agricultural products and reduce food price (Schoengold & Zilberman, 2004). According to Farkas, Hozalpfel, Lorite, Oliveira, and Pannunzio (2009) irrigation recovers and improve soil quality, increase, and dissolve nutrients in fibers and improve the growth of plants as it regulates temperature of the surface area. Irrigation is important especially when drought occur or when the rainfall is below 30 cm because it is impossible in conduct agricultural activities (Heng, Shahid & Zamani, 2018).

According to Thakur (2018) in Nepal temperature rise and change in precipitation

pattern causing drought resulted in reducing agriculture productivity and food production and accelerating poverty and because agriculture is the first sector to Nepal's national economy largely depend on irrigation hence the long-term adaptation planning to support the irrigation systems, and agriculture practices improve the sector. According to Braga (2014) irrigation becomes important as climate conditions become drier (increase in drought) and as drought increase also increase the importance of irrigation increase. According to Lobel and Zaveri (2019) irrigation reduces sensitive to heat and contribute to the increases of wheat yields continuously for 40 years in India and is believed and projected that there is a probability of decreasing in irrigation due to the increase in rainfall in 2040-2069 and 2070-2099 if the efforts of reducing carbon oxide will continue.

2.1.3 Crop Diversification

Climate change cause changes in seasons whereby unpredictable weather such as shortage of rainfall as well as increase in temperature happen for so long and affect the agriculture activities and many areas in Tanzania experience this situation and becomes common to see drought in rain season or drought to whole year under this condition to depend on planting one crop is risk (Drakenberd, Ek & Fernqvist, 2011). Through crop diversification whereby farmers change their crops depending on weather of that season will help to solve the problem of climate change and improve agricultural productivity and solve the problem of food shortage (Alur & Maheswar, 2017). According to FAO (2018) many sub-Saharan countries practicing crop diversification to control the effects of change in climate specially to control pests and diseases also has benefits in controlling soil quality. Also, crop diversifications improve soil quality because the changes of crops help land to protect against pests and diseases (Makate, 2016). It is important to use cop diversification because it improves soil quality and cope with the problem of change in climate (Malik & Singh, 2002).

Crop diversification used to minimize the risk of change in climate like the combination of trees, crops and livestock mitigates environmental risks, helps to create a permanent soil

cover against erosion, minimizes damage from flooding and high temperature, trees provide shelter to crops, and enhances water storage, bring nutrients from deeper soil layers, or in the case of leguminous trees, as a result increasing productivity (The European Climate Adaptation Platform, 2015). Climate change has negative impacts to agriculture sector, but crop diversifications help to improve crops productivity as it improves soil quality, protect from pests and diseases, cope with change in climate (Lin, 2011).

2.1.4 Green House Farming

Greenhouse farming is a technique that provides conducive environments for plant to grow; and is used to shield the plant against extreme weather events like high temperature, solar radiation, heavy wind and cold as well as insects and diseases and produce products with high qualities and quantities (Aznar-Sanchez, Lopez-Felices, Roman- Sanchez & Velasco-Munoz, 2020). Greenhouse farming reducing negative impacts caused by rising in temperature and climate vulnerability in general because protects both daytime heat and cool night winds as well as seasonal temperature fluctuation that can harm crop cycle and also act as a shield to protect plants from direct sunlight and rainfall for example, heavy rainfall caused both soil washout and easy to destroy crops such as tomato when they are planted in open-air method (Makate, 2016). But greenhouse farming mitigates this effect by consolidating soil and shielding crops against direct rainfall also is good and economical especially during the drought because it helps to preserve water as it protects the direct sunlight, hence, uses a little amount of water compared to open-air farming (Biek, 2015).

According to FAO (2013) during summer seasons the areas like Mediterranean and tropical the greenhouse effects become a severe problem to the crop performance because the temperature become higher to the extent that it become difficult to conduct agricultural activities. But these challenges have been compensated by greenhouse farming because it shades the crops and protect the plants from the direct sunlight and hence regulates and

provides proper ventilation and/or cooling environment. Greenhouse farming not only protect crops from high temperature but also due to high cold and wind (Braga, Coelho, Cunha & Féres, 2014).

2.1.5 Crop Rotation

According to Chalaba (2014) crop rotation increases crop productivity because it improves soil and is the most useful technology for improving soil quality also used as strategies to control effect of change in climate and the best outcomes obtained when farmers allocate large areas for legumes. Crop rotation helps a lot in improving agricultural activities because it control the growth of weeds, pests as well as diseases whereby legumes crops are good and recommended as rotational crops because of their nitrogen-fixing functions which improve the fertility of the soil and improve the soil conservation system (Friedrich, 2014).

2.2 How to Adopt Climate Change

According to Jiri and Mafongya (2017), the adoption of the factors for mitigating the effects of climatic change towards agriculture depends on income, geographical location, size of the farm, experience, types of crops grown and perception toward the use of a certain technique.

III. THEORETICAL BACKGROUND

It is seen for some years that climate keeps on changing and expected to continue as days go but many people in Tanzania participate in agricultural activities while depending on weather conditions (Komba & Muchapondwa, 2015). Even if climate keeps on changing is impossible to leave agriculture and run to other activities because agricultural products needed to human life, hence it is must to use techniques that will enable agriculture to proceed in any weather condition. (Mozumdar, 2012). When farmers adopt, fertilizer, irrigation, crop rotation, greenhouse farming and crop diversification strategies can cope with this problem of climate change (Akinnagbe & Irohibe, 2014).

3.1 Anthropogenic Global Warming Theory

The theory explains that climate change occurs when human activities emit greenhouses gases such as nitro oxide, methane and carbon dioxide which absorb the internal thermal radiation as a result the earth's atmosphere becoming warmer than it otherwise might be (Bast, 2010). This situation affects agricultural productivity and it is believed that climate change is natural so nothing can be done to handle its effects. The problem of drought can be addressed through the use of irrigation systems and the government has to put effort and consideration in constructing and supporting irrigation projects, also to construct dams especially to rural areas where agriculture taking place at large (Wiebe, 2003).

3.2 Theory of Change

According to Anderson (2005) the theory of change explains the relationship about how the stakeholder will reach a common understanding of their goals (Anderson, 2005). Hence, this theory connects with an adaptation of climate change towards agriculture because to adopt new strategies in agriculture involve many stakeholders hence will take a long time to have a common understanding, accepted and succeeded even though it is believed that they will reach consensus (Pringle & Thomas, 2019). It is seen for some years that climate keeps on changing

and expected to continue as days go but many people in Tanzania participate in agricultural activities while depending on weather conditions which mostly leads to land degradation (Komba & Muchapondwa, 2015). The problem of land degradation can be solved by planting trees, good farming system like crop rotation and soil improvement strategies (Mozumdar, 2012). Also, when farmers adopt irrigation strategies can cope with this problem of climate change (Akinnagbe & Irohibe, 2014).

IV. HYPOTHESIS DEVELOPMENT

For the country that depends on agriculture must ensure that working the whole year for effective and efficient production. But if no effort is taken to stop depending on weather, agriculture will always fail because it will be performed during the moderate rainy season only. For example, in Tanzania has about two months of moderate rainy in a year, this is not enough for this sector to grow at maximum. Hence, for the sense of development, Tanzania must adopt some measures that will help the agricultural activities and should stop depending on weather conditions.

Hypotheses to be tested are:

4.1 Effects of Temperature Change on Agricultural Productivity

Change in temperature reduces the productivity in crop yields (including cropland productivity and water stress), livestock mortality, pasture- and rangeland productivity, changes in aquaculture production, and changes in fisheries catch (OECD, 2015). The crop productivity has been studied and suggested that the global level will decrease (have negative effects) as global warming increase from moderate to a high level (Rosenzweig, 2013). According to Nastis, Michailidis, and Chatzitheodoridis (2012) in Greece for the past three decades, there is agricultural productivity decrease because of an increase in average temperatures.

H1: Change in temperature affects agricultural productivity.

4.2 Effects of Rainfall Change on Agricultural Productivity

Rainfall and availability of water determine the decision of crop selection and the output of agricultural production because their influence is high (Alam, Toriman, Chamhuri & Talib, 2011). 80% to 90% of African and global farming communities and about 60% of staple foods depend on rain-fed agriculture especially in Ghana whereby maize yield expected to decline for 20% by 2050 because of decrease in rainfall (Adu-Acheampong, Kyei-Mensah &

Kyerematen, 2019).

H2: Change in rainfall affects agricultural productivity.

4.3 Effects of Irrigation System on Agricultural Productivity

According to Jin, Muraoka, and Yu (2012) the irrigation has the direct impact on farm productivity through increases in crop yields, crop technologies, and diversification and results to higher households' income, consumption, employment opportunity, and lower food's price which is a good thing, especially to the poor. In developing world crop productivity, are higher in irrigated than in rain-fed areas (Lipton, 2007).

H3: The use of irrigation systems affects the increase in agricultural productivity.

4.4 Effects of Crop Diversification Usage on Agricultural Productivity

According to Alur and Maheswar (2017) crop diversification enable farmers to grow different types of crops depending on weather condition at a specific time. Hence, crop diversification plays a vital role in to cope the challenge of change in climate (Makate, Makate, Mango &Wang, 2016).

H4: Crop diversification affects the increase in agricultural productivity.

4.5 Effects of Greenhouse Farming Usage on Agricultural Productivity

According to NEHA (2019), greenhouse farming combating effect of change in weather in agriculture because use to traps the moistures, reduces the duration of cropping, and increases the quality of crops, control temperature, and humidity according to the requirements of the crops, possible to grow off-season crops and easy to control pests. Greenhouse farming is the best technology to combat climate change as to provide favorable environments to crops all over the year by protecting adverse conditions like high temperature, cold, excessive winds and solar radiation as well as pests and diseases (Reddy, 2019).

H5: The use of greenhouse farming affects the increase in agricultural productivity.

4.6 Effects of Crop Rotation Usage on Agricultural Productivity

According to Mercer-Quarshie, Sauerborn, and Sprich (2001) crop rotation has positive impacts on soil quality improvements compared to mono cropping. Crop rotations used as foundation of organic systems and organic farmers realize the importance of increasing soil quality to maintaining field productivity (Johnson & Mohler, 2009).

H6: The use of crop rotation affects the increase in agricultural productivity.

4.7 Effects of Government Help on Agricultural Productivity

According to Ahern, Huffman, and Yee (2002) brings huge impacts in improving agricultural productivity. For the agriculture sector to develop the government needs to perform better the roles like formation and execution of policies, provision of physical infrastructure, granting of loans, credits, and subsidies (School Mattzz, 2017).

H7: The help from the government like policies, subsidies, and loans to help farmers to cope with climate change affects agricultural productivity.

V. METHODOLOGY

Regarding the objective of this study, it has been conducted on a quantitative way to evaluate the exploring factors affecting agricultural productivity in Tanzania: policy implication for climate change. The study used a random sampling method to get respondents which incudes, students, farmers, government officers, private companies' workers, pastoralists, businessmen, and people who do not have a job. The study is conducted by using primary data as a source of information. Primary data collected from respondents by using survey questions (annex 1) whereby 172 (equal to 86%) out of 200 surveys distributed responded and 99.4% of respondents agree that they understand the term climate change. The response rate was 0.86. The questionnaire was in English and the Qualtrics link sent to participants and asked to conduct an online survey.

Among the 172 respondents, 68.6% were female and 31.4% were male. More details concerning the demographic data showed in the table below.

Table 1. Demographic Data from the Sample

	Total	
Total Respondents = 172	%	N
Gender		
Male	68.6%	(118)
Female	31.4%	(54)
Age		
41-50 years old	3.5%	(6)
51-60 years old	30.2%	(52)
61-70 years old	45.3%	(78)
70+ years old	20.9%	(36)
Education		
Secondary school or below	0.6%	(1)
High school or certificate	2.9%	(5)
Diploma	5.2%	(9)
Bachelor degree	49.4%	(85)
Master's degree and above	41.9%	(72)
Employment		
Student	6.4%	(11)
Businessman	9.9%	(17)
Farmer	11.6%	(20)

Pastoralist	2.9%	(5)
Government employee	63.4%	(109)
Private employee	5.8%	(10)
Jobless	0%	(0)
Marital Status		
Married	69.4%	(118)
Single	30.6%	(17)

VI. DATA ANALYSIS

6.1 Hypothesis Testing

This study applied simple linear regression analysis to the test hypothesis.

7. 1.1 Effects of Temperature change on Agricultural Productivity

H1: Temperature change affects agricultural productivity

The analysis of effect of temperature change on agricultural productivity represented in table 2. According to ANOVA, the model seems to be significant at 0.1 level with F = 0.608 and r-square = 0.004. Hence, based on the result H1 is accepted.

Table 2. Temperature change affects Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Temperature change → agricultural productivity(H1)	1.164*, 0.60

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.2 Effects of Rainfall Change on Agricultural Productivity

H2: Rainfall change affect agricultural productivity.

The analysis of effect of rainfall change on agricultural productivity represented in table 3. According to ANOVA, the model seems to be insignificant at 0.1 level with F = 37.331 and r-square = 0.181. Hence, based on the result H2 is rejected.

Table 3. Effects of Rainfall Change on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Rainfall change → agricultural productivity(H2)	16.797*, -0.425

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.3 Effects of Irrigation System usage on Agricultural Productivity

H3: The use of irrigation system affects the increase of agricultural productivity in Tanzania.

The analysis of effect of the use of irrigation system on agricultural productivity represented

in table 4. According to ANOVA, the model seems to be significant at 0.1 level with F = 37.331 and r-square = 0.181. Hence, based on the result H3 is accepted.

Table 4. Effects of Irrigation System Usage on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Irrigation system → agricultural productivity(H3)	4.615*, 0.086

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.4 Effects of Crop diversification Usage on Agricultural Productivity

H4: The use of crop diversification affects the increase of agricultural productivity in Tanzani a.

The analysis of effect of the use of crop diversification on agricultural productivity represented in table 5. According to ANOVA, the model seems to be significant at 0.1 level with F = 1.009 and r-square = 0.081. Hence, based on the result H4 is accepted.

Table 5. Effects of Crop Diversification Usage on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Crop diversification → agricultural productivity(H4)	12.453*, 0.081

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.5 Effects of Greenhouse Farming Usage on Agricultural Productivity

H5: The use of greenhouse farming affects the increase of agricultural productivity in Tanzani a.

The analysis of effect of the use of greenhouse farming on agricultural productivity represented in table 6. According to ANOVA, the model seems to be significant at 0.1 level with F = 2.575 and r-square = 0.15. Hence, based on the result H5 is accepted.

Table 6. Effects of Greenhouse Farming Usage on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Green house farming → agricultural productivity(H5)	12.453*, -0.123

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.6 Effects of Crop Rotation Usage on Agricultural Productivity

H6: The use of crop rotation affects the increase of agricultural productivity.

The analysis of effect of the use of crop rotation on agricultural productivity represented in table 7. According to ANOVA, the model seems to be significant at 0.1 level with F = 3.195 and r-square = 0.19. Hence, based on the result H6 is accepted.

Table 7. Effects of Crop Rotation Usage on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Crop rotation → agricultural productivity(H6)	17.724*, -0. 137

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

7.1.7 Effects of Government Help (like Policies, Subsidies and Loans to help Farmers to Cope with Climate Change) on Agricultural Productivity

H7 The help from the government like policies, subsidies, and loans to help farmers to cope with climate change affects the increase of agricultural productivity.

The analysis of effect of the use of the government help on agricultural productivity represented in table 8. According to ANOVA, the model seems to be significant at 0.1 level with F = 1.116 and r-square = 0.07. Hence, based on the result H7 is accepted.

Table 8. Effects of Government help on Agricultural Productivity

Independent variable to dependent variable	t- value, standardized coefficient
Government help → agricultural productivity(H7)	3.593*, 0. 081

indication of statistical significance P<0.1*, P<0.005**, P<0.001***

VII. CONCLUSION AND RECOMMENDATION

7.1 Findings

The study intended to investigate if climate change affects agricultural productivity and it focused on temperature change and climate change as the factors that affect agricultural productivity. These factors were chosen based on the literature review and have been used in hypothesis 1 (H1) and hypothesis 2 (H2). The study shows that H1 accepted that temperature change affects agricultural productivity while H2 rejected that rainfall change does not affect agricultural productivity. It meant that when the temperature changes agriculture activities affected much, for example, if there is a high temperature, the land becomes dry so crops will die, and even irrigation might be difficult because even sources of water like rivers might dry. While a change in rainfall might not affect much agricultural productivity because for example if there is low rainfall, an irrigation system might be used also crop diversification can apply such as planting crops that sustain with a low level of rainfall.

7.2 Additional Findings

The study shows that in Tanzania the problem of climate change exists, and it seems this is a common challenge as 99.4% of the respondents aware of it, while 97.1% said have been experiencing it, and among them 86.7% experience at least one year. And this challenge affects human activities as the study shows that 100% of the respondents agree that change in climate affects human activities. Regardless of this fact, but still farmers depend on weather conditions for their agricultural activities as the study shows that about 94.2% of the respondents agree that farmers in Tanzania depend on weather conditions to perform their agricultural activities. This situation affects agricultural productivity as 98.3% of responding said that agricultural productivity is affected by climate change. That is why agricultural productivity tends to vary every year in Tanzania as a study shows that 93% of the respondents agree on this while the study shows that to be the main activity in Tanzania as 86.6% of the respondents said they have participated in agriculture activities.

The study explains much about the effect of climate change on agricultural productivity. From data collected analysis shows that 89.5 % of respondents agree that changes in Tanzania's temperature affect agricultural productivity, 94.8% agree that agricultural productivity affected by the change in rainfall, and 98.3% agree that Tanzania's farmers are also disturbed. The government must use different techniques to rescue this situation and the people have trust towards the government that can help them. As the study shows, 94.7% of responding agree that government can help farmers to ensure their products are not affected by a change in climate through different measures like policies, subsidies, and loans. And the farmers are ready to use different techniques to increase their productivity as the study shows that 92.4% of responding agree that the farmers in Tanzania can use other agriculture techniques than depending on the weather.

Also, for the government to help farmers toward the challenge of climate change to agricultural activities and its impacts will increase government trust. As the study shows that 88.3% of the respondents said that government trust will be improved by helping farmers and people believe that, the government can help the farmers as 82.9% of the respondents agree on that. Hence, the study shows that for Tanzania to improve agricultural activities they must adopt other techniques than depend on the weather as 97% of the respondents agree on that. Techniques like irrigation, crop diversification, greenhouses farming, and crop rotation can be used. The study shows that these techniques have a great contribution toward the improvement of the agriculture sector in Tanzania as 94.6% of the respondents agree that the use of an irrigation system will increase agricultural productivity. Also, 94.6% of respondents agree that crop diversification will increase agricultural productivity, and 91.7% of respondents agree the same on the use of greenhouse farming, not only that but also 95.9% of the respondents agree that the use of crop rotation will increase agricultural productivity in Tanzania.

Generally, the study shows that agricultural productivity has been affected by climate change but much with temperature change. Also, it shows that this is possible and it is a useful

measure for the government to help the farmer to ensure their products are not affected by changes in climate through different policies, also the use of irrigation, crop diversification, crop rotation and greenhouses farming are the alternative techniques that farmers have to apply for improving their productivity. Also, the study shows that farmers in Tanzania are ready to use other agriculture techniques than depending on the weather to improve their productivity.

7.3 Policy Implication

The study explained and analyzed the challenge of climate conditions as it affects agriculture improvements in Tanzania and evaluated the techniques to improve this sector. Also, provides advice to the farmers and government concerning the better method to address this problem as well as to give the theory that change in weather condition might not be harmful to the agriculture sector. Thus, the following recommendations suggested to this challenge: farmers must change their cultivation style from depending on weather and adopt a mechanism that will enable them to continue with their activities even though the climate going to change; Government must support farmers to ensure that can adopt the new techniques in terms of enacting policies, subsidies, and loans; government must provide extension services to farmers through media programs also government through districts extensions officers must have regular meeting with farmers to listen to challenges facing them, must-visit farms and see how the farmer proceeds with their activities and must provide advice to the farmer to improve their productivity depending on their locations.

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ANNEX 1. SURVEY QUESTIONS

Please take 5 minutes to read, understand and answer the survey questions. This study aimed at improving the agriculture sector as the backbone of Tanzania's economy. Regardless of efforts that the government and farmers have been devoted ensuring that agriculture industry improves, the sector still challenged in doing better. Hence, researcher wants to know if climate change contributes to this problem.

Part 1: Demographic Data

1. Gender: Female ( ) Male ( ).
2. Marital Status: Married ( ) Single ( )
3. Age: 18 – 20 ( ) 21 – 25 ( ) 26 – 30 ( ) 31 – 35 ( ) 36 – 40 ( )
   41 -45 ( ) 46 – 50 ( ) 51 – 55 ( ) 56 – 60 ( ) 60+ ( )
4. Education level:
   i. Secondary school or below ( )
   ii. High school or certificate ( )
   iii. Diploma ( )
   iv. Bachelor degree
   v. Master degree and above
5. Occupation:
   i. Student
   ii. Businessman
   iii. Farmer
   iv. Pastoralist
   v. Government employee
   vi. Private employee
   vii. Jobless

Part 2: Climate Change and Agriculture Issues (answer according to your understanding towards climate change, agricultural activities, and their relationships).

6. Do you understand the term climate change? Yes () No ().
7. Have you ever experienced climate change in Tanzania? Yes () No ().
8. For how long you have experienced climate change in Tanzania.
   i. Less than one year
   ii. 1 year – < 5 years
   iii. 5 years – < 10 years
   iv. 10 years – < 15 years
   v. 15 years and above
9. Does climate change affect human activities? Yes ( ) No ( )
10. If yes, how much do you agree that climate change affect human activities

i. Strongly disagree ( )
ii. Disagree
iii. Somewhat disagree ( )
iv. Neither agree nor disagree ( )
v. Somewhat agree ( )
vi. Agree ( )
vii. Strongly agree ( )

11. Have you ever participated in agriculture activities? Yes ( ), No ( ).

12. If yes for how long have you participated in agriculture activities?
    i. Less than one year
    ii. 1 year – < 5 years
    iii. 5 years – < 10 years
    iv. 10 years – < 15 years
    v. 15 years and above

13. How much do you agree that farmers in Tanzania depend on weather condition for their agricultural activities?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

14. Does climate change affect/hinder agricultural productivity in Tanzania? Yes ( ) No ( ).

15. How much do you agree that the agricultural productivity vary in Tanzania every year?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

Please rate your opinion based on questions 14 and 15 for questions 16 and 17

16. Does change in temperature affect/hinder agricultural productivity in Tanzania?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

17. Does change in rainfall affect/hinder agricultural productivity in Tanzania?

i. Strongly disagree ( )
ii. Disagree ( )
iii. Somewhat disagree ( )
iv. Neither agree nor disagree ( )
v. Somewhat agree ( )
vi. Agree ( )
vii. Strongly agree ( )

18. Is it possible for the farmers in Tanzania to use other agricultural techniques than depending on weather (seasonal rainfall) to increase agricultural productivity? Yes ( ) No ( )

If yes please rate your opinion on the following techniques (question 19 -22)

19. The use of irrigation system will help to increase agricultural productivity in Tanzania?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

20. The use of crop diversification will help to increase agricultural productivity in Tanzania?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

21. The use of greenhouse farming will help to increase agricultural productivity in Tanzania?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

22. The use of crop rotation will help to increase agricultural productivity in Tanzania?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

23. How much do you agree that adoption of new strategies will help to increase agricultural productivity?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat disagree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

24. Help from the government like policies, subsidies and loans will help farmers to cope with climate change?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )

25. Do you think government of Tanzania can help farmers to ensure their productivity are not affected by change in climate? Yes ( ) No ( )

26. How much do you agree that the government's trust will be improved by helping farmers to cope with climate change?
    i. Strongly disagree ( )
    ii. Disagree ( )
    iii. Somewhat disagree ( )
    iv. Neither agree nor disagree ( )
    v. Somewhat agree ( )
    vi. Agree ( )
    vii. Strongly agree ( )