EFFECT OF CLIMATIC VARIABILITY ON COTTON PRODUCTION TRENDS IN SENGEREMA DISTRICT - TANZANIA

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ABSTRACT

Cotton production in Sengerema - Mwanza region is one of the major economic activities. Other economic activities include fishing industry, livestock keeping, mining, and cereal crops production. The focus of the study was to establish the influence of climatic conditions on cotton production trends in Sengerema District, Mwanza Region and to identify the essential climatic condition for cotton production that would improve productivity in Sengerema District.

Both primary and secondary data were used to explore the relationship existing between cotton production and climatic condition. Secondary data were obtained from cotton board reports and from other publications while questionnaires were used to obtain information from the farmers about important production aspects like rainfall, soil fertility, temperature and general production trend which were carefully analysed for interpretation. The study's analysis has shown a very strong relationship between climatic condition and the general production trend. This provides the way forward to reduce production difficulties through persuading people around the Lake Zone to avoid poor farming practices which can affect the environment and general climatic condition which is likely to harm the cotton farming activities. Cotton farmers have to adapt the precision agriculture so as to increase quality and quantity of output; eventually to be the giant cotton producer and exporter in the world market.

Keywords: *cotton, climate change, agricultural production, farmers, Vulnerability and trend*

Introduction

In Tanzania, Cotton production was introduced in the lake zone by the Germans as a pilot cotton farming project around 19th century. India in Asia was the dominant producer of cotton in the world and the climatic condition favours a lot. Production of cotton on a commercial scale started in 1928 following the construction of a railway from Tabora to Mwanza. During the 1930s, local research led to the development of a pest-resistant variety, which raised cotton production considerably. In the 1930s, Asian businessmen dominated the sector, while the colonial government engaged itself in regulating the operations, investing in seed varietal research, free distribution of seeds to producers and announcing floor prices at the start of each marketing season. During the 1950s, a total number of 400 co-operative societies and 20 co-operative unions gained strength (Gwimbi & Mundoga, 2010). In the context of this study, cotton is defined as a tropical and subtropical plant which is commercially grown to make cotton fabric and thread. Oil and protein - rich flour are also obtained from the seeds. Board, T. C. (2010).

Literatures are explaining the general trend of cotton production in relation to climatic condition of which the main focus under climatic condition is temperature, rainfall and soil. Trend is a pattern of gradual change in a condition, output, or process, or an average or general tendency of a series of data points to move in a certain direction over time, represented by a line or curve on a graph (Saunders, 2011).

However, studies on the general trend of cotton production do not connect the relationship existing between the yields (cotton production trends) and the climatic condition. Numerous studies (IPCC, 2013, Muller, 2010, Manase, 2011, Hulme, 2012) have explored so many issues as far as climatic condition is concerned for cotton production in Africa at large, and the general trend of cotton production since its commencement around 19th century in Tanzania and Africa at large. The studies do not connect the relationship existing between the variability of climatic condition

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in relation to cotton productivity in Lake Zone. Therefore, the study on the hand helped to link the relationship between the two aspects and provide the way forward so that cotton growers can be aligned to the suggested situations for maximum productivity.

Numerous studies (IPCC, 2013, Muller, 2010, Manase, 2011, Hulme, 2012) have explored so many issues as far as climatic condition is concerned for cotton production in Africa at large, and the general trend of cotton production since its commencement around 19th century in Tanzania and Africa at large. The studies do not connect the relationship existing between the variability of climatic condition in relation to cotton productivity in Lake Zone. Therefore, the study at hand establishes the relationship between the two aspects namely: climatic conditions on cotton production and the needful climatic conditions for cotton production

The Objectives of this study were to:
  i.   Establish the influence of climatic conditions on cotton production trends in Sengerema District, Mwanza Region.
  ii. Identify the essential climatic condition for cotton production that would improve productivity in Sengerema District.

The Rationale of the Study
  i.   The study is reminding and emphasizing to the farmers to be aware with general trend of the changing climatic condition that favour or disfavor cotton productivity.
  ii. The study is helping to minimize the guesswork in production of cotton for farmers and stakeholders
  iii. The study provided the best procedures and practices for the forthcoming years for farmers to choose the best cotton breed to be planted with the present climatic condition
  iv. The study advised the environment authorities to work on stabilising the environment so that can help cotton growers to increase productivity

Scope of the study
The study covered Sengerema district in Mwanza region and eventually generalized for regions falling in Lake Zone.

Definition of key terms:
Cotton: the tropical and subtropical plant which is commercially grown to make cotton fabric and thread. Oil and protein - rich flour are also obtained from the seeds. Board, T. C. (2010).
Farmer: is a person engaged in agriculture, raising living organisms for food or raw materials. The term usually applies to people who do some combination of raising field crops, orchards, vineyards, poultry, or other livestock. Oladele, O. I. (2011).
Trend: is a pattern of gradual change in a condition, output, or process, or an average or general tendency of a series of data points to move in a certain direction over time, represented by a line or curve on a graph. Saunders, M. N. (2011).
Climatic change: is a fluctuation in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels. Hulme, M. (Ed.). (2012).
Agricultural production: includes activities like cultivating soil; planting, raising, and harvesting crops; rearing, feeding, and managing animals and they can result into a product that will be sold at retail. Oladele, O. I. (2011).
Vulnerability: is a function of the character, magnitude, and. rate of climate change and variation to which a system is exposed. Meera, S. N., Jhamtani, A., & Rao, D. U. M. (2010).

Empirical Studies
Climatic change is a fluctuation in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels (Hulme, 2012).

Climate change is a significant constraint on agriculture throughout much of Sub - Saharan Africa (Burke *et al.,* 2009). Recent evidence and predictions show increasing temperatures and drought frequency, as well as shifting rainfall patterns. The combination of increasing temperature and shifting rainfall amounts and patterns negatively impact on agriculture (IPCC, 2009; Muller, 2010).

Southern Africa in particular is highly vulnerable to extreme variability of precipitation for about 74.9% given its high dependence on rain-fed agriculture and natural resources for livelihoods; limited knowledge on climate change

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and limited resources for adaptation (Manase, 2008). Consequently, there is an increasing concern regarding the impact of climate change on agriculture, especially in terms of the rainfall impact on crop production (Hulme, 2010).

Scientific evidence on temperature and rainfall variability and its impact on crop yields are now stronger than ever. While globally the temperature has increased by over 0.5°C since 1910, a similar rate of warming of about 0.05°C per decade has been observed in southern Africa (Hulme, 2010). The rainfall in the region has been erratic over the same period, with annual rainfall anomalies mostly below normal. Climate change scientists' view is that temperatures are likely to continue to rise and that increases in rainfall is necessary in order to compensate for the loss of moisture from the land due to elevated evaporation rates (Hulme, 2010).

For Tanzania, a country of wide geographical diversity with a predominantly rural population that lacks some basic infrastructure, the impact of climate change on agriculture is very high (Manase, 2008). IPCC (2013) most communal farmers in Tanzania rely on natural rainfall for their farming activities and are affected worse by climate change. Their difficulties are compounded by the erratic seasonal rainfall patterns, which have been experienced by the country in the last three decades. This dependence on natural rainfall has resulted in low agricultural productivity as communal farmers, who make up about 75% of the entire farming community find difficulty in ensuring that their crops have adequate water supply until harvest. Significant rainfall deficits at critical stages of crop growth have frequently led to a serious shortfall in crop production. For example, recently in Mwanza region the rainfall is not so much stable as it had before for cotton production.

Sengerema District is one such rural area in Mwanza affected by climate change. The district is a major cotton producing area in Mwanza and has been a destination for internal immigrants seeking for the fortunes associated with cotton growing (Govereh, 2009). The area is relatively newly settled and farm sizes are larger than the national average for cotton production. The soils have high agricultural potential and few farmers apply any supplementary nutrients. Household income levels have improved and enabled them to acquire assets and sent their children to school, not otherwise possible by those not engaged into non cotton growing. To acquire assets like draft cattle Govereh's (2009) study in the district showed that 53% of the farmers used income gained from cotton, 20% used a combination of cotton and maize income and18% used wage savings. Consequently, farmers' not growing cotton had less than half the assets owned by those growing cotton. Moreover, by 1990 cotton accounted for more than 30% of the cultivated area in the district as compared to only 5% in other cotton-producing regions in the country. The average area under cotton increased from 0.5 ha per household in 1980 to almost 10 ha in 1985/86, while the average devoted to maize dropped substantially (Jayne, 2011; Govereh, 2009).

The success of farmers' cotton production however depends on the normal climate pattern, especially rainfall. Changes in climatic conditions worry farmers as this adversely affects farmers in a variety of ways. While farmers' general vulnerability to climate change is now well known at a global scale, great uncertainty remains at specific locations. Limited knowledge on local livelihoods vulnerability to climate change exists and this poses challenges to policy makers when it comes to tackling adaptation to climate change.

Against the above background, this study has assessed the vulnerability of cotton farmers in Sengerema to climate change so as to provide the basis for mainstreaming climate change adaptation into their farming activities.

Vulnerability to climate change in this study is conceptualised with reference to climate change. The IPCC (2010) defines vulnerability as the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes. Fussel (2015) argues that there are three dimensions of vulnerability to climate change, namely the physical, the socioeconomic and the external assistance. The first dimension, the physical environment, focuses on the climate as the phenomenon that causes harm to those systems in its prone locations. This dimension puts emphasis on the climatic conditions in a region and to the biophysical impacts of climate change, such as changes in agricultural productivity or the distribution of disease vectors (Fussel, 2015). People in this context are treated as victims or vulnerable owing to their presence in locations where the hazard is experienced (Fordand Smit, 2014; Fussel, 2015). This approach has however been criticised for downplaying the role of the human system in modifying conditions within a region and the climate itself, hence contributing to the resultant climate change impacts (Oladele, O. I. (2011).

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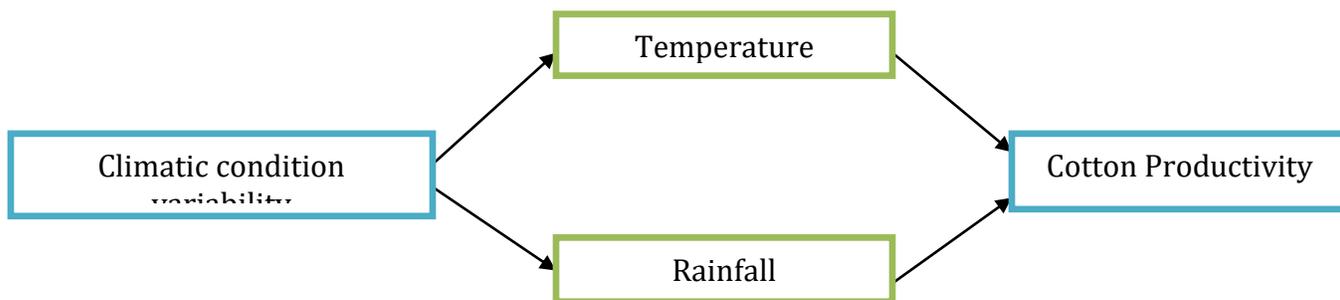
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The second dimension, the socioeconomic, refers to the region's capacity to recover from extreme events and adapt to changes over the longer term (Fussel, 2015). This has also been referred to as social vulnerability by Brooks (2013). According to Brooks (2013), hazards and disasters are not a result of physical events alone, but are also influenced by the social, economic, and cultural aspects of the humans exposed to such hazards. This approach emphasizes the socio – economic processes that constrain human ability to cope with climatic hazards. Central to this argument are factors such as the presence and strength of social protection measures such as food entitlements (Adger, 2010). The capacity of individuals or groups to cope with, resist, and recover from the impact of hazards determine their vulnerability (Fussel, 2015).

Furthering the debate of human vulnerability to climate change is the argument put forward by Sen (2009) that famine which is one output of vulnerability is not caused by lack of food, but by lack of access to food. From this perspective, vulnerability can be viewed as the lack of access to and entitlement of households or communities to available resources due to several factors such as prices and affordability by members of the community of the priced goods. The third dimension to vulnerability is the external assistance, defined by Fussel (2015) as the degree to which a system maybe externally assisted in its attempts to adapt to change. This conceptualization includes factors outside the vulnerable system, such as level of external assistance to address the impact.

Arguably, it is agreeable among researchers of different persuasions that vulnerability exists because of the presence of a hazard (Ford and Smit 2014; Fussel 2015). It is also agreeable among authors that vulnerability to climate change is a function of exposure, sensitivity and adaptive capacity of the affected community members individually or collectively (Johnston et al. 2009, Devereux 2010). Exposure consists of factors such as *temperature and precipitation that make up the climate system* (Devereux 2010). Sensitivity is viewed as the degree to which the system of interest (e.g. agriculture) is affected by climatic stimuli. The combination of exposure and sensitivity is often referred as the impact of climate change (Devereux 2010). This study, while incorporating the arguments presented above, views vulnerability as the likelihood of rural communities in Lesotho suffering from climate unfavourable impacts and their inability to respond to stresses resulting from such impacts.

Communities' inability to cope with negative impacts of climate change is at the centre of the study. This inability is worsen by changes in the climate average conditions and the occurrence of extreme events and variability. This definition is also in agreement with the definition of IPCC (2010) given earlier in this argument. The issues addressed in the study were first, evidence that climate change or variability vis-à-vis rainfall and temperature patterns existed in the district, and if it existed, what its impact on cotton production output was. Second, how the results of the study could be used by farmers and other stakeholders effectively to adapt to the changes. *The hypothesis of increasing temperature and decreasing precipitation trends associated with declining cotton production level was tested using annual temperature and precipitation data against cotton production output for the district.*

Figure 1: Conceptual framework indicating the relationship between cotton production and variability in climatic condition

Source: Research Construct (2019)

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METHODOLOGY

Study design: The study focused to the contribution of climate to cotton production and is the reason for the study to engage exploratory research design as it is in our interest to clearly explore the link between the present climatic condition and cotton production and how it can be improved in one way or another to enhance productivity in the farm practices. In so doing, the study established the way forward and best tactics which should be adopted by producers (farmers). In additional, the descriptive research designs used so as cover demographic statistics and in providing any other statistical analysis.

With regards to the approach, this study employed both qualitative and quantitative research approach. Qualitative research involves collecting, analysing and interpreting data by observing what people do and say. Hence, this was crucial in obtaining field views from cotton growers and weather experts from stations and institution around the lake. Moreover, a case study or in-depth study was involved as it helped us to acquire specific issues regarding the relationship existing between climatic condition and cotton production as per views from the growers of the product. Quantitative data on the other hand used for analysis, providing descriptive, climate-cotton production comparative from different years in past and statistical results for the situation.

Study place: The research covered Sengerema District in Mwanza region as a case study. However, studies group the cotton producing zones in two regions excluding clarification about the link between cotton production and weather condition. There are two cotton zones producing in Tanzania; Western Cotton Growing Area (WCGA) and the Eastern Cotton Growing Area (ECGA). The WCGA consists of regions of Shinyanga, Simiyu, Mwanza, Mara, Geita, Tabora, Kigoma and Singida and accounts for 97-99% of the total cotton production in the country. The ECGA includes Manyara, Morogoro, Coast, Kilimanjaro, Tanga and Iringa regions and accounts for the remaining 1-3% of cotton production (Mwangulumba & Kalidushi, 2012). Hence, based on the grounds of their contribution, it is viable for us to concentrate on the lake region specifically Mwanza region as our focus.

Socio-Economic and Demographic Characteristics

The area's main source of income is agriculture, including farming and livestock. Most of the country's cotton is grown in the lake region; however our study focused on Sengerema District in Mwanza region as case stated which eventually would be generalized for Lake Zone and Tanzania at large. Other crops grown in the lake zone include sorghum, cassava, tobacco and peanuts. Apart from agriculture, gold and diamond mines are other major sources of income. In Mwanza, located along the shore of Lake Victoria, many people work in the fishing industry.

Table 1: Lake Zone Population Size According To Regions

REGIONS	TOTAL POPULATION
Kigoma	2,399,121
Shinyanga	1,701,220
Mwanza	3,217,328
Mara	1,972,173
Simiyu	1,736,839
Geita	1,983,653
Singida	1,539,286
Tabora	2,652,514
Total	**17,202,134**

Source: United Republic of Tanzania National Census 2012

Through the population size of Mwanza Region; we have decided to take Mwanza as case study so as to explore the general situation of linking between climatic condition and cotton production in lake zone, which in turn generalizing for the entire country. The demographic data for Mwanza is 3.2 million which is very big as compared to other regions forming Lake Zone. Therefore, Mwanza has relevant data for generalization of the study.

Study population and Unit of analysis: The study used Climatic/Weather Controller Agencies/Authorities (weather forecasting Authorities) - from Mwanza Airport; Cotton cooperative union's individual farmers as the unit of analysis, where by the target population of the study covered both large scale and small scale cotton farmers.

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Moreover, documentary reviews from cotton agencies and or authorities were obtained the necessary information as per demands of the study.

Sample size
Sample Size Selection
In conducting a study, it is not be possible, practical and sometimes expensive to collect data by taking into account the whole population. Thus, a sample was necessary to be chosen to represent the relevant attributes of the whole of the units (Resnik, 2011).

According to Nsimbila, Nylandsted, & Kimeme, (2014) presented that the entire Western Cotton Growing Area in 2012 covered more than 50 competing ginneries and had 115,000 registered smallholders in Mwanza Region. Therefore, target population was 115,000 and was used in the determination of true sample.

Saunders (2011) proposed a use of infinite formula in order to select sample for the study. Thus, this study adopted the following formula to calculate the sample size.

$$n = \frac{N}{1+N(e)^2}$$

Where
n = Sample size
N = Targeted Population (115,000)
e = The precision level (error of estimations) (5%) i.e 95% Confidence interval
Thus

$$n = \frac{115,000}{1+115,000\,(0.05)^2}$$

n = 398
Based on this formula the sample size that used for this study were 398 cotton farmers based in Mwanza region in Tanzania and all the present weather controller stations/institutions in the region.

Sampling Techniques: This study adopted a non-probability sampling strategy, in this case convenient sampling**.**
The purpose of using convenient sampling was to ensure the sample selected was a true representative of the population of cotton farmers (Saunders, 2011).
Despite the fact that non-probability sampling does not involve the use of randomisation to get a representative sample, this study relied upon expert sampling. In this case, we identified both small scale and large-scale cotton farmers (small holders) who were considered as having particularly high quality of information for sampling. We targeted small- and large-scale cotton farmers from Sengerema district in Mwanza who possessed information relating to climatic condition variability in relation to cotton production which helped to have clear direction for generalization

Methods and data collection tools
This study used both primary and secondary data. Primary data which involved the collection of data from respondents by use of a questionnaire, focus group discussion and interview guide. The use of the questionnaire was justified because it is an effective way of collecting information from a large literate sample in a short period of time and at a reduced cost than other methods. Additionally, questionnaires facilitate easier coding and analysis of data collected (Resnik, 2011).
The questionnaires were important tool in assessing whether the model is effective in facilitating best farming cotton practices. The data collections were through the circulated questionnaires containing number of questions as per demands of the study. The nature of the information were categorized into two important aspects which are the essential information relating to climatic condition for cotton productivity and historical background on cotton production trend for future determination.
Secondary data were important in this study and they were retrieved from published journals, articles and documentary review from cotton cooperative unions at Sengerema District.

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Moreover, focus group discussion and interviews used so as to help in data collected that are not readily available from document records. This is mostly be used in identifying which information is readily available to different stakeholders in relationship between cotton production and climatic condition. This guided in creating a better platform for stakeholders to work together in improving the better farming practices for stakeholders particularly in adopting the relevant cotton seeds of species that can be grown with the existing climatic condition.

Data Analysis Methods: The data collected from this study was both qualitative and quantitative in nature in order to obtain reliable results**.** The quantitative data was analysed through the Statistical Package for Social Sciences (SPSS). For qualitative data, the researcher proceeded to examine raw data in order to find linkages between the research objectives and the outcomes in reference to the research questions. This made it possible to triangulate data in order to strengthen the research findings and conclusions. Analysis for the determination of the relationship between variables the author used multiple regression analysis and the analysis of variance while data collected through personal interview and documentary review were analysed using content analysis.

Findings and Discussion

The target of the study was to identify the essential climatic condition for cotton production that would improve cotton productivity, to assess the general trend for cotton production in relation to climatic condition and eventually to develop a formal relationship existing between climatic condition and cotton production and the way forward for agricultural improvement. The information gathered from the field through responses have reflected the demand of the study as discussed in the itemised sections:

Findings and Discussion: The trend in cotton production had been fluctuating from the year 1999/2000 to 2011/2012 as seen in Table 2. However, the fluctuation was high at its last year of trend due to the changes in climatic condition and related factors affecting production.

Table 2: Overview of the cotton industry in Tanzania (Seed Cotton Production Trend):

Seasons	Production (tons)
1999/2000	105,853
2000/2001	123,589
2001/2002	148,142
2002/2003	187,883
2003/2004	138,917
2004/2005	341,789
2005/2006	379,591
2006/2007	130,585
2007/2008	200,662
2008/2009	368,697
2009/2010	267,004
2010/2011	163,644
2011/2012	300,000 (estimated)

Source: Cotton Board Annual Report (Experimental Cotton Agriculture)

The constant incremental in production process for about 30% annually as shown above is due to favourable climatic condition and adaptability to precision agriculture by cotton farmers. The information gathered from the field is summarized as following:

Table 3: Needful Climatic Condition for Cotton Production

S/N	Needful Climatic Condition	% of respondents

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1	Appropriate rainfall for cotton production	89
2	Appropriate temperatures for cotton production	93
3	Fertility of the soil for cotton production	69
4	Amount of humidity needed for cotton production	23
5	Manure (organic and inorganic)	31

Table 4: General trend for cotton productivity (at individual level of producer)

S/N	Possible production trend	% of respondents
1	Horizontal (constant)	8
2	Upward (increasing trend)	77
3	Downward (decreasing trend)	11
4	Cyclical (ups and downs)	81

The findings were obtained from the field as responses from the respondents through the circulated questionnaires containing number of questions as per demands of the study. The nature of the information were categorized into two important aspects which are the essential information relating to climatic condition for cotton productivity and historical background on cotton production trend for future determination.

Essential Climatic Condition

i. *Appropriate rainfall for cotton production*:
A minimum of 500mm of water between germination and boll formation is required for cotton production, however in traditional cotton production it can take about 10,000 litres of water to produce one kilogram of cotton fabric. The adaptability to precision agriculture can result into application of simple techniques that can significantly reduce this amount. Generally, the amount of rainfall raining around Lake Zone is satisfactory for cotton production as it had been suggested by the cotton farmers for 89%.

ii. *Appropriate temperatures for cotton production:*
Cotton production requires moderate temperature which favours the farming system. In Lake Zone there is a Constant temperature between 18 and 30° which is the standard temperature for cotton production. The validation of this standard temperature had been supported by 93% of the cotton farming class, and this temperature is steady for March to June every year where the production commences and ends respectively.

iii. *Fertility of the soil for cotton production:*
69% of the farmers argued that the soil is fertile to some extent. However for this the study has gone extra mile by judging the lowest percentage of support on fertility of the soil, and re-thinking of adding more manure in the soil to make it more productive. As compare to the previous years the fertility of the soil is decreasing due to the effects of acidic rainfall, erosion and unprofessional crop cultivation. This has made the farmers to adopt precision agriculture (small area with high product volume) in it there is a use of organic manure and inorganic manure like NPK (Nitrogen (N) Phosphorus (P) and Potassium (K)) in the ratio of 20%-10%-10% respectively.

iv. *Amount of humidity needed for cotton production:*
Cotton farmers are not so much sure about the quantity of amount of water vapour required for cotton to grow well under fertile and appropriate rainfall. However 23 of them were certain and managed to provide information about the required humidity for cotton cultivation.

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v. Manure (organic and inorganic)

Unethical farming and environmental pollution resulted into acidic rainfall; soil erosion has caused the decline in the worth of the soil. 31% of the farmers are using fertilizers for production particularly for those cultivating in the same area for many years. The reflections upon this situation will more active in the following years due to the present industrialization around Lake Zone with affects environments causing destruction of ozone (O3) layer eventually excessive acidic rainfall and sunshine affecting cotton farming at great extent.

Cotton production requires moderate temperate and rainfall. The appropriate annual mean temperature and rainfall for cotton production is provided by Tanzania Meteorological Agency (TMA) from their weather forecasting stations for the year 2012 to 2016, however the mean annual temperature and rainfall are in the form of cyclical caused even the cotton production trend to be characterized by ups and downs in the respective years. Table 5 and 6 below; summarise the mean annual temperature and rainfall from the year 2012 to 2016 which can be related to the cotton production trend as indicated in table 1 as following:

Table 5: Annual Mean Temperature (ºC), by stations from 2012 to 2016

Station	2012	2013	2014	2015	2016	Mean
Bukoba	26.5	26.5	26.4	27.3	26.2	26.6
Mwanza	28.6	27.3	28.3	28.6	28.9	28.6
Musoma	28.7	28.9	28.2	29.7	28.6	28.8
Kigoma	29.5	29.2	28.1	29.9	30.0	29.3
Tabora	30.3	30.2	29.5	30.3	30.5	30.1
Dodoma	29.2	29.6	29.1	29.6	29.4	29.4
Iringa	27.8	27.4	26.4	27.4	27.2	27.0
Arusha	26.2	25.7	25.8	26.5	26.6	26.3
Kilimanjaro (KIA)	30.8	30.3	29.7	30.4	30.1	30.1
Dar es Salaam (JNIA)	32.2	32.1	32.0	32.0	31.3	31.8
Mtwara	30.6	31.0	30.7	31.1	30.9	30.9
Songea	26.7	27.3	26.7	27.7	28.0	27.5
Mbeya	25.1	24.6	23.7	26.2	24.0	24.6
Mean	28.6	28.5	28.0	29.0	28.6	28.5

Source: Tanzania Meteorological Agency (TMA), 2017

Table 6: Annual Mean Rainfall (mm), by stations from 2012 to 2016

Rainfall Regime	Station	2012	2013	2014	2015	2016	Mean
	Bukoba	2,280.0	1,863.3	2,227.2	1,755.1	1,452.9	1,915.7
	Dar es Salaam	702.2	1,004.4	1,278.9	1,038.9	782.9	961.5
	Mwanza	1,307.5	1,125.6	971.4	1,530.7	1,039.3	1,194.9
Bimodal Areas	Musoma	646.3	766.2	720.9	1,038.0	627.2	759.9

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	Kilimanjaro (KIA)	429.2	411.8	501.7	482.8	492.5	463.6
	Morogoro	646.7	551.8	993.8	587.6	587.6	673.5
	Mtwara	646.3	1,157.1	1,023.9	1,072.0	1,332.9	1,046.4
	Songea	896.0	1,072.7	1,010.8	852.3	846.7	935.7
	Tabora	810.8	939.8	826.5	957.4	911.6	889.2
Unimodal Areas	Kigoma	735.3	999.9	832.7	951.6	913.5	886.6
	Mbeya	508.1	1,028.3	1,220.3	876.0	952.6	917.1
	Iringa	545.3	859.1	885.5	555.4	752.6	720.6
	Dodoma	620.9	487.4	489.7	452.2	545.2	519.1
	Annual Mean	828.8	872.7	968.8	934.6	864.8	893.9

Source: Tanzania Meteorological Agency (TMA), 2017

Temperature, rainfall and cotton productivity are in constant proportional. Refer to table 1, 4 and 5 by considering the relationship between cotton production, temperature and rainfall respectively. For example, by considering the year 2012 cotton production is expected to be 300,000tons while temperature and rainfall are at the average of 28.6°C and 1,194.9mm respectively for Mwanza region in which Sengerema District is taken as a case study. What is observed in this aspect is that, when temperature is high, rainfall will be moderate and cotton productivity likely to be high if farmers adapt to modern farming practices like use of manure (organic and inorganic), newest cotton seeds' bread and proper planting system. Generally, increased annual mean temperature, causes reasonable and steady average rainfall, resulting into maximum cotton productivity, the relationship is developed from tables 1, 4 and 5 indicating trends in cotton productivity, mean temperatures and rainfall in different years respectively.

General trend for cotton productivity (at individual level of producer: The fluctuation of cotton productivity mainly is caused by seasons and soil fertility variability, however, there are some many other factors like rainfall and temperature fluctuation which may cause the production to be in either of the trends like constant (horizontal), upward (increasing), downward (decreasing), cyclical (ups and downs).Board, T. C. (2010). This study has gathered and analysed information from the farmers related to general productivity so as to have clear picture of cotton production trend in relation to the present climatic condition.

i. *Horizontal (constant)*
It is very difficult to have constant production trend, meaning that every year yields remain the same. The difficulties have reflected by the respondents by 8% of them that their output does not change for a long. Despite such weaknesses they never put more efforts to raise their production through application of artificial and natural manures and adaptability to precision agriculture.

ii. *Upward (increasing trend)*
The reflection of increased production is through trend analysis and basically when is upward (increasing). 77% of the farmers are in the upward trend. That is to say, they have adapted new means of production; they are systematic by observing the steady seasons of production, and involving new means of production like use of manures and modern cotton seeds which has increased yields.

iii. *Downward (decreasing trend)*
The recession part of the cyclical trend is reflecting the decreasing trend of the cotton farming. The major reason on this aspect is due to negligence of adaption of modern farming techniques, temperature and rainfall variability, acidic rainfall causing loss of soil fertility and general change of the environment. From table 2; the production had been decreasing in some interval of production periods like 2002/2003 to 2003/2004 decreased by 48,966 tons, 2005/2006 to 2006/2007 decreased by 249,006 tons and 2009/2010 to 2010 to 2011 decreased by 103,360 tons and the farmers rated this situation by 11% which is not very common in production of cotton around Lake Zone.

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iv. Cyclical (ups and downs)

Cyclical trend may in the form all categories of trends (horizontal, upward, and downward) however based on the information gathered from farmers themselves and the annual production trend as indicated in the table 2 indicating production trend from 1999/2000 to 2012/2013 there is an element of upward production trend. Cotton farmers recommended the production trend by 81%, that is to say the farmers adapt modern cotton farming techniques resulting to annual production incremental and if there is an element of fall in production is due to fluctuations of rainfall, fertility of the soil, and appropriate atmospheric temperature.

Based on the findings and presentations from Tanzania Meteorological Agency (TMA), 2017/2018 that, bad human practices always destroys weather and climatic condition variability. The weather condition constitutes mainly temperature and rainfall. Both elements of weather condition should be balanced properly in order to avoid unusual climatic condition which will disfavour any kind of agriculture particularly cotton as targeted product by the study. The trends for cotton production as presented and discussed in the previously sections are due to the variability of climatic condition. The recommended trend is upward, indicating that, human activities are not distractive to the environment; temperature and rainfall are at recommended level for maximum cotton production.

Conclusion and Recommendations

The existing relationship between climatic conditions favouring cotton production is at the average of 61% and the average percent of production increase annually is approximately to 44.2%. Therefore, the study summarises by persuading people around the lake zone to avoid poor farming practices which can affect the environment and general climatic condition which are likely to harm the cotton farming activities. Moreover, cotton farmers have to adapt precision agriculture so as to increase its quality and quantity of output; eventually, to be the giant cotton producers and exporters in the world market

The study has assessed all the necessary aspects of cotton production like the required information for cotton production, and the general trend for cotton production in lake zone specifically Sengerema district and eventually establishing the value of climatic condition and cotton production. The first thing that society around lake zone should avoid is poor human practices that destroy both weather and climatic condition, as discussed in this study about the proportional relationship between average temperature, rainfall and cotton productivity; the second, for the purpose of maximizing production, the farmers and cotton stakeholders should keep interacting to each other and allow sharing of cotton farming related information, and the third thing is that farmers should adopt precision agriculture because without that possibilities of falling in production is high due to the great variability on the fertility of the soil, temperature and rainfall fluctuations which are the best components of cotton farming in the lake zone.

Areas for further studies

The areas that need further research studies include conducting research study on types of cotton breeds that can adopt the available weather conditions, impact of soil fertility on cotton production and both domestic and international cotton market.

REFERENCES

Adger, W.N. (2010). Institutional adaptation to environmental risk under the transition in Vietnam. *Annals of the Association of American Geographers,* 90(4), 738– 758.

Board, T. C. (2010). Annual report and accounts for the year ending on 30th June 2010. Pamba House, Garden Avenue PO Box, 9161.

Brooks, N. (2013). *Vulnerability, risk and adaptation: a conceptual framework.* Working Paper 38, Tyndall Centre for Climate Change Research, Norwich, UK.

Burke, M. B., Lobell, D. B., & Guarino, L. (2009). Shifts in African crop climates by 2050, and the implications for crop improvement and genetic resources conservation. Global Environment Change.

Devereux, S. (2010). *Building Social Protection Systems in Southern Africa.* Background paper for the European Report on Development

Hillocks, R. A., & Kibani, T. H. M. (2002). Factors affecting the distribution, incidence and spread of Fusarium wilt of cotton in Tanzania. Experimental Agriculture, 38(1), 13-27.

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Business Education Journal (BEJ), Volume III, Issue II, 12 Pages. www.cbe.ac.tz/bej

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Hulme, M. (Ed.). (2012). Climate Change in Southern Africa: An Exploration of Some Potential Impacts and Implications in the SADC Region. Climatic Research Unit, University of East Anglia.

Ford, J. D. & Smit B. (2014). A Framework for Assessing the Vulnerability of Communities in the Canadian Arctic to Risks Associated with Climate Change. *ARCTIC, 57*(4), 389– 400.

Fussel, H.M. (2015). Vulnerability: a generally applicable conceptual framework for climate change research. *Global Environmental Change, 17*, 155–167.

Govereh, J. (2009). Impacts of Tsetse Control on Immigration and Household Accumulation of Capital: Zambezi Valley, Zimbabwe. Ph.D. dissertation, Michigan State University.

IPCC.(2010). Emission scenarios, summary for policy makers. Online at http://www.grida.no/climate/ipcc/spmpdf/sres - e.pdf.

IPCC.(2013). *Climate Change 2007 the physical science basis.* Contribution of Working Group I to the Fourth Assessment Report of IPCC. Cambridge. UK: Cambridge University Press.

Jayne, T. (2011). Do High Food marketing Costs Constrain Cash Crop Production? Evidence from Zimbabwe. *Economic Development and Cultural Change,* 42, 387-402.

Manase, G. (2011). Documentation of Research on Climate change and water in Southern Africa, 2nd Draft, The Danish Water Forum.

Müller, C. (2010). Climate change impact on Sub-Saharan Africa: an overview and analysis of scenarios and models. Discussion Paper.

Meera, S. N., Jhamtani, A., & Rao, D. U. M. (2010). *Information and Communication Technology in Agricultural Development : A Comparative Analysis of Three Projects from India*.

Mwangulumba, E. I., & Kalidushi, B. M. (2012). Tanzania Cotton Production and Productivity.
Nsimbila, P., Larsen, M. N., & Kimeme, J. (2014). *The rise and fall of cotton contract farming in Tanzania: What went wrong?*

Oladele, O. I. (2011). Effect of information communication technology on agricultural information access among researchers, extension agents, and farmers in south western Nigeria. Journal of agricultural & food information, 12(2), 167-176.

Resnik, D. B. (2011). Scientific research and the public trust.Science. *trust.Science and Engineering Ethics*, *17*(3).

Saunders, M. N. (2011). *Research methods for business students* (5th ed.). Pearson Education India.

Sen, A. (2009). Poverty and Famines: An Essay on Entitlement and Deprivation. Oxford: Oxford University Press.

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