RAINFALL VARIABILITY AND ITS ASSOCIATION TO THE TRENDS OF CROP PRODUCTION IN MVOMERO DISTRICT, TANZANIA

Msafiri Mkonda
Sokoine University of Agriculture, Department of Physical Siences, Morogoro, Tanzania

Abstract

A study was carried in two villages of Mvomero and Makuyu of Mvomero District, Tanzania. The overall objective of this study was to assess the relationship between the trend of rainfall variability and that of crop production in the study area. Both secondary and primary were used. Primary data were obtained using different Participatory Research Approaches (PRA) including, focus group discussions and household questionnaires. A sample size of 7% of the total households was sampled for the study. Findings showed that there is a relationship between the two variables. In years where rainfall was decreasing, the crop yields decreased too. The study concluded that, the possession of climatic knowledge by the farmers helps them to be aware of the climate change impacts. This help to increase their resilience regarding climate change impacts and improve food security.

Keywords: Rainfall variability, crop production, and wet spells

Introduction

Mvomero is one of the six districts of Morogoro region in Tanzania. It covers an area of about 14,0042km^2. It is located between latitudes 05^o 80′ and 07^o 40′S and between longitudes 37^{o}20′ and 38^o 05′E and lying between 300 to 400m above the sea level. The mean annual rainfall in the area is approximately 1,000 milimetres. About 800 to 1000 milimetres of rainfall are received near the coast while in the inland areas towards Dodoma and north of the Wami Sub-Basin the average rainfall is between 500 to 600 milimetres per year. The drainage system of the area is mainly characterized by rivers that serve as sources of water for agriculture and domestic uses. Some of these rivers include Mvomero, Wami Sub-Basin and their tributaries. Kinyasungwe, Lumuma, Mkondoa, Miyombo, Kisangata, Mkata, Tami, Rudewa, Lukigira, Diwale and Divue are the main tributaries to Wami River Sub-Basin (Hyera, 2007). Crop production is the key economic activity in this area. The cultivation of sugarcane, rice, maize and sorghum is more predominant (Olmos, S. 2001). Livestock keeping is as well done by the Pastoralist societies especially the Masai.

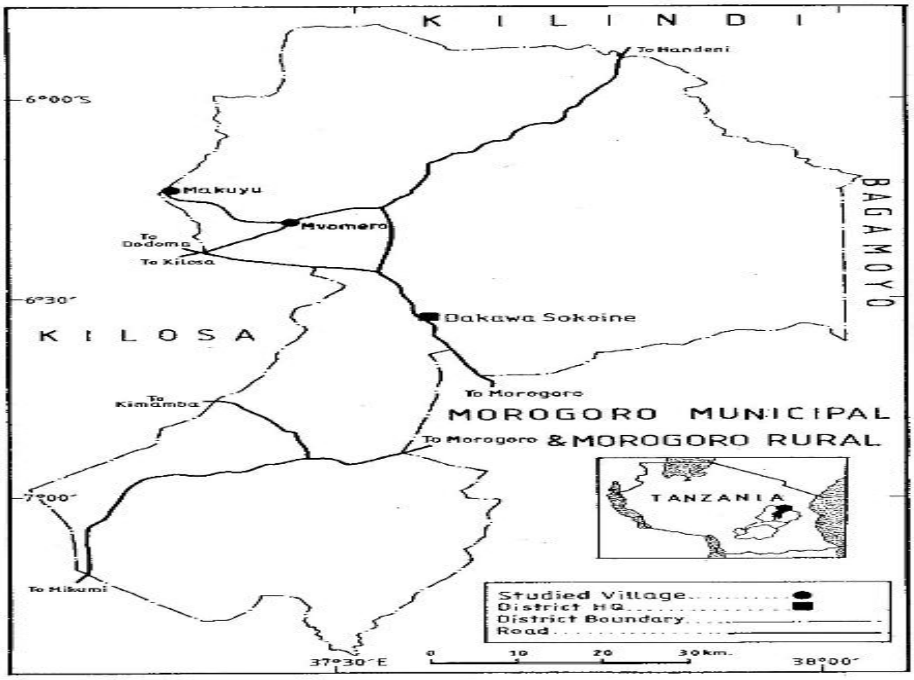

Figure 1: A Map of Mvomero District

Methodology

Data Collection Procedures

Sampling Design, Procedure and Sample Size

The sampling unit for this research was a household. Both random and purposive sampling were employed in selecting both the study area and/or sampling units. Random sampling was used to select one ward out of 17 wards as a preliminary stage of sampling (Kothari, 2004). Likewise, random sampling was used to select Mvomero and Makuyu villages among the villages in Mvomero ward. Purposive sampling was used to select two sub-villages from each village. Geographical location, time, financial constraints, transport and communication networks were factors considered in the selection of these sub-villages. The sample size of 7% of the total households was sampled for the study. Purposeful sampling was also employed for respondents at ward distict level. Thus, 20 households were randomly sampled from each sub-village to ensure that every household had equal chance to be selected for the study.

A household was taken as a group of people who eat from a common pot, sharing the same house and may cultivate the same land (Njana, 1998). According to Tanzania National Census of 1988 a household is the arrangement made by persons individually or in groups for providing themselves with food and other essentials for living or a group of persons who live together and share expenses. Key informants in this study involved Village Executive Officer (VEO), Ward Executive Officer (WEO), District Executive Office (DEO), District Agricultural and Livestock Development Officer (DALDO), Agricultural Extension Officers, elders and meteorological station officers for Kongwa and Kinyasungwe stations in Dodoma region. Data were analysed using Statistical Package for Social Science (SPSS).

Results and discussion

Seasonal Rainfall Trends

The mean annual rainfall patterns in the area appear to decrease at a non-significant rate of R^2 =0.0207. The findings show that the mean annual rainfall has been fluctuating overtime at a decreasing trend. Both temporal variability and decreasing rainfall pattern pose effects on the environment and affect negatively the biodiversity of the area (Orindi, A. & Murray, A. (2005). Similarly these findings (decrease in rainfall) are further supported by the information from the socio-economic survey done in the study area through household questionnaire.

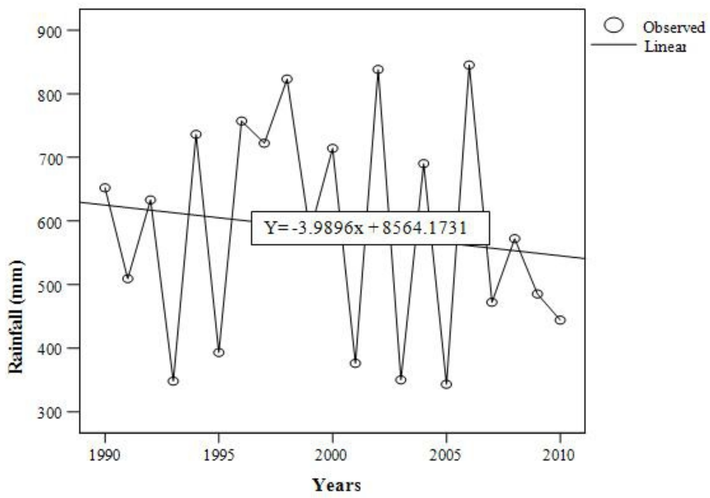

Figure 2: Mean Annual Rainfall from 1990 to 2010 in Mvomero District
Source: Kongwa Meteorological Station, 2011

Analysis in Figure 2 above show that the trend based on mean annual rainfall data provide general impression which may not capture actual situation on the ground particularly on droughts and associated crop failures in the field. To depict the actual situation, particularly the dry spells and their associated implications during the growing season, it is important to focus on monthly and daily rainfall trends for February, March and April which constitute the growing season as shown in Figure 3 and 4 below.

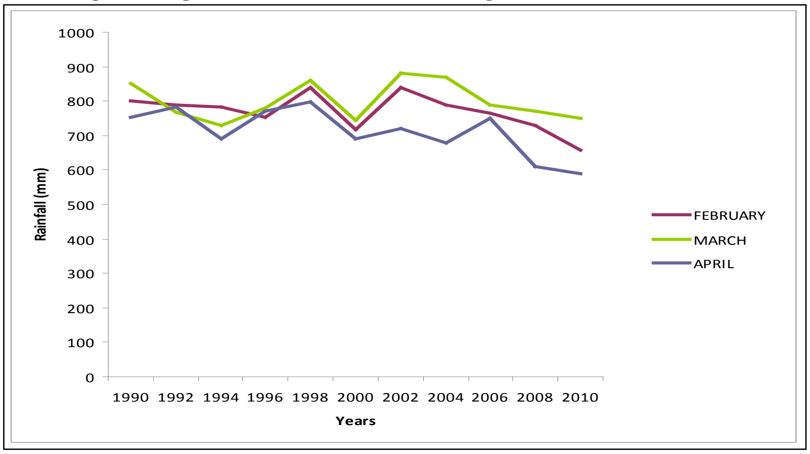

Figure 3: Rainfall Variability for; February, March and April From1990 to 2010.
Source: Kongwa Meteorological Station, 2011

Since analysis of rainfall distribution in Figure 3 for the three months was general, and since crops seem to flourish well in months with abundant days of rainfall than those with few days of rainfall, then further analysis of rainfall distribution in each month is very important in order to reflect the real situation on crop production. Therefore, Figure 4 below illustrates this situation as it looks on the number of wet spells in each month of the growing season as folows:

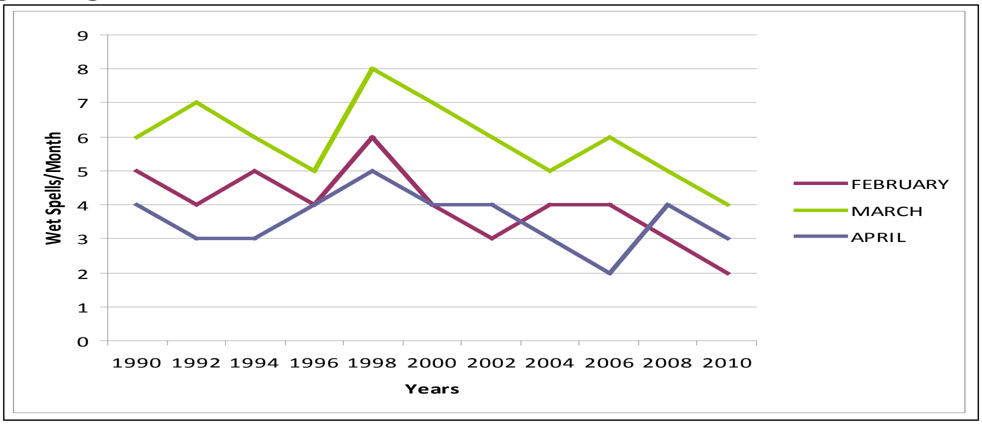

Figure 4: Number of Wet Spells per Month in the Growing Seasons from the Year 1990 to 2010
Source: Kongwa Meteorological Station

Research findings show that the trends of wet spells within a month are not uniform, but they fluctuate over time (Figure 4). Due to these fluctuations, the area can record poor crop production while in actual fact the amount of rainfall was high. This is because within a month, the area can receive unfair distributed wet spells as more wet spells can be experienced when crops are already affected adversely by drought. This perception can be difficult to comprehend among the farmers because their general perception is that; when the number of wet spells is high then the crops will also grow well and the vice versa. However, their perception overlooks the distribution patterns of wet spells within a month. Thus, in favour of crop production, available wet spells need to be fairly distributed within a month during the growing season. Thus, fair distribution of wet spells is very important as it ensure the sustainability of wet on the ground. On the other hand, heavy rainfall with few wet spells in the growing season might have no favour to crop production because it occurs with fewer wet spells while crop production is favoured by numerous and fairly distributed wet spells. Hence, fair distribution of wet spells mean the temporal occurence of wet spell in terms of their numbers which is perhaps more evenly throughout the growing season to reflect the needs of crops.

Therefore, it is not surprising to observe the situation of crop failure in the presence of large amount of rainfall and a large number of unfairly distributed wet spells. Using Figure 3 and 4 above, an attempt is made to further analyse both rainfall intensity and number of wet spells in each of the three months in order to reflect the real situation in the study area. Therefore, hereunder is the discussion based on the relationship between the amount of rainfall and the number of wet spells for February, March and April..

February

In February there are evidences that usually the amount of rainfall is high (Figure 3) while the number of wet spells is low (Figure 4). To suppport this argument, both Figure 3 and 4 show that in 1996 and 2002 the total amount of rainfall was high while the number of wet spells was low and at the same time crop production was poor as seen in Figure 11below. Crop production was poor because of fewer number of wet spells. These findings was supported by the farmers in the study area as about 80% of respondents said that 1996, 1998 and 2002 were among the years which experienced very low crop yields and subsequently food insecurity due to severe drought.

March

The study area experiences more rainfall (Figure 3) and increased number of wet spells (Figure 4) at a fluctuating trend in March compared to February and April. However, the temporal fluctuations in the amount of rainfall (Figure 3) and number of wetspells (Figure 4) also do not occur in the same pattern in this month. Hence, high rainfall does not necessarily correlate with high number of wet spells and the vice versa. For example, in 1992 there was a decrease in the amount of rainfall (Figure 3) while the number of wet spells (Figure 4) was at maximum, hence the situation led to better yields. This is supported by information from PRAs survey done in the study area as about 70% of the respondents said 1992 was among the good years in terms of crop yields. Likewise in 2006, there was a decrease in the amount of rainfall with increased number of wet spells which subsequently favoured crop production.

April

April marks the end of the growing season. It is a time when most of the crops get matured. During this month, the total amount of rainfall (Figure 3) and number of wet spells (Figure 4) seem to have no direct correlation. For instance, in 1996 and 2002 there was high rainfall with fewer number of wet spells as it rained thrice within this month. This trend was also supported by farmers through PRAs as about 80% of respondents said that 1996, 1998 and 2002 were among the bad years as they experienced very low crop yields and subsequently led to food insecurity due to prolonged drought.Therefore, the fewer the number of wet spells, the poor the crop produced and subsequently food insecurity.

Trends of Crop Production in the Study Area

Results from respondents in the study area shows that the production trends of key crops such as rice, maize and sorghum are fluctuating overtime. The fluctuation patterns of these crops are relatively similar to that of the national level. Hereunder is a brief description on the trends for rice, maize and sorghum.

Trend of Rice Production in the Study Area

Results show that rice is one of the significant crops cultivated in the area because it is both a staple food crop and cash crop for most farmers. However, 77.5% of the respondents reported that rice yield is decreasing overtime due to severe drought. On the other hand, 22.5% of the respondents reported a fluctuating trend of the crop over time. Meager yields of food crops are likely to lead to food scarcity and subsequent food insecurity in the study area.

Trend of Maize production in the Study Area

Maize is another dominant food crop in the study area. The crop is grown in large part of the study area because it is somehow a drought resistant crop compared to rice. The crop is grown in both highland and lowland zones while rice is mainly grown in valleys and lowland areas where water is reliable (IPCC. 2007a&b). As a response to the impacts of climate change and variability (CC&V) on crop production, 82.5% of the respondents said that the production trend of the crop is decreasing over time due to severe drought while 17.5% said it is fluctuating. The decrease in maize yields threatens food security since it is a staple food crop for the people in the study area.

Trend of Sorghum Production in the Study Area

Sorghum is another dominant crop in the study area. It is the most drought resistant crop adopted as a measure towards adapting to excessive drought caused by the impacts of climate change and variability (CC&V). However, 76.3% of the respondents said that regardless of being drought resistant crop, the trend of sorghum production is decreasing overtime due to severe drought while 23.7% said the trend of the crop is fluctuating. The decrease and fluctuation of this crop happens as a result of the occurrence of excessive drought in the area. Thus, the decrease in sorghum yields lead to food scarcity and subsequent food insecurity in the study area. Also, the information from the DALDO of Mvomero District support the trends of these crops in the study area as they indicate that; the production trends of rice, maize and sorghum have been fluctuating overtime at a decreasing trends. For example; in 2000/2001 and 2001/2002 the production trend of these crops was at peak while in 2003/2004 these trends experienced a significant fall.

Another peak was experienced in 2007/2008 with a remarkable fall in 2009/2010. According to PRAs survey; erratic rainfall and increased temperature are the cause of these trends (URT, 2010). Figure 11 below shows the trends of maize, rice and sorghum production in time series from 1997/1998 to 2009/2010 in the study area. The amount produced is shown in tons per hectare.

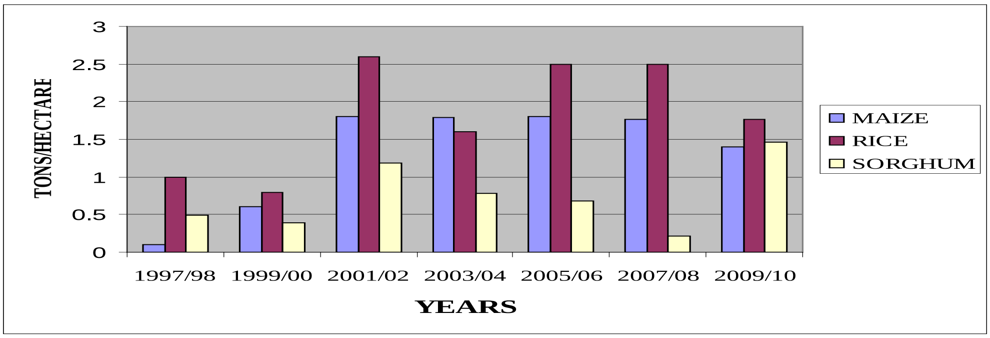

Figure 5: Key Crops Expressed in Ton per Hectare in Mvomero District (1990 – 2010)
Source: DALDO; Mvomero District, 2011

The trends imply that better crop yields ensure food security while poor yields may lead to food insecurity in the area. Hence, stable trends of food crop production kept at maximum will ensure food security in the area.

At both local and national levels these fluctuations are caused by a number of factors including the impacts of climate change and variability. Therefore, these impacts in turn are likely to affect adversely the production of food crops in the study area.

Linking Temporal Rainfall Trends and Crop Production

The adverse impacts of climate change and variability have posed a dreadful condition to crop production at both national and local level. Results show the fluctuating trends of crop production particularly maize, rice and sorghum (Ehrhart, & Twena, 2006). Similarly, the trends of both rainfall (Figure 3) and that of the crops in the study area (Figure 5) have been fluctuating overtime in a similar pattern. Also, the increase in temperature has increased evapotranspiration to already affected areas (areas with severe drought) . The following sections describe the impacts of climate change and variability on crop production in the study area by viewing at rainfall (Figure 3)

Rainfall

Rainfall is the most important element for crop production. The research findings show that rainfall has been fluctuating overtime in the similar pattern to that of crops.The decrease in rainfall has reduced the production of crops in the study area. In this remark, drought has adverse effect to the production of food crops.

The findings show that in years when rainfall was little during the growing season, crops yield was also minimal. This was supported by the information from DALDO through interview as he said that severe drought is a major factor for crop failure in the district. Furthermore, the decrease in crop yield always lead to food insecurity among the people in the community. Furthermore, the findings show that the temporal trends of both rainfall (Figure 3) and crop production (Figure 5) have been fluctuating together in a roughly similar pattern. Hence, there is a positive correlation between these two variables.

Therefore, rain scarcity in the area has affected adversely the production of crops. Also, the farmers in the study area supported these findings as about 90% of respondents reported that prolonged drought is the major problem for crop failure. Furthermore, they said that the production of maize, rice and sorghum have been decreasing overtime due to exceesive drought.

In February there are evidences that usually the amount of rainfall is high (Figure 3) while the number of wet spells is low (Figure 4). To suppport this argument, both Figure 3 and 4 show that in 1996 and 2002 the total amount of rainfall was high while the number of wet spells was low and at the same time crop production was poor as seen in Figure 11above. Crop production was poor because of fewer number of wet spells. This was supported by the farmers in the study area as about 80% of respondents said that 1996, 1998 and 2002 were among the years which experienced very low crop yields and subsequently food insecurity due to severe drought.

On the contrary, in 2004 the amount of rainfall was low but the number of wet spells was high (Figure 3 and 4) and crop production was better (Figure 5). This was also supported by the farmers from both Makuyu and Mvomero villages who reported through focus group discussion that 2004 and 2006 were better years for them as they got better crop yields. This means that, despite the decline in the amount of rainfall; the increased number of wet spells which were probably fairly distributed have favoured crop production in the study area.

Also, in 1992 there was a decrease in the amount of rainfall (Figure 3) while the number of wet spells (Figure 4) was at maximum, hence the situation led to better crop yields. This is supported by information from PRAs survey done in the study area as about 70% of the respondents said 1992 was among the good years in terms of crop yields. Likewise in 2006, there was a decrease in the amount of rainfall with increased number of wet spells which subsequently favoured crop production.

This implies that crop production was better as a result of increased number of wet spells. This was further supported by the farmers from both Makuyu and Mvomero villages through focus group discussion as about 70% said that 2004 and 2006 were better years for them as they earned better yields. The reason behind better crop yields was due to fovourable rainfall received in the area. However, in 1996 and 2002 there was an increase in rainfall amount while the number of wet spells was declining. As a result; this condition affected negatively crop production. Also, this was supported by the farmers in the study area as about 80% of respondents said that 1996, 1998 and 2002 were among the years which experienced very low crop yields and subsequently food insecurity due to prolonged drought. Again, in 2006 there was also fewer number of wet spells as it rained twice within the month. Thus, basing on the results above; the fewer number of wet spells in the study area has contributed to poor crop production.

However, in 2008 there was a decrease in the amount of rainfall with the increase in the number of wet spells. Thus, the increase in the number of wet spells favoured crop production in the study area. This finding was supported by the information from the Mvomero-DALDO which show that the District increased the production of food crops from 155,063 tonnes in 2007/2008 to 239,034 tonnes in 2008/2009 while the size of the cultivated area was almost the same, hence this is an increase of about 54%.

Also, this study reveals that in 2010 both the trend of amount of rainfall and number of wet spells experienced a sharp decline. This has adverse affects on the production of food crops (Figure 5) in the study area due to decreased number of wet spells.

Conclusion

There are suffient aspects which shows the sensitive relationship between the trend of rainfall and the production of crops in the area. Figures 2, 3, 4 and 5 describes this relation which is very potential in enabling farmers to take measures, adaptation and strategies so as to stabilise crop production at maximum and subsequently to improve food sucurity in the specific area.

References:

Ehrhart, C., & Twena, M. (2006), *Climate Change and Poverty in Tanzania "Realities and Responses Options for CARE*, pp. 5-7.

Eriksen, S., & Noess, L. O. (2003), *Pro-Poor Climate Adaptation: Norwegian Development Cooperation and Climate Change Adaptation*: Oslo. Norwegian Agency for Development Cooperation.

Gill ham, B. (2000), *Developing a Questionnaire* (real world research). London; Continuum.Pp 208-211.

Hyera, P . (2007), *Environmental Flow Assessment (EFA), Wami River Basin*. Tanzania: Social-Economic Components of the Wami EFA Study, pp. 10-15.

IPCC. (2007a), *Climate Change 2007 Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of IPCC. Cambridge: Cambridge University Press.

IPCC. (2007b), *Climate Change 2007 Mitigation of climate change.* Contribution of Working Group III to the Fourth Assessment Report of IPCC. Cambridge. UK. Cambridge University Press.

Lobell, D. & Field, C. (2007), *Global scale climate-crop yield relationships and the impacts of recent warming Environmental Research. Lett.*

Kothari, C. (2004), *Research Methodology; Methods and technique* . New Delhi. New Age International Limited.

Liwenga, E. T. (2003), *Food Insecurity and Coping Strategies in Semiarid Areas: The Case of Mvumi in Central Tanzania*. PhD Dissertation No. 11. Stockholm Studies in Human Geography, Stockholm University, Sweden.

Olmos, S. (2001), *Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Method*. Available from the Climate Change Knowledge Network web site, www.cckn.net.
Orindi, V. A. & Murray, L. A. (2005), *Adaptation to Climate Change in East Africa: A Strategic Approach*, iied, Gatekeeper Series 117.
Paavola J. (2006). *Livelihoods, vulnerability and adaptation to climate change in the Morogoro Region of Tanzania*, Centre for Social and Economic Research on the Global Environment (CSERGE), Univ. of E. Anglia, UK Working Paper, pp. 9-16.