Trends of Banana Production among Smallholders' Farmers Due to Rainfall and Temperature variations in Mount Kenya Region, Kenya

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Abstract: *Unreliability and unpredictability of rainfall amount and temperature fluctuations have negative impact on agriculture production especially in Africa where coping mechanisms are limited. The future of rainfed agriculture is uncertain more so on banana production among the smallholder's farmers due to climate variability. This study examined the extent of rainfall and temperature changes on banana production among smallholders' farmers in Mount. Kenya region of Kenya from 2009 and 2017. The sites were purposively selected to include Imenti south (Meru County) and Mukurweini sub-counties (Nyeri County) where banana production has been practiced since 1990. A sample size of 381 respondents was identified using simple random sampling. Production and climatic (rainfall and Temperature) data were sourced from Horticultural Crop Directorate and Kenya Meteorological Department respectively for the stations adjacent to the study sites for the study period. Results showed decreasing trends on rainfall amounts while temperature increasing trend. Study found that rainfall increase does not necessarily translate to increased production while temperature level of about 18.5^0C gave the maximum yields. Majority of the respondents (42.8%) in the study region admitted to have changed the land use and type of crops they have been farming during the study period whereas 30% changed from other crops to banana farming. Banana acreage and production in both sub-counties have been increasing during the study period. The County and National government should provide irrigation as a coping mechanism to banana production due to the declining rainfall and increasing temperature in the region. We recommended provision of weather information on the onset of the rainfall period and distribution within the seasons in order to respond to the effects of climate variability.*
Keywords: *banana; rainfall; temperature; Mt Kenya; small holders; variability*

I. Introduction

Agriculture is the major occupational sector in many Sub-Saharan Africa (SSA) countries and a source of livelihood for the rural community (UNEP, 2011). Agricultural production in SSA is predominantly reliant on climate conditions with respect to its temperature and rainfall requirements. Scholars have noted that rural livelihoods that depend on agricultural production will continue to face challenges emanating from climate variability impacts (IPCC, 2007; Nhemachena, 2009). This is a result of changes in temperature level and water availability. Temperature moderates the rate of nutrient absorption and crop growth rate, the evapotranspiration potential and hence the wilting points of a crop, which all determine the production potential. Rainfall in turn is a crucial hydrological process that determines the water availability in the root zone of a crop. The levels of temperature and rainfall amounts and its distribution develop a set of synergetic environmental conditions that spatially and temporary determine the potential of a crop's production, its yielding levels and its sustainability over space and time in a region.

Rainfall amounts and temperature levels affect the growth and production of bananas. Rates of photosynthesis and leaf emergence are reduced by prolonged dry seasons, high temperatures levels or low light availability (Turner, 1998). During hot days the size of the

banana fruit reduce and also the bunch size. Flying fox damage in plantations increase due to reduced nectar flows in native forests, particularly during dry period. Decreased rainfall and prolonged dry season results is critical since bananas have a rapid physiological response to soil water deficit, which slows and eventually stops leaf emergence leading to reduced production. Bunch emergence is affected by low temperatures (Simmonds, 1966). To resolve the over dependency on rain fed production of bananas, irrigation is the remedy. Increases in daily minimum temperatures above 14^0C, and in the mean daily temperatures in the range 13–22^0C accelerate fruit development and shorten the crop cycle (Turner and Barkus, 1982). Brat et al., (2004), notes that fruit quality is significantly affected by environmental factors, particularly temperature. Annual temperature and annual rainfall negatively affect agricultural output growth in the long run and short run respectively (Melaku and Gebrekirstos, 2019)

Banana production has become a popular enterprise in Kenya since the enactment of the Kenya Coffee Act (GOK, 2015c) section 4, gave the small holder farmers leeway to uproot coffee plants. This gave farmers opportunity to replace coffee plants with banana crop in the tradition coffee production region of Mt Kenya (Karanja and Nyoro, 2002). This change offered farmers with hope and freedom to diversify from coffee production to other crops and in particular bananas, which can fetch more prices (with immediate payments, which was more preferable than coffee). Due to this reason many coffee farmers opted to engage in banana production after long periods of low coffee returns, poor management of co-operative societies, rising cost of farm inputs and low yields (GOK, 2002). With the positive developments in banana production most of the small-scale farmers took up banana production but produce small, inconsistent quantities of varying quality (Splisbury et al., 2003). Bananas farming have emerged as the major income earner and food item among the rural small holder's population of Kenya (GOK, 2011). In 2012 banana production constituted 38% of the total value of fruits produced in Kenya (GOK, 2012).

Banana production provides potential for the achievement of food security while at the same time generating income among households in Mt. Kenya region. Banana is the key economic enterprise in Mt. Kenya enviros providing food and source of income to cater for health care, households school fees, procurement of food and home improvement (Mbaka et al., 2008, USAID, 2013). According to GOK (2012), the leading counties in banana production in Kenya are Meru (40%), Kirinyaga (21%), Tharaka Nithi (19%). Banana is a key livelihood source for Meru's population and is grown on 2.2% of the County's total agricultural land. In 2015, a total of 382,390 metric tonnes were produced earning the farmers approximately KES 3,700 million. It accounts for nearly half the annual total tonnage of fruits produced in Kenya (GOK, 2008). Banana grows in various climatic conditions and produce harvestable fruit all seasons, thus providing energy during the 'hungry period' between the harvests of supplementary food crops. Banana production is ideal for intercropping and mixed farming with livestock. Due to their suitability for production in backyard systems, banana form an important element of peri urban agriculture where land is limited.

1.1 Banana Farming Requirements

Morton, (1987) describes the best conditions for banana farming globally. Banana does best in areas with an optimal mean monthly temperature of 27^0C. Temperatures below 10^0C extend the crop maturity period and reduces the bunch weight. Low temperature for about two months causes injury to banana (Islam and Hoque, 2003). Temperature is very central in different phases of banana growth; about 27^0C is optimal for growth and production (Figure 1).
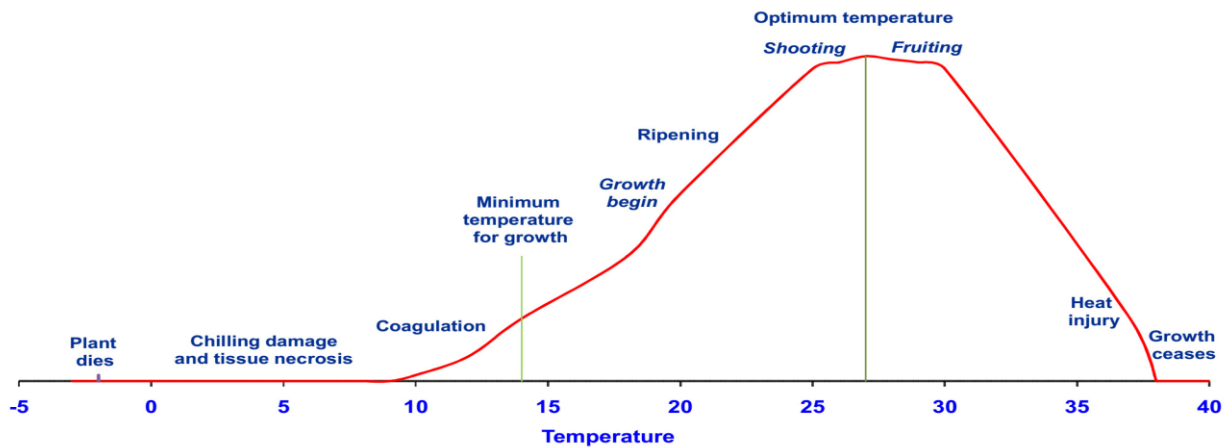
Figure 1. *Relation between temperature and growth processes in banana culture. (Source: Samson (1980) cited in Sastry (1988)*

Banana has high water demand due to its vegetative nature, with approximately 25 mm per week being the minimum for optimum growth. An average annual rainfall of 1500-2500mm, which is well distributed, is considered the most optimal. However, with good management of available water, bananas can even grow in areas with mean annual rainfall lower than 1200 mm (Robinson and Saúco, 2010). Bananas require deep, well-drained loam soil with high humus content and a pH range of 5.6 - 7.5. Bananas require considerable amounts of Nitrogen and Potassium (NK) to maintain high yields. Drought, water logging condition and inadequate sun light cause crop damage and low yield. The recommended spacing is 3m between and 3m within the row (3m x 3m). Rows should be straight in flat fields to allow plants to receive maximum amount of sunlight. Holes should be 45cm deep and 45cm wide. Generally, planting holes size ranges from 30 - 60 cm deep and wide (Morton, 1987). The deep and large holes provide water retention during the rainy season.

Banana is an important fruit (GOK, 2012) which is among the top three most valuable crops grown (AHBFI, 2012) in Kenya. Banana is both a source of food and income for millions of smallholders in Africa and developing countries worldwide (Arias et al., 2003). Banana growing is usually rain-fed with little irrigation in some parts of Kenya. According to AHBFI (2012) there are approximately 390,000 banana farmers in Kenya, most of which (84%) are smallholders cultivating <0.2 hectares. Majority of the smallholder producers have become more reliant on income generated from banana sales, especially in areas that were negatively affected by declining incomes from traditional cash crops such as coffee (Wambugu and Kiome, 2001). Climate variability is a key factor affecting banana production globally (Willam et al., 2018). In addition to the distinctive variation of climatic variables comprising of temperature and precipitation regimes, there is a collective need for farmers to address the effects of climate variability on banana production.

1.2 Objective of the Study

The objective of the study was to evaluate the extent of rainfall and temperature variations on banana production among the small holders' farmers in Mt Kenya region Kenya between 2009-2017.

II. Research Methods

2.1. Spatial Context of the Study Region

The study was carried within Mt. Kenya region focusing on selected areas located in Meru and Nyeri Counties.
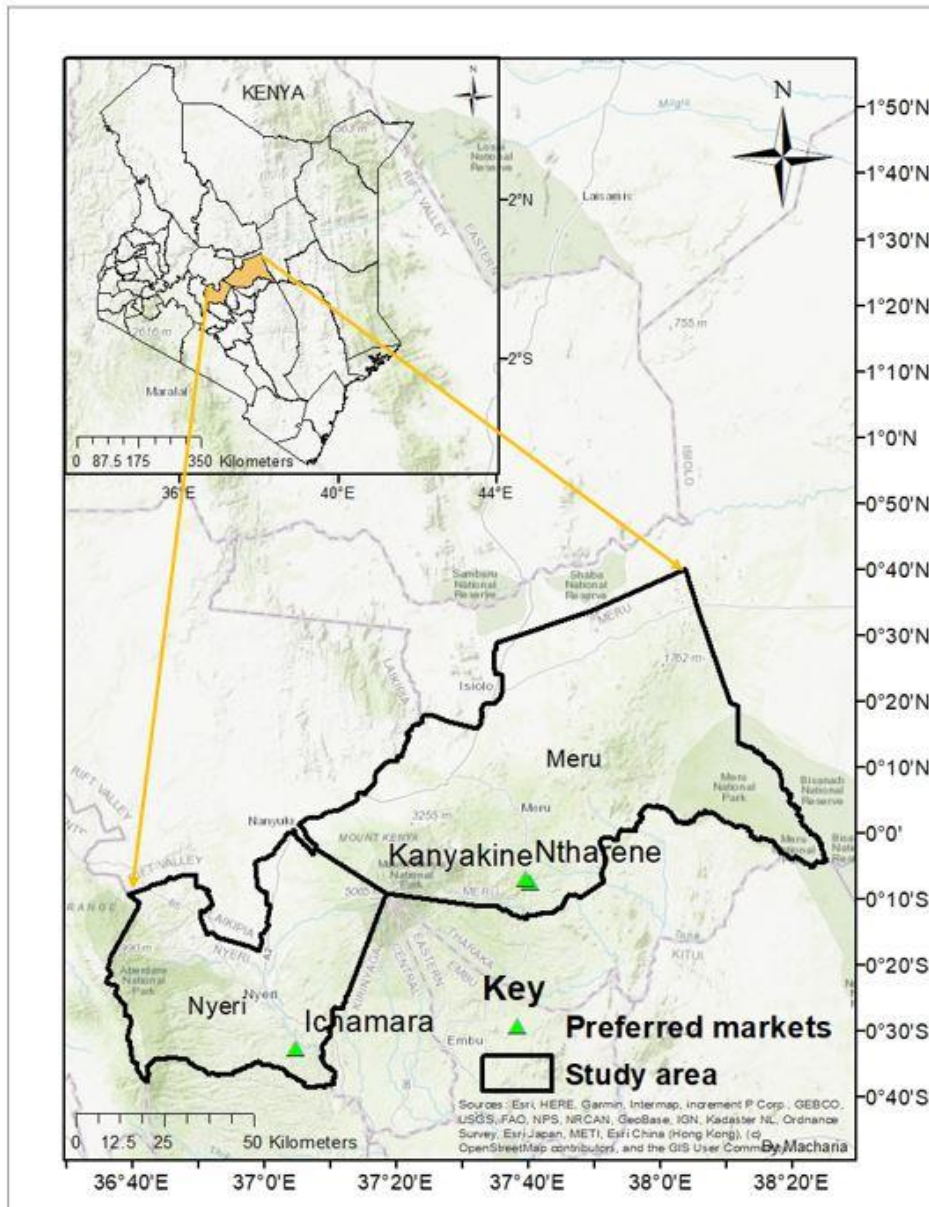

Figure 2. *Map of Kenya showing the location of the study areas in Meru and Nyeri county*

2.2 Climate

The region receives bi-modal rainfall pattern with long rains (LR) season falling from March to May (MAM) and short rains (SR) season falling between October and December (OND). According to Jaetzold et al., (2006), the climate in Meru County can be described as cool with temperatures in the highlands ranging between 14^0C to 17^0C while those of the lowlands, between 22^0C to 27^0C. The region receives an average rainfall of between 1250mm annually (GOK, 2015a). Nyeri County experiences equatorial rainfall with the monthly mean temperature ranging from 20^0C to 20.8^0C. The region receives an average rainfall of between 1200mm annually (GOK, 2015b). Banana plants thrive in tropical regions where the annual average temperature is 17° C

and the yearly rainfall is between 1300 mm (Bose et al, 1996) making Mt Kenya region ideal for banana production.

2.3 Research Design

The study adopted mixed research design to evaluate the extent of rainfall and temperature variability on banana production in Meru (Imenti South Sub County) and Nyeri (Mukurweini Sub County) within the Mt. Kenya region. The study involved use of triangulation of methods whereby both qualitative and quantitative techniques were adopted to collect data using structured questionnaires administered to smallholder farmers; Focus Group Discussions (FGDs); in-depth interview to key informants; analysis of photographic images and visual observations of land use systems. Historical data on meteorological variables (rainfall amounts in millimeters(mm) and temperature levels in degree centigrade(0C)) and banana yield (in tonnes) were acquired from Kenya Meteorological Department (KMD) and Horticultural Crops Directorate (HCD) respectively.

a. Selection of Study Area and Sites

The study area was purposively selected to include diverse locations where banana has been grown from 1990. In Meru County, Imenti South sub-county while in Nyeri County, Mukurweini Sub-County.

b. Selection of the Respondents

Simple random sampling method was used to choose the respondents for the study. The target population for this study consisted of smallholder's banana farmers. According to GOK (2009) population statistics, the population of Imenti-South was approximately 179,604 in 47,197 households while that of Mukurweini Sub-County 83,932 within 24,083 households.

The sample size was thus calculated following Krejcie and Morgan, (1970) as follows: -

$$S = X^2 NP (1-P) \div d^2 (N-1) + X^2 P (1-P)$$

Thus, a sample size of 382 respondents was obtained from a total population of 71,280 households. Further to determine the sample size per each study area, proportionate method was used and actual sample size per site attained as shown in Table 1. The respondents also included key informants such as agricultural extension officers and Horticultural Crops Directorate (HCD) officers in both study locations. A total of 381 (99.73%) questionnaires were fully filled and returned after the data collection.

2.3. Data Collection
a. Methods and Procedures

Data collected comprised of primary and secondary data which included individual interviews, (FGDs), data mining from records and researcher observations. Quantitative and qualitative data collection methods and acquisition were used. Studies that combine the two methods have been proven to be more inclusive than those that employ one type of methodology (Creswell and Plano, 2011).

Table 1. Tabulated sample size per study area based on number of households according to GOK (2009) KPHC data

Study location (sub county)	Number of households	% Proportion	Tabulated sample size
Imenti south	47,197	66.2	253
Mukurweini	24,083	33.8	129
Total	71,280	100	382

1) Primary Methods

Quantitative methods included the use of surveys to collect data on banana production. Qualitative methods employed for the study included interviews to key informants and FGDs. In addition, researcher observations were conducted to enrich the primary data. FGDs sessions were undertaken to validate data collected from individual households. The FGDs has several advantages over individual interviews as it saves time and money and provides an opportunity to collect diverse information on a particular topic (Morgan, 1988).

2) Secondary Sources

Historical document analysis was used to examine climatic data (temperature and rainfall) and production data. These two climatic parameters have the longest and widest data coverage in the country and are the most common climatic variables considered by many studies in Sub-Saharan Africa. Temperature and rainfall were used for respective yearly data and their long-term values to capture climate variability and estimate the short- and long-term effects of climate on banana production. A similar approach has been followed in previous other studies (Kabubo-Mariara and Karanja, 2007; Lobell et al., 2008; Sarker et al., 2012). Other sources of data included journal articles, government reports, County strategic plans, County abstracts and books which gave background information on climate and production.

b. Research Instruments/ Equipment

The study used structured questionnaires for the purpose of gathering information from the smallholder farmers. In-depth interviews were administered to key informants Photographs analysis and field observations were used to enrich the gathered data.

2.4 Data Analyses

Survey data from the questionnaires were coded and entered in SPPS Version 21 (SPSS, 2012) for analysis while quantitative data was analysed using both descriptive. Graphical methods including charts, tables and graphs were used for data presentation. Excel 2016 was used to analyse rainfall and temperature variability to come up with annual means and trends.

III. Discussion

The objective of the study was to evaluate the extent of rainfall and temperature variability on banana production among the small holders' farmers in Mt Kenya region Kenya between 2009-2017.

3.1 Rainfall and Temperature Trends in Mt Kenya region

This section highlights the findings of data analysis on climate variables and their effects on banana production. For numerical and graphical measures, the analysis of temperature and rainfall was done for the period 2009-2017. This period is adequate to understand the climate trends. In order to understand the changes in temperature levels and rainfall amounts during

the study period (9 years), the monthly statistics for every year were reduced to single annual value.

a. Temperature Trends in Imenti South and Mukurweini Sub-County between 2009 and 2017

The temperature data was presented in terms of its annual average and the gradient which is the slope (m) to show trend during the study period.

Table 2. Temperature Characteristics in the Study Area

Location	Average Temp(^{0}C) 2009-2017	M
Mukurweini	18.40	**0.0335**
Imenti South	18.73	**0.0133**

The study revealed that Imenti South Sub-county was slightly warmer than Mukurweini Sub-county with mean average temperature of 18.73^0C and 18.40^0C respectively (Table 2). The temperature in the two locations keeps of fluctuating during the study period with a positive slope. The highest recorded mean temperature for Mukurweini Sub-County was in 2009 at 18.7^0C while in Imenti south Sub-County it was in 2015 at 18.9^0C. The lowest recorded mean temperatures recorded was in the year 2013 with Imenti South Sub-County being 18.5^0C while in Mukurweini Sub-County recorded 18.2^0C. This is supported by the IPCC (2001), which indicates that temperatures levels were anticipated to increase in East Africa while Naresh and Diptimayee (2013) in their study conducted in Odisha, India revealed that the annual average temperature was increasing with about 0.03^0 C.

As indicated in the Figure 2, the two study areas display increasing linear trends of temperature as denoted by positive slopes in the trend line equations. The yearly trend line analysis of Mukurweini sub-county presented showed a positive slope m=0.0002 while in Imenti South, m= 0.0133 (Figure 2). This indicated that temperature was rising in both counties during the said period.
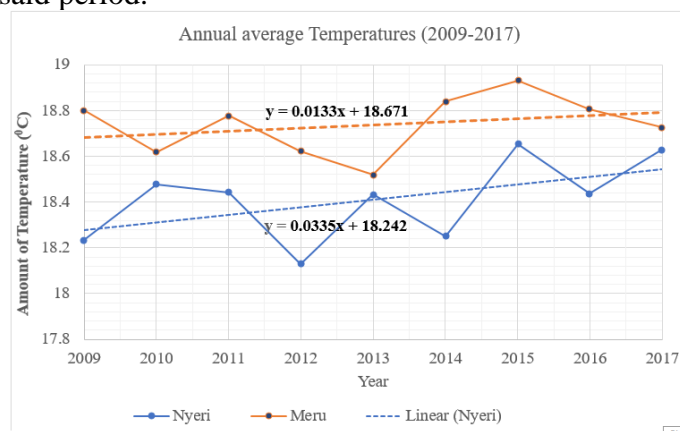

Figure 2. Time series of annual temperature data for Meru (Imenti South Sub-county) and Nyeri (Mukurweini Sub-county) and their linear trend lines

b. Rainfall Trends in Imenti South and Mukurweini Sub-County During the Period 2009 to 2017

The highest average annual rainfall for Mukurweini and Imenti South sub-counties were 1206 mm and 1464 mm respectively (Table 3). The rainfall shows a decreasing trend (negative gradient) in both study locations with m=-38.77 in Meru and m=-0.44 in Nyeri county.

Table 3. Rainfall characteristics of the study area

Location	Average amount of rainfall (mm) 2009-2017	M
Mukurweini	906	**-38.77**
Imenti South	1226	**-0.44**

The study findings reveal a decreasing trend in Mt. Kenya region, which is represented by negative slope (m) in the corresponding trend line equations (Figure 3). The same trends have been documented by (IPCC, 2001) who noted that precipitation in Africa would decline at a rate of between 10 and 20% in Southern Africa and 10 to 50% in Eastern and Northern parts of Africa. Mukurweini recorded lowest amount of rainfall (735mm) in the year 2009 while in 2016 Imenti south recorded rainfall below 1000mm annually. In Mukurweini Sub-County the rainfall had been moderately below 1000mm annually except in the year 2012. Niang et al., (2014) reported that climate variability is expected to increase temperature levels and precipitation variations in East Africa.
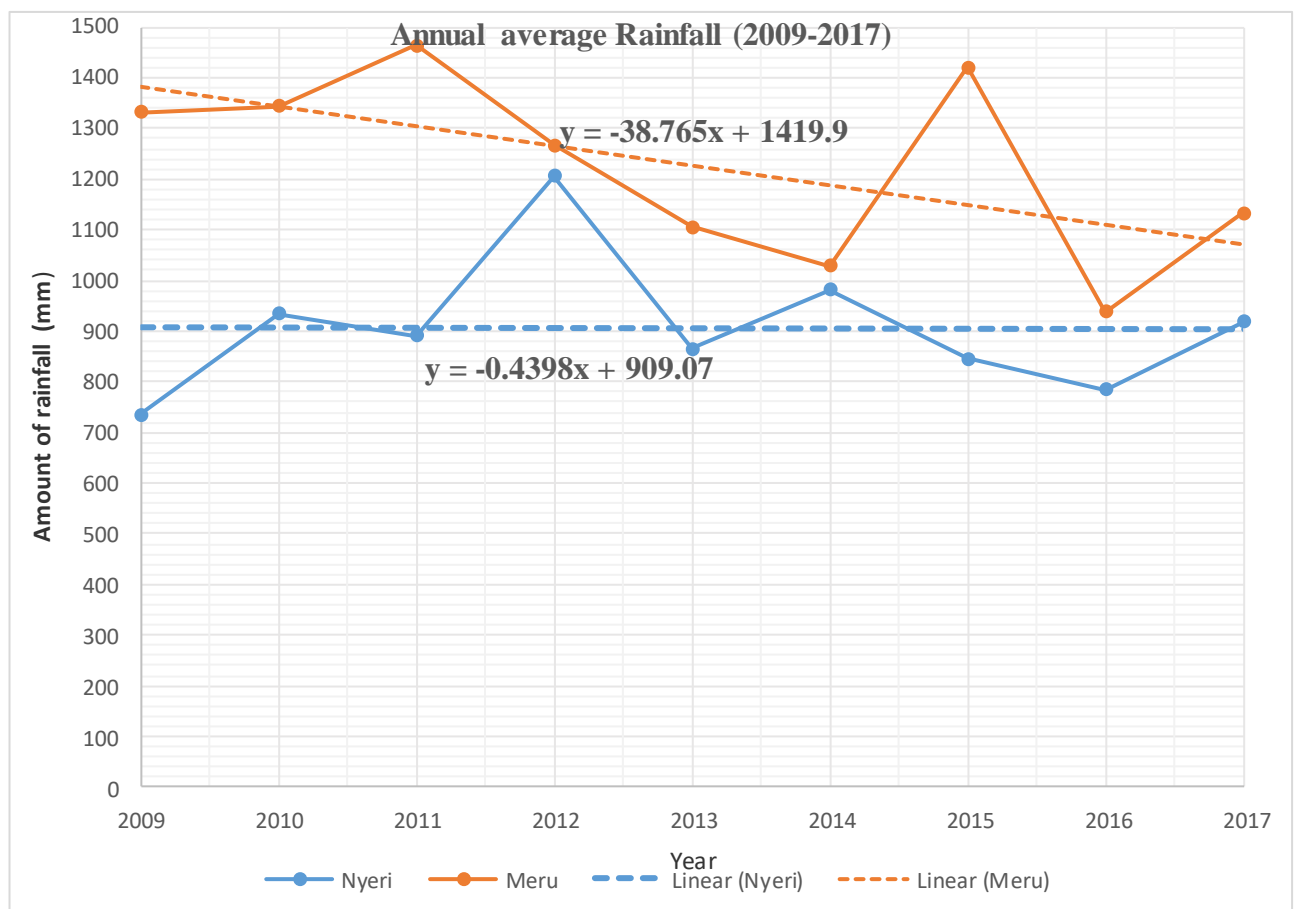

Figure 3. Time series of annual Rainfall data for Meru (Imenti South Sub-county) and Nyeri (Mukurweini Sub-county) and their linear trend lines.

3.2 Effect of Rainfall and Temperature on Banana production (2009-2017)

Banana production is an all year-round enterprise in the study areas while the quantity of banana produced varied depending on rainfall amounts and distribution. In Imenti south (Figure 3(a)), banana production increased as rainfall decreased from 2009 until 2013 when rainfall reached 1500mm. From 2015 the production increased as rainfall decreased perhaps due to irrigation input. An exceptional trend was noted in the year 2014 when production

increased as well as the rainfall. In Mukurweini Sub-County the annual banana production was steady with amount of rainfall. Figure 3(b) revealed that in year 2012 as the rainfall increased the banana production dropped. This is supported by Opeyemi et al. (2016) who noted that strong wind destroys the banana stool, resulting to an overall reduction in the banana productivity and pest infestations. In the year 2013, the production rose slightly as rainfall dropped which was a unique observation.
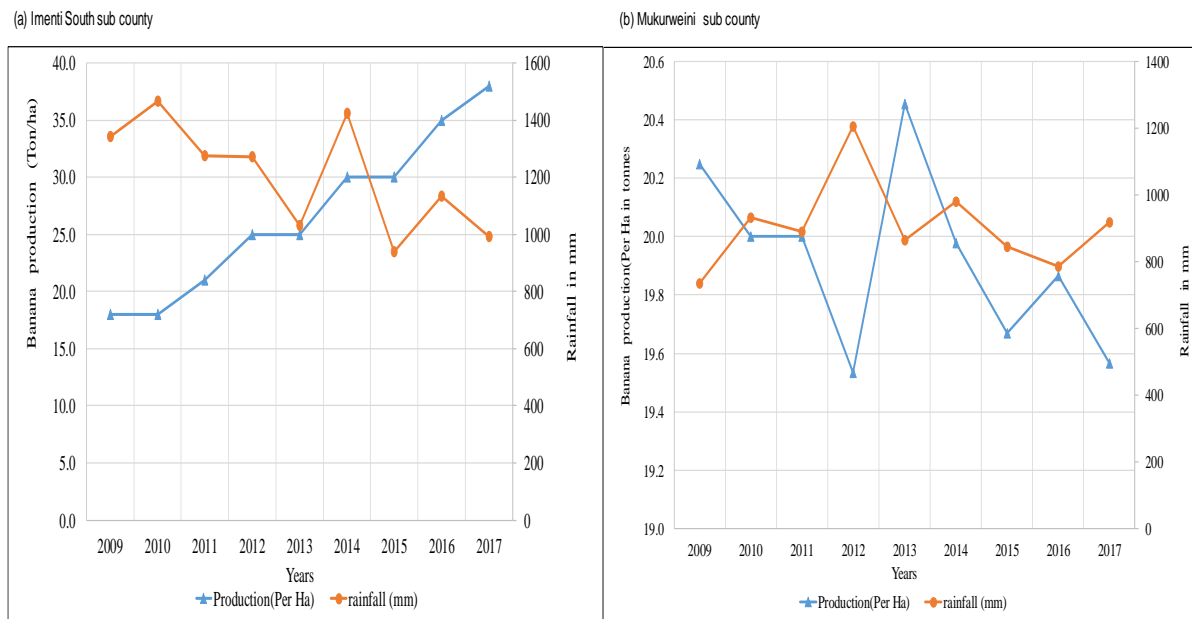

Figure 4. *Time series of banana production and Rainfall trends (a) Imenti South and (b) Mukurweini sub counties for the period 2009-2017*

Figure 4 (a) shows banana production trends in relation to temperature in Imenti South Sub County. In the year 2009, the temperature recorded was highest at 18.7^0C which corresponded to lowest banana production (17 tonnes per ha) in Imenti South while temperature of 18.9^0C corresponded to low production (19 tonnes per ha) (Fig 4 a and b). In Imenti south the production showed increasing trend despite temperature fluctuations with no definite trend, which can be explained by the introduction of irrigation in the study location. In Mukurweini Sub County, as temperature decreased there was corresponding increase in banana production from 2009 to 2012 while increase in temperature led to decrease in production from 2013-2015 as shown in Figure 4.6 (b). The production was maximum when the temperature was 18.5^0C. In Mukurweini sub county banana production and temperature amounts showed corresponding trends. This is supported by Ericksen, et al., (2011) who documented that high temperatures directly reduce yields of the desirable crops in the long-term in studied conducted in South West Kenya. Peng et al., (1999), further notes that Fusarium wilt severity is positively correlated with soil temperature leading to decline in yields during dry spell. Opeyemi et al. (2016) noted that, low rainfall, excessive rainfall and low temperature or very high temperature affect the productivity level of banana as banana tends to produce less under these climatic conditions in a study conducted in Ondo State, Nigeria.
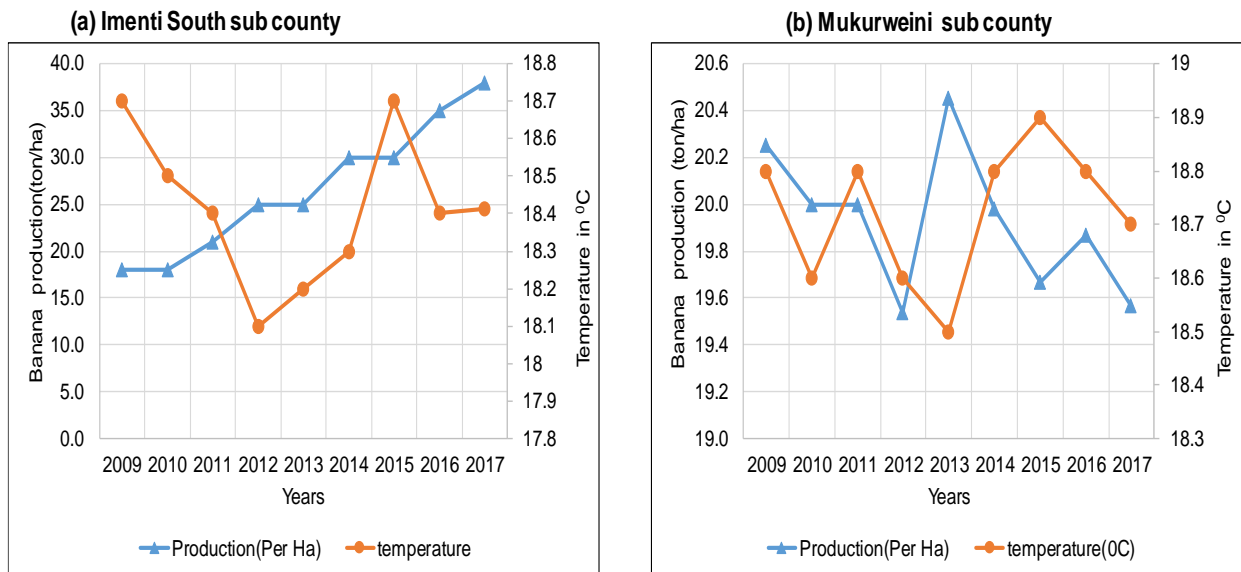
Figure 5. *Time series of banana production and Temperature trends (a) Imenti South and (b) Mukurweini sub counties for the period 2009-2017*

3.3 Banana acreage in Hectares and production in tonnage for the period 2009-2017

Banana being perennial crop provides steady source of income and food to the family possibly all year round. This has been supported by Kabunga et al., (2011) who cited that in Kenya, banana is almost exclusively grown by every smallholder farmer for home consumption and for markets. The results showed that banana acreage and production has been increasing in the period between 2009 and 2017 Imenti South and Mukurweini sub counties (Figure 5). Land under banana production increased gradually in both Sub-Counties starting at 960 and 400 hectares of land in 2009 and increasing up to 2910 and 460 hectares in 2017 for Imenti South and Mukurweini sub counties respectively. GOK (2008) noted that horticulture farming where banana production falls is among the fastest growing industry within the agricultural sector in Kenya, recording an average growth of between 15% and 20% per annum. The production increased from 17,280 and 8,100 tonnes in 2009 to 116,400 and 9,000 tonnes in 2017 for Imenti South and Mukurweini sub Counties respectively (Figure 5 (a) and (b)).
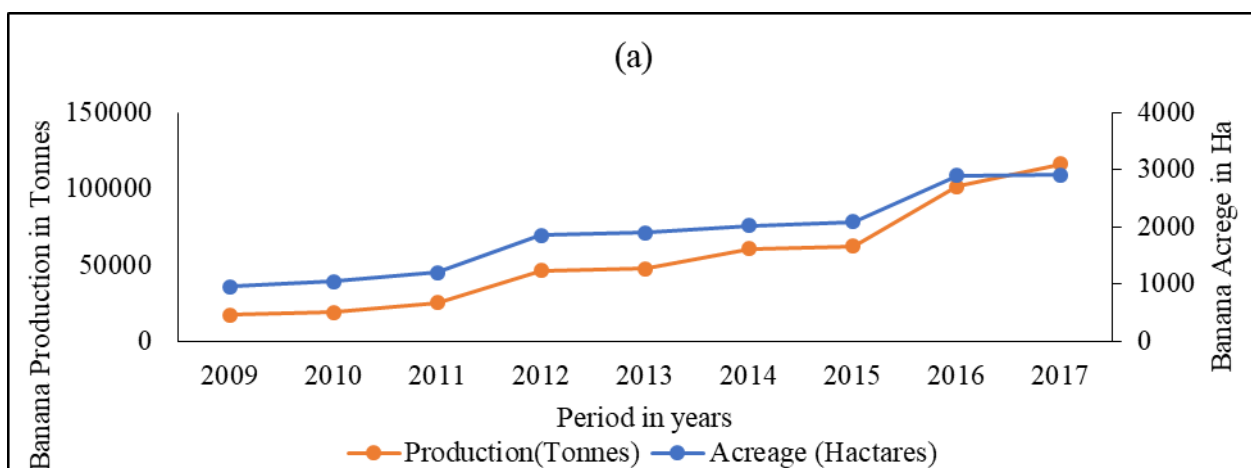

Figure 6. *Trend of the changes in banana production against changes in acreage for (a) Imenti south and (b) Mukurweini sub counties*

3.4 Other Factors Affecting Banana Production in the Region

The study also revealed that apart from temperature and rainfall parameters, there were other factors that influenced banana production. These included land use changes, soil fertility, pests and diseases, fluctuating labour costs and soil water retention. Approximately 73.2%) of the total respondents specified that soil fertility had an antagonistic effect on banana yields (Table 4.) while soil water retention (18.6%) was the second most important factor affecting banana production in the region. Soil organic matter greatly affects soil pH, water retention capacity and nutrient availability. This concurs with studies conducted by Van Asten et al., (2011) which suggested that soil nutrient deficiencies, poor/inefficient nutrient cycling and retention of adequate soil moisture is major obstacles to enhancing banana production. Pest and disease have adverse effect on banana production as noted in table 4. This has been supported by (Thornton and Cramer, 2012) who observed that, significant yield loss may be due to increased risk of pest and diseases if the temperature increased by 2°C.

Table 4. Other factors affecting banana production in the study areas

Location Sub county	Water retention in the soil	Soil fertility	Labour costs	Pest and disease infestation	Total
Mukurweini	7(5.4%)	115(88.5%)	3(2.3%)	5(3.8%)	130(100%)
Imenti South	64(25.5%)	164(65.3%)	6(2.4%)	17(6.8%)	251(100%)
Total	**71(18.6%)**	**279(73.2%)**	**9(2.4%)**	**22(5.8%)**	**381(100%)**

Water retention is related to rainfall and temperature amounts and therefore could explain why it was an important factor in banana production. The study findings also revealed that land area under banana production increased during the period under study as farmers opted to convert most of their crop land to banana production. It was reported that the trends of banana production have been changing in the study region (Table 5). Majority of the respondents (42.8%) in the study region admitted to have changed the land use and type of crops they have been farming in the last 10 years with the highest number of respondents recorded in Imenti Sub County at (53.7%).This concurs with GOK (2014) which found that 47% of the total households in Meru County had changed crops grown as a response to climate variability. Out of those who reported changes in land use, 20% had changed from coffee farming to other crops, 4.7% changed from banana farming to others crops whereas 30% changed from other crops to banana farming with only 0.8% changing to coffee farming. Majority of respondents (4%) changed to banana farming in Imenti South Sub-County and 9% from Mukurweini Sub-County. Some respondents preferred farming food crops mainly beans and maize with 2.4% and 5.5% respectively. Many smallholder farmers depend on the cash income generated from banana sales, due to declining incomes from traditional cash crops such as coffee (Wambugu and Kiome, 2001).

Table 5. Proportion of land use change under Banana production in relation to other crops in the study region

Study Location	Changed from						Changed to					
	Not Changed	Banana	Beans	Coffee	Maize	Others	Total changed	Banana	Beans	Coffee	Maize	Others
Mukurweini	102(78.5%)	3(2.3%)	2(1.5%)	8(6.2%)	7(5.4%)	8(6.2%)	28(22%)	12(9.2%)	0(0%)	1(0.8%)	8(6.2%)	7(5.4%)
Imenti South	115(45.8%)	15(5.9%)	11(4.4%)	68(27.1%)	26(10.3%)	15(5.9%)	135(53.7%)	101(40.2%)	9(3.6%)	2(0.8%)	13(5.2%)	10(4.0%)
Total	**217(57.0%)**	**18(4.7%)**	**13(3.4%)**	**76(20.0%)**	**33(8.7%)**	**23(6.0%)**	**163(42.8%)**	**113(30.0%)**	**9(2.4%)**	**3(0.8%)**	**21(5.5%)**	**17(4.5%)**

IV. Conclusion

The rainfall amount showed negative trend while temperature recorded positive trend. The amount of rainfall fluctuated however increase in rainfall didn't correspond to increased production. The temperature increase had adverse impact on production with banana giving maximum yields at 18.5^0C.

Banana farming has enormous potential to benefit not only producers the smallholder's farmers but other actors. However, several interdependent constraints that amplify each other, hinder the realization of the benefits. The constraints include; pests and diseases, small farms, inadequate irrigation water, inadequate know-how on banana management and low production. Soil fertility is affected by the presence of pest and diseases in the soils while high soil temperature permits the spread of panama disease in the soil, hence affecting the banana production negatively. It is therefore important that interventions be made from the County government, national government and other actors in order to comprehensively address these constraints.

The acreage under banana production has been increasing in the study region from 2009 to 2017. This is as a result of increased demand of bananas produce in urban and peri urban area for hotels and also big institutions such as schools and hospitals. Banana being perennial crop provides steady source of income and food to the family possibly all year round.

The climate has been changing for the study period between 2009 and 2017. The rainfall has been declining in Mt Kenya region too during the study period. These trends in climate negatively affect banana productivity in the region hence food insecurity will persist unless precautionary adaptive measures are taken. These adaptive measures, both at the local farm level and county levels are necessary to reduce the potential negative effects associated with these changes in temperature levels and precipitation amounts. High rainfall events accompanied by strong storms that destroys banana and increased incidences of pest infestations and diseases led to low yields.

The major impact of climate variability on banana productivity in Mt. Kenya is reduced banana yields. The reduced yield can be viewed in two perspectives, firstly low rainfall hence reducing the banana productivity and also low quality of produce leading to banana with small bunches referred to as "seketa" and on the other hand high temperature led to damage of banana crops and also host pests and diseases leading to decline in yields. High rainfall and storms led to damage of the banana stool and infestation of new pest and diseases leading to low yields.

The study realized that farmers had changed the type of crop they were farming for and adopted banana farming. This was due to the fall of coffee price in the global market as well as high cost of inputs for coffee production. Farmers therefore opted banana production as source of steady income and food for the household due to its perennial nature and the possibility of year-round harvest.

Nevertheless, the future of banana production in Mt Kenya may not be predicted especially in Imenti south sub-county due to challenges associated with unavailability of water for irrigation. Farmers are opting to reverse to coffee farming due to new prices and the newly amended Coffee Act which has transformed coffee industry.

Recommendations

The county government should assist the community in establishing irrigation projects in the region to allow farmers access water for irrigation. Investments in irrigation projects to offer opportunity to address water shortages and tap into the County's irrigation potential. This guarantees high yields and year-round harvest.

To reduce declining soil fertility caused by soil erosion, soil and water conservation measures should also be up-scaled. To address disease and pest incidences, farmers need to

control them through proper crop husbandry practices which should be encouraged. Alternative crops should be introduced to diversify the crops grown to avoid over relying on banana which might be vulnerable to climate variability. Intercropping with climate smart crops should be encouraged.

We recommended provision of weather information on the onset of the rainfall period and distribution within the seasons in order to respond to climate change issues. This can be done through e- mobile and among other social media platforms.

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