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Research Article

Effects of Seasonal and Annual Rainfall Variability on Sugar Cane Yields in Mumias Sub County, Kakamega County, Kenya

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Abstract: This paper addresses the effects of seasonal and annual rainfall variability on agricultural production that has had great influence on sugarcane biomass yields in Mumias Sub County in Kakamega County of Kenya. Seasonal and annual rainfall variability has adversely affected agricultural production globally. Mumias Sub County experienced rainfall variation between 1982 and 2012. The objective of this paper was to establish the effects of variations in total seasonal rainfall and total annual rainfall amounts on sugarcane biomass yields. A descriptive longitudinal research design was adopted. Document analysis was used to obtain data on rainfall amounts from Mumias weather station and sugarcane biomass yields from Mumias Sugar Company records. Quantitative data on seasonal and annual rainfall variability and sugarcane yield were analyzed using simple linear regression. The results show 55% (r^2=0.55) and 40% (r^2=0.4) of variation of sugar cane biomass yields can be explained by long seasonal rainfall (March, April, May) and short seasonal rainfall (October, November, December) respectively. Similarly, 61 % (r^2=0.61) of variation of sugarcane biomass yield can be explained by total annual rainfall amounts. The study demonstrated that long seasonal rainfall and total annual rainfall amounts are dominant climatic factors accounting for variation of sugar cane biomass yields in Mumias. Recommendations made to farmers are they align activities of sugarcane production with temporal rainfall variability by observing planting dates, apply fertilizers when heavy rains sub size and apply mitigating measures such as irrigation to supplement water supply to sugarcane crops during dry seasons and grow more of drought resistant varieties.

Keywords: Rainfall variability, sugarcane production, sugarcane biomass yields, seasonal rainfall variability, inter annual rainfall variability.

INTRODUCTION

Rainfall variability refers to change in rainfall amounts at a given area through time such as season to season or year to year in relation to long-term average as in studies by Ribot *et al.*, (1996). They associate seasonal rainfall variability with floods, dry spells or drought. In related studies, Philips *et al.*, (1999) identify rainfall variability as having a major effect on crop production. Rudd and Chardon (1977) showed that sugar cane yield declined by 0.46 t/ha each day the water table was within 0.5 m of the soil surface during the peak growth period (Dec–June). According to a study by Di Bella *et al.*, (2008), in Herbert District, Australia, it was reported that varieties of sugar cane that are harvested late in the growing season are at great risk of poor yield response due to high probability of significant rainfall events. Similarly, studies by Salter and Schroeder (2012) in MacKay (Australia) reported that high total seasonal rainfall variability had an impact on sugar cane production and hence high rainfall amounts leads to high sugarcane yields. In a study done in Mexico, Pablo and Antonio (2015) argued that historical rainfall trends between 2002 and 2007 were harmful to crop production, where 10% higher rainfall variations led to an output of 0.8% lower on average in maize crop. These studies from various parts of the world point out that change in rainfall amounts affects agricultural production. However, the studies done by Di Bella *et al.*, (2008) and Shruti, *et al.*, (2017) analyzed the effects of seasonal rainfall on crops grown over a year under rain fed conditions. The studies by Salter and Schroeder (2012), Pablo and Antonio (2015) focused on significant rainfall events rather than

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analyzing the variations in seasonal rainfall amounts and how they affect sugarcane yield.

Seasonal Rainfall variability associated extreme events such as drought adversely affects agricultural production and food security (Christensen *et al.,* 2007). In a study over Zimbabwe, Masavya *et al.*, (2009) reported that rainfall variability affects crop yields since planting dates are altered, though in their study they did not specifically focus on sugar cane. A study done in Kuta (Nigeria) by Yahaya *et al.*, (2014) showed a continuous yield increase of yams from 11.26tons/ha realized in 2001 to 16.91tons/ha realized in 2009: and gave a general explanation as that, there was an increase in the amount of rainfall received during this period. This study focused on yams which take six months to mature unlike sugarcane which takes 12—18 months. In a similar study over Ghana Kyei-Mensah, *et al.*, (2019) elucidated a decline in terms of yields of key agricultural cash crops such as cocoyam due to reduced rainy days throughout different seasons. The aforementioned studies focused on the quantity of crops harvested. However, they did not analyze how variations in annual rainfall amounts affected the yields harvested on crops such as sugarcane that take over a year to mature that this study intends to explore.

Rainfall variability and changes in frequency of extreme events are one of the important factors that determine crop yield, its stability and quality. Studies by Jorio *et al.*, (2006) over Charb, Morocco revealed that the rainy seasons which normally begin in January disrupt harvesting, transporting and crushing operations of sugarcane which in turn affect the ultimate yield. The study points out that the sugar mills set the harvest schedule based on crop yield and sugar content, however, the plan is compromised by the onset of rain that prevents infield access of transport vehicles and this also reduces sugarcane quantity produced they assert. In a study over Uganda, Orianga, (2013), noted that annual rainfall amounts affected the quality of millet yields. The aforementioned studies that have been done in Africa show how seasonal rainfall amounts affect the quality of crops grown; however they did not pinpoint the effects of total amounts of annual rainfall on sugarcane biomass yields.

Decreasing sugarcane biomass yield has been associated with seasonal rainfall fluctuations as suggested in studies by Kenya Sugar Research Foundation (KESREF), (2009). Extreme events such El Nino events which complicate seasonal rainfall amounts received causing rainfall variability have been linked to diminished agricultural output by various studies such as Herrero *et al.,* (2010)**.** In related studies Kirungu, (2011) argued that water stress during the major rainfall season at the late canopy development stage and stalk elongation stage affected sugarcane biomass yields. According to Barasa *et al.*, (2015), reported evidence of increment in unpredictable rainfall events in the region of Mumias , Kenya, and hence agricultural production of crops such as sugarcane will be affected immensely since farmers are unware of rainfall variability. However, this study did not analyze the extent of effects of rainfall variability at seasonal and annual scales on sugarcane biomass yields yet it is the predominant cash crop grown in the area.

Seasonal and annual rainfall variability has had a great influence on rain fed agricultural production and a lot of focus on how the variations in seasonal rainfall amounts affect sugarcane biomass yields need to be done. The variations in total seasonal and total annual rainfall amounts affect the quantity of crops harvested. Studies on effects of seasonal rainfall amounts on crops have been done showing how the yield quality is affected, however analysis on how variations in seasonal and annual rainfall amounts affect crops such as sugarcane that take a long period to mature need to be explored and to pinpoint the effects of total amounts of annual rainfall on sugarcane biomass yield that is one of the main agricultural products in Mumias sub county.

STUDY AREA AND DATA

Study Area

The study was conducted in Mumias Sub County in Kakamega County in western part of Kenya. It covers a total area of 586.2 sq.km and lies between latitude 1˚30΄N and 0˚05΄S, longitudes 34˚and 35˚45΄E. The altitude ranges from 1240 m to 1641m above sea level, (Republic of Kenya, 2009). Mumias sub county is mainly tropical humid, characterized by day temperatures varying between 23˚C and 33˚C. This study area has high rainfall almost throughout the year, with minimum rainfall being received between December and February.

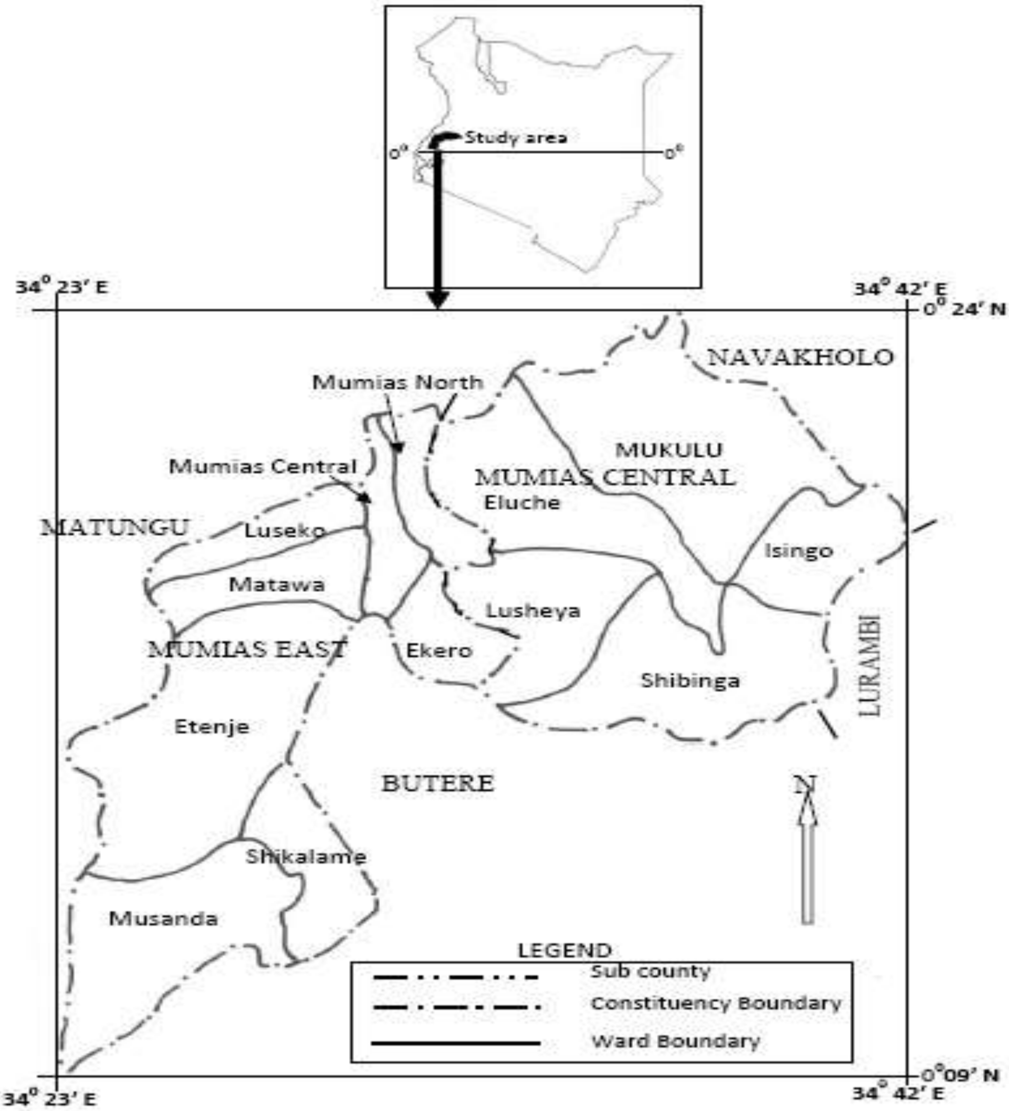

Figure 2: Map of Mumias Sub County
Source: Mumias District Development Planning, 2010 Sampling and Data

The present work used survey descriptive research because it was possible to collect large rainfall and sugarcane production data at one point at a time. In this study the rain gauge station was the unit of analysis from which rainfall data was surveyed because this is the data that gives the rainfall distribution in the area. The rainfall data collected from Mumias rain gauge stations covered a period of 31 years which was assumed to be representative of the entire population. According to Mumias synoptic weather station, (2017) the number of rain gauge stations within Mumias Sub County was 5 and located within an average distance of 10km apart. Simple random sampling was used to obtain rainfall data from 5 rain gauge stations for six years to ascertain whether the rainfall pattern is similar or homogenous. In a study over Ghana, Nyatuame, *et al.*, (2014),to find temporal disparity of three different rain fall zones analysis of variance (one way ANOVA) test was used. Similarly in this study to ascertain whether there were differences between the means for five rainfall data regions Anova test was used. The importance of this test is to assess whether there exists any variance in groups of data collected from a wide area, if no variance exists then the outcome variables are of the same magnitude in each of these groups (i.e. the rainfall data). Different years were picked with corresponding rainfall data from the five rain gauge stations in the area within the 31 years study period. They were assumed to provide information about the rainfall pattern in the sub county.

Analytical Methods

Quantitative data were analyzed using descriptive statistics such as means, percentages and simple linear regression analysis. Statistical Packages for Social Science (SPSS version 20) and OriginLab software version Origin Pro 8 were used to process the data. Total seasonal rainfall and total annual amounts data was taken as an independent variable and sugarcane yields as the dependent variable. An analysis of variance was used to measure the trends in historical total annual rainfall amounts for purposes of predicting rainfall patterns. Rainfall data was collected from five rain gauge stations which were located within Mumias Sub County. A test on the means of annual rainfall amounts from the five rain gauge stations was carried out to find out whether the rainfall pattern is similar over Mumias Sub County. This was done using the analysis of variance test

RESULTS AND DISCUSSION

The results from analysis of variance indicated that there is no difference between the means of annual rainfall amounts among the five rain gauge stations for six consecutive years (F=0.365 and a corresponding critical value of 2.76 was obtained) at 0.831 significance. The null hypothesis failed to be rejected at 0.05 significance level. This implies that the rainfall pattern over Mumias Sub County is similar in the areas covered by the five rain gauge stations and this makes it prudent to use recordings from one rain gauge station to analyze the effects of total seasonal and annual rainfall amounts on sugarcane production. The effect of the rainfall amounts variation within the long rains season, that is, March, April and May (MAM) seasons was analyzed with a view of assessing its impact on sugarcane yields during the period of 1982 to 2012. This was due to the fact that the main planting period of sugarcane in the study area falls within this season. Total seasonal rainfall amounts were analyzed along total sugarcane yields in terms of tonnage (TCH) of raw harvested cane. The total seasonal rainfall amounts received were correlated to the sugarcane biomass yields from out grower farmers and results presented in Figure 2.

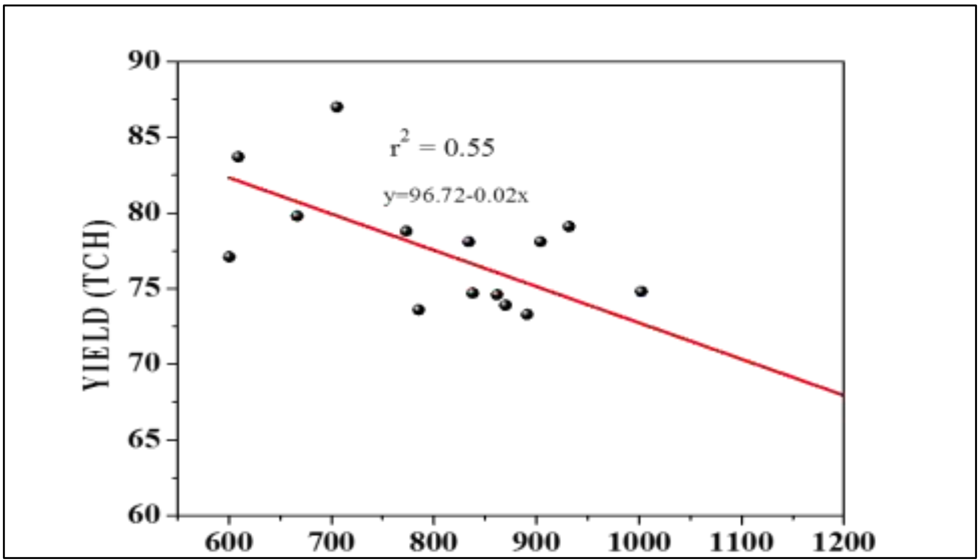

Figure 2: Total MAM rainfall amounts received between 1982 and 2012 in relation to sugarcane biomass yields (Yield) in tonnes. MAM stands long rains season during months of March, April and May.

Figure 2 shows that relationship between total seasonal rainfall (MAM) and sugarcane biomass yields was decreasing at non-significant rate of (slope= -0.02) as illustrated by regression model, y=96.72- 0.02x implying that when high long rains total amounts were recorded, sugarcane biomass yields decreased. Moreover, Figure 2 shows that 55% (r^2=0.55) of variation of sugarcane biomass yield can be accounted for by total rainfall amounts in during the "long rains" season (March, April and May). These results demonstrate that the total seasonal rainfall during long rains (MAM) is a very important factor influencing sugarcane yield because other factors accounted for only 45% of variation of sugarcane yield. These other factors could be temperature, leaching of soils or time of harvesting as suggested by Kirungu,(2011).

A number of authors such as Samui, *et al*., (2014) in a study over Maharashtra, India revealed that sugarcane yields are adversely affected during the high rainfall season because the sun shine hours are reduced. The findings of this study are consistent with studies of Mortimore and Adams, (2001), Kiringu, (2011), Mulianga, *et al.*, (2013), Zhao and Yang, (2015) who observed that the distribution and length of the period of rain during the growing season and the effectiveness of the rains in each rainfall event is the real factor that affects the effectiveness and success of crop farming. Similar studies by Salter and Schroeder (2012) confirms with the findings of this study in that they reported that during the traditional high total seasonal rainfall period in Mackay, Australia sugar cane yields were low due to the season influencing the radiation and thermal time falling below average. In another study over Ilha Solteira, Brazil, Fabio, *et al.,* (2013), reported that rain fed sugar cane yields reduced during the major rainfall season due to reduced temperatures. In similar studies over Fiji, Zhao and Yang, (2015), reported a record sugar production in 1994 of (516,529 tons) due to well distributed main seasonal rainfall amounts. Other studies over tropical Sri Lanka by Naveendrakumar *et al.*, (2018), showed an increasing trend in total seasonal rainfall amounts affecting sugarcane yields. The analysis in Figure 4 confirms to other sugarcane growing zones whereby well distributed main seasonal rainfall amounts received lead to high yields as reported by a number of authors such as Zhao and Yang, (2015).

The study area also receives enhanced rainfall in the months of October to December which is referred to as the short rains season (OND). Figure 3 shows the relationship between total OND rainfall amounts to sugarcane biomass yields during the period 1982 to 2012 in Mumias Sub County.

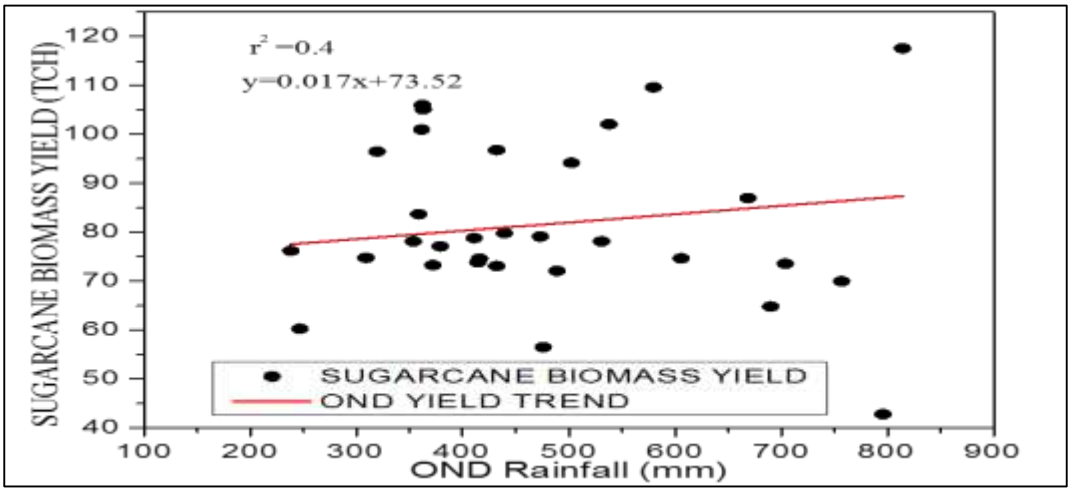

Figure 3: Total OND rainfall amounts received between 1982 and 2012 in relation to sugarcane biomass yields. OND stands for short rains during October, November and December.

From Figure 3 the relationship between total (OND) rainfall amounts and sugarcane biomass yields shows a slight increase in sugarcane biomass yields as illustrated by regression model, y = 73.52+0.017x (slope= 0.017). Besides, the results show that 40% (r^2=0.40) of the variation in sugarcane biomass yields can be accounted for by total short rains (October, November, December) rainfall amounts. The results demonstrate that the short rains season (OND) rainfall is not a major factor influencing sugarcane biomass yields because other factors accounted for 60% of the variation of sugarcane yield. These factors that were not considered in this study could have been that some genotypes/cultivars are tolerant to water deficit, temperature stresses, radiation use efficiency and nutrient use efficiency as suggested by De Silvia and De Costa, (2012). From Figure 3 analysis, there is a period when OND total seasonal rainfall amount recorded was 800mm yet the sugar cane biomass yields were low (almost 40tonnes per hectare) and this could be attributed to challenges such as availability of labor, leaching of nutrients and management practices brought about by high rainfall amounts experienced during the minor rainfall season as reported by Salter and Schroeder (2012). Further still, Figure 3 shows during the short rains season total rainfall of 850m corresponded to high yields, this could be attributed to the period when sugarcane crops were exposed to well distribute soil moisture content with high temperatures as revealed by Zhao and Yang, (2015). The analysis from Figure 3 are in agreement with findings from a similar study in Kenya, Mulianga, (2018) who reported that when rainfall is normalized at seasonal level, its impact on sugarcane biomass yields is minimized.

Total seasonal rainfall amounts affect the annual rainfall hence it was therefore prudent to find out the relationship between total annual rainfall amounts and sugarcane biomass yields using linear regression. The sugarcane biomass yield tonnage was taken from the out grower farmers output since they are the key stakeholders in the industry and also most of the cane harvested in the study area is from the farmers. The information is depicted in Figure 4.

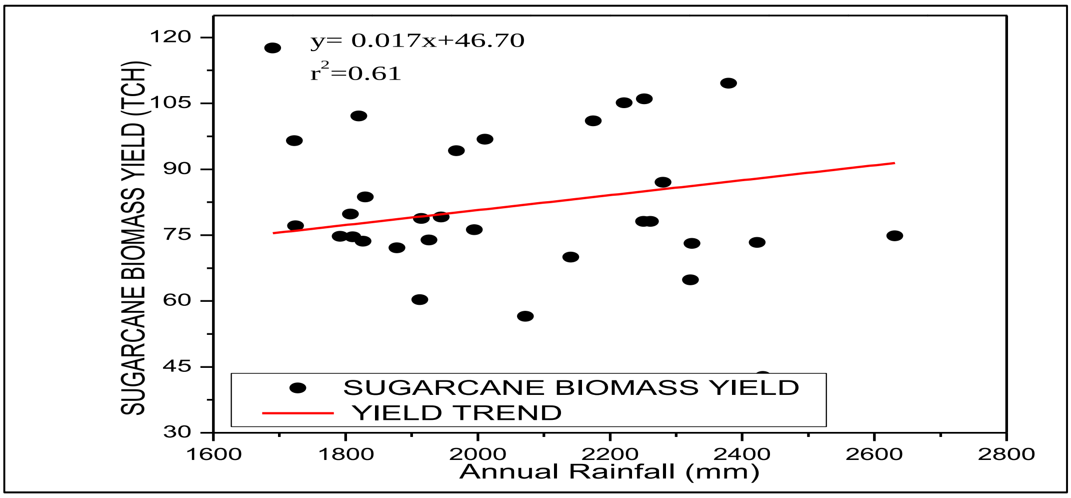

Figure 4: Total annual rainfall amount (mm) in relation to sugarcane biomass yields for out grower farmers during the study period of 31 years

From Figure 4 the analysis showed the relationship between total annual rainfall amounts and sugar cane biomass yields was increasing slightly, as illustrated by regression model, y = 46.70 +0.017x (slope =0.017). In addition, the result shows that 61% (r^2=0.61) of the variations in sugarcane biomass yields can be explained by total annual rainfall amounts. The result demonstrates that total annual rainfall amounts is a very important factor influencing sugarcane biomass yields since other factors accounted for only 39% of variation of sugarcane biomass yield. From Figure 4, the analysis shows that when high total annual rainfall amounts were recorded corresponding high sugarcane biomass yields were realized. This was due to high accumulation of moisture content and nutrients from the soils making the cane fibre to be dense and heavy. From the results in Figure 4, when total annual rainfall amounts received ranged between 1800mm to 2000mm the sugarcane biomass yield was high whereas below 2000mm the yields were poor due to water stress. Similarly when total annual rainfall ranged above 2200mm the yield was poor and this could be attributed to leaching of soils. On average therefore, the production of optimum sugar cane yields was when total annual rainfall amounts ranged between 1800mm and 2000mm. The main outliers were falling within periods of global phenomenon the *El Niño* and *La Nina*. Rainfall amounts that were above or below average could be interfering with agronomic activities such as harvesting, weeding and even the soil fertility. From the analysis the sugar cane yield increased in relation to increase in total annual rainfall amounts. Therefore from Figure 4, sugarcane biomass yield is strongly affected by total annual rainfall amounts accounting for about 61% of the variations.

The findings in Figure 4 are similar to a study by Kabir and Golder, (2017) over Bangladesh that reported yields of major crops such as rice appeared to increase per acre with an increase in total annual rainfall amounts though increasing it beyond its normal, the yields declined because of water logging and salinity. A similar study done by Karanja, (2013), in Nyandarua, Kenya, reported that the main cash crop in the area Irish potatoes recorded an increase in yields with an increase in total annual rainfall amounts. Other related findings by Ogega, *et al.*, (2018) in a study over western Kenya reported that low total annual precipitation impacted negatively on crops such as maize where low yields were recorded. Jamoza, (2005) concurs with these findings where it was suggested that erratic and low annual rainfall amounts were the main cause of low cane yields in the highlands western of Kenya. The study findings show that the availability of enough total annual rainfall amounts lead to high yields. The analyses were also done on sugarcane ratoons mainly for plant, first ratoon, second ratoon and third ratoon that are economically viable. Figure 5 shows the relation between total annual rainfall amounts and the mentioned viable sugarcane ratoon yields.

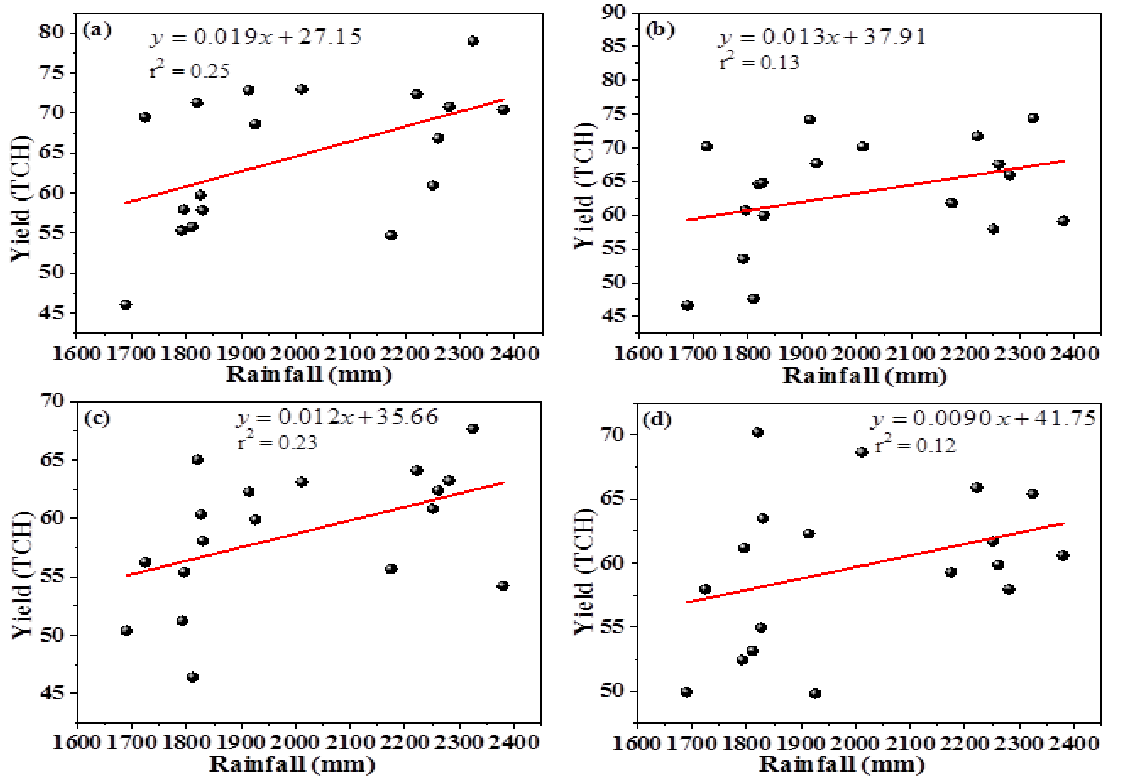

Figure 5: Scatter plots of yield (TCH) versus annual rainfall (mm) for (a) plant, (b) first ratoon, (c) second ratoon, (d) third ratoon during 1982-2012

From Figure 5 a-d, the scatter plots show the relationship of annual rainfall amounts versus the ratoon yields. Figure 5(a), the plant yield appeared to increase at significant rate (R^2=0.25, $p<0.05$). The Figure 5(a) shows only 0.25 (25%) of the variation in sugarcane biomass yields can be explained by total annual rainfall amounts. The relationship between the plant crop yields shows that high biomass yields (above 65TCH) were recorded during the years that received high total annual rainfall (above 2200mm. In years that the total annual rainfall amounts fell below 1900mm the yields were low or moderate. In Figure 5 (b), the yield of the first ratoon increased at a non-significant rate (r^2=0.13), implying that only 0.13(13%) of variation in sugarcane yield can be explained in terms of total annual rainfall amounts. The rest 87% could be other factors not considered in this study such as the first ratoon crop could have had more tillers than the plant crop resulting in higher yields as suggested by Gomathi *et al.*, (2013). This shows total annual rainfall amounts are an important factor of variation in first ratoon crop biomass yields since they could be influencing the number of tillers sprouting after the harvesting of the first crop. In Figure 5(c), the second ratoon yield appeared to increase at a significant rate (R^2=0.23) implying only 0.23 (23%) of variation in sugarcane biomass yields can be explained for by total seasonal rainfall amounts. Other factors not considered in this study accounted for 0.77 (77%). The increment was lower than the first ratoon though still higher total annual rainfall amounts influenced the yield. This could be attributed to good establishment of the ratoons and sprouting of many tillers due to the available soil moisture as suggested by Smit, (2011). Total annual rainfall amounts above 2200mm gave rise to higher yields whereas those below 1800mm gave rise to low yields. In Figure 5 (d), the third ratoon yield appeared to increase at a significant rate (R^2=0.12) implying only 0.12 (12%) of variation in sugarcane yields can be explained for by total annual rainfall amounts. Other factors not considered in this study accounted for 0.88 (88%). Further analyses in Figure 5 showed that the plant, first ratoon, second ratoon and third ratoon yields were all higher than their long term mean against high total rainfall amount of 2324.2mm and also against a total rainfall amount of 2011.3mm. In similar over Pakistan, Hussan *et al*., (2017) revealed that the time of harvesting sugarcane ratoon crops and the amount of total rainfall amounts available affect the yield.

Similar results were observed by Gomathi *et al.*, (2013), in India where the production of sugarcane was analyzed in terms of tiller production and it was reported that rainfall was highly associated with the yield of the first ratoon (r=0.630), second ratoon (r=0.553). From Figure 5, in summary number of factors may contribute to the variation in ratoon yields among them bud development in ratooning , the amount of total seasonal rainfall and the roots of a sugar cane plant develop into a layer that covers the soil and this may not allow the penetration of water easily leading to differences in yields. However, above all these factors variations in total annual rainfall amounts is key accounting for at least 20% of the factors across all the major ratoons. The results confirm to studies done by various authors who suggested that a number of factors may also contribute to the variation in ratoon yields among them bud development in ratooning , (Ferraris and Chapman, 1991), also the number of buds per stem piece that decrease with older ratoons and damage at harvest time could affect ratooning ability, (Hurney, 1992). He further stated that, these factors put together may explain the variation in yield output for various ratoons in relation to total rainfall amounts.

Other factors that could lead to differences in ratoon yields are the age of the sugarcane plant as reported by Gomathi *et al.,* (2013). In another study over Australia, An-Vo,*et al.,* (2017) reported that the roots of a sugar cane plant develop into a layer that covers the soil and this may not allow the penetration of water easily leading to differences in yields from one ratoon to another. They further concluded that ratoons will therefore correlate differently to precipitation. Therefore, these results obtained were similar to the study done by An-Vo,*et al.,* (2017) in Burdekin District, Australia where the largest yield gaps during wet and dry conditions (up to 50tons/ha) were observed in the first ratoon crop, second ratoon crop and third ratoon crop. A study done in India by Gomathi *et al.,* (2013), reported that the sugar yield production of ratoons was highly associated with the variation of growth and physiological factors. Another factor of yield gaps in ratoons is their root canopy at the ground that does not allow easy penetration of ground water which may be influenced by total annual rainfall amounts. In addition during the years the amount of total annual rainfall is low yields are low suggesting that few plant buds develop when harvesting takes place. The production of buds may also be as a result of genetic component because commercial cultivars have been selected to do well for the first three to four cultivation cycles and it is important to look at the varieties grown in the study area.

The agriculture office data revealed that most farmers preferred to plant varieties that offer higher yields which were Co 945 and CB38-22 varieties were grown majorly within the period 1982 to 2012.

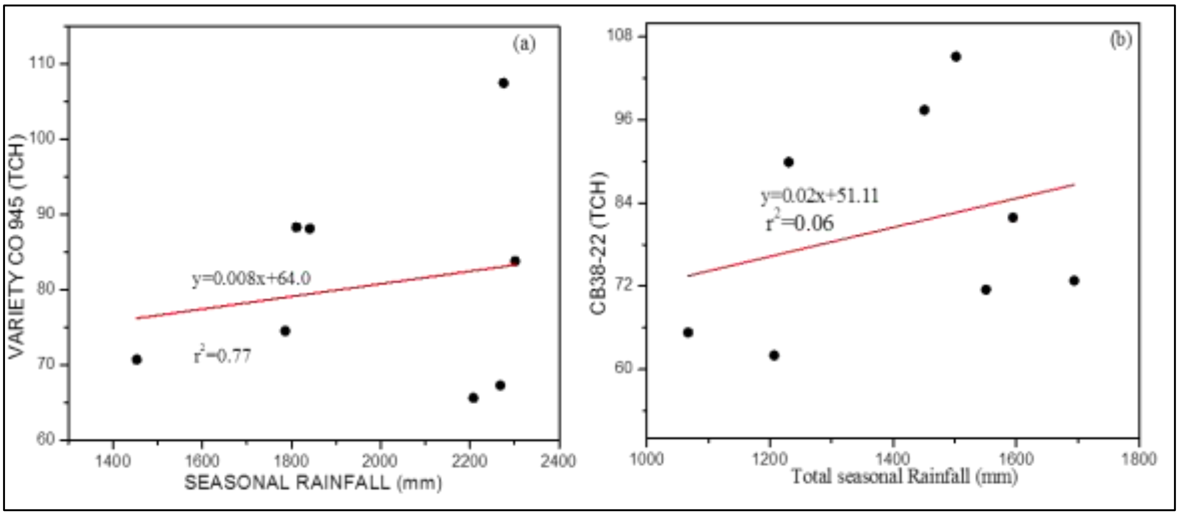

Figure 6: Scatter plots of sugarcane varieties (CO 945 and CB38-22) yield (TCH) versus total annual rainfall (mm) over Nucleus zone during the study period

Figure 6 shows the linear regression analysis of the most common planted sugarcane varieties C0 945 and CB36-22 by farmers in Mumias Sub County during the study period. Figure 6 (a) shows that sugar cane variety CO 945 yields increased at a significant rate(slope 0.008, r^2=0.77) implying that 77% of variation in sugarcane biomass yields in this variety can be explained for by total annual rainfall amounts. This means total annual rainfall amounts is a very important factor of variation of yield in this variety. In Figure 6 (b) the yields of sugarcane variety also increased as the total annual rainfall amounts increased, (slope= 0.02, r^2=0.06). This implies that only 6% of variation of sugarcane biomass yield in this variety can be accounted for by total annual rainfall. 84% of variation in yields in this variety could be accounted for by other factors not considered in this study. This means annual rainfall amounts are not an important factor in yield variation in this variety of sugarcane. The two varieties respond to total rainfall amounts almost in an equal measure such that their yields relate to the changes in rainfall amounts as seen especially when rainfall amounts are between 1400mm and 1800mm. Similarly both varieties recorded low yields of TCH value of 75 when total rainfall amounts were below 1300mm. This is despite the fact that the crops were under the care of factory professional management of Mumias Sugar Company.

According to a study by Di Bella *et al.*, (2008), in Herbert District, Australia, it was reported that varieties of sugar cane that are grown under conditions of low total rainfall amounts are at great risk of poor yield response. Similar studies by Salter and Schroeder (2012) in MacKay (Australia) reported that total annual rainfall variability had an impact on sugar cane production by high rain giving rise high yields. Sugarcane variety Q124 out-performed other varieties, across most soil types, in the Mackay region. However, weather conditions during that period may also have been more favorable for cane production. The 1994–1998 period experienced, on average, 118 mm more effective rainfall, 682 mm lower total rainfall, better rainfall distribution, and likely lower incidence and severity of waterlogging than during (2008–2010).The difference in effective rainfall alone could account for ~ 10 t/ha using the total water use efficiency data described by Chapman (1997). In another over Gujarat, 1ndia, Mali, *et al.*, (2014) noted that there was a decrease in average crop productivity in 2012-13, as compared to the previous two years. They elucidated that yield reduction was directly the result of unusually profuse flowering incidences from 0 to100 %, which varied from variety to variety in 2012-13 attributing this to total rainfall amounts. From this we may attribute some of the disparities seen in yields to different varieties hence the reason new varieties are developed to respond to environmental changes. In related studies, Jamoza, (2005), Kirungu, (2011) when they analyzed the yields of various sugarcane varieties they suggested that erratic and low annual rainfall was the main cause of low cane yields in the highlands western of Kenya.

CONCLUSION & RECOMMENDATION

Based on the study findings, it was concluded that variability in total seasonal rainfall amounts could be a major climatic factor affecting sugarcane biomass yields. The total long rains season (March, April and May) amounts could be significantly used to predict the sugarcane yields received. High long rains total seasonal rainfall amounts affected sugarcane biomass yields due to leaching of soil nutrients and slowing down of agronomic activities thereby giving rise to low yields. Total annual rainfall amounts were noted to have affected sugarcane production in this study particularly the years that the total annual rainfall amounts were well distributed such as ranges of between 1800mm and 2000mm that gave rise to high sugarcane biomass yields. The effects were similarly evident on various ratoons and sugarcane varieties. However the study was limited to rainfall amounts and it would be important to conduct a similar study on the effects of rainfall variability on agronomic activities such as planting, weeding, application of fertilizers and harvesting. It is recommended farmers to look for mitigating measures such as irrigation to supplement water supply to sugarcane crops at various stages during dry seasons and grow more of the drought resistant varieties. It is also recommended that farmers need to align activities of sugarcane production with temporal rainfall variability patterns in the study area

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