THE ROLE OF WEATHER INFORMATION IN SMALLHOLDER AGRICULTURE: THE CASE OF SUGARCANE FARMERS IN KENYA

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By

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Plan

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1. INTRODUCTION

- Agriculture corresponds to International Standard Industrial Classification (ISIC), divisions 1-5 (World bank, 2013)

- Recent global concern over climate change and its detrimental effects on natural and human systems
- Need for weather information

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- Agriculture is the main source of livelihood in most developing countries
- Yet, it is vulnerable to changes in climatic variables such as rainfall, temperature and radiation (Mendelsohn et al 2008).
- Despite technological advances made, climate and weather play a vital role in agricultural production (Villanueva and Hiraldo 2011).
- Increased variability in climate and weather will lead to increased drought, aridibility and ground water depletion.

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- Enhanced temperatures create an enabling environment for pests and diseases to thrive(Adamgbe and Ujoh 2013).
- Worse off if this happens when the crop is still very young
  - Recent pests and diseases reported are:
    a) The Fall army worm – in maize and sugarcane
    b) The yellow aphids in sugarcane!!
- This infestation drastically affects crop yield (productivity)
- Crop productivity is therefore significantly influenced by variability in rainfall and temperatures(Rowhani, Lobell et al. 2011)

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- Changes in temperature, rainfall, ultra violet (UV) radiation, and carbon dioxide (CO_2) levels also have a major impact on agricultural production
- Current climatic trends, predictions and analysis have shown that the most vulnerable groups to increased climate risks are small scale farmers in the tropical and subtropical areas (Change 2007).
- This is why there has been decrease in production of main crops such as maize, sugarcane, wheat and rice while populations continue to increase.
- Because of these we are likely to experience the risk of food insecurity

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- In order to address these challenges there is need to make weather information accessible for timely farm operations
- Sugarcane is highly herbaceous, being a source of food for man and also fodder for feeding animals.
- Sugarcane may have over 5 cycles under good agricultural practices
- The first crop is referred to as plant crop
- The subsequent cycles after the plant crop are called ratoons
- Ratoons mature in two months lesser period than the first crop

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- In each cycle, a farmer is advised to intercrop with legumes or any other food or fodder crop
- Farmers also undertake border management by growing food crops along the sugarcane boarders to enhance food security
- On re plough, farmers are advised to undertake crop rotation for green fallowing
- This cultural practice encourages a highly intensive agriculture system
- In the absence of weather information, farmers delay to plant these food crops and the sugarcane being highly herbaceous, over grows the intercrop age

Sugarcane, a herbaceous crop, with intercrops

Yield of all these crops suffers under uncertain and erratic weather conditions

OBJECTIVE

To investigate the role of weather (rainfall & temperature) on sugarcane yield

Sugarcane Yield:

Measured Y = At the mill entry - Regardless of area from which it is harvested.

Yield (Y) = Stack processed/ planted Area

Estimated Y = (current) By the sugar directorate (Human expertise)

15% fields sampled
Density
Vigor
Color
Diseases

2. MATERIALS AND METHODS

Study Area

- The study covers the western region sugarcane growing Counties of Kenya
- An altitude of 1000 m (in lowlands)- >1800 m (in the escarpment) characterizes the topography
- Rainfall of between 1400 mm within the Lake region and 1900 mm in the highlands.
- The main crop in the region is sugarcane, besides maize and food crops (legumes, horticultural crops).

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The Western region of Kenya

- Intensive agriculture practiced

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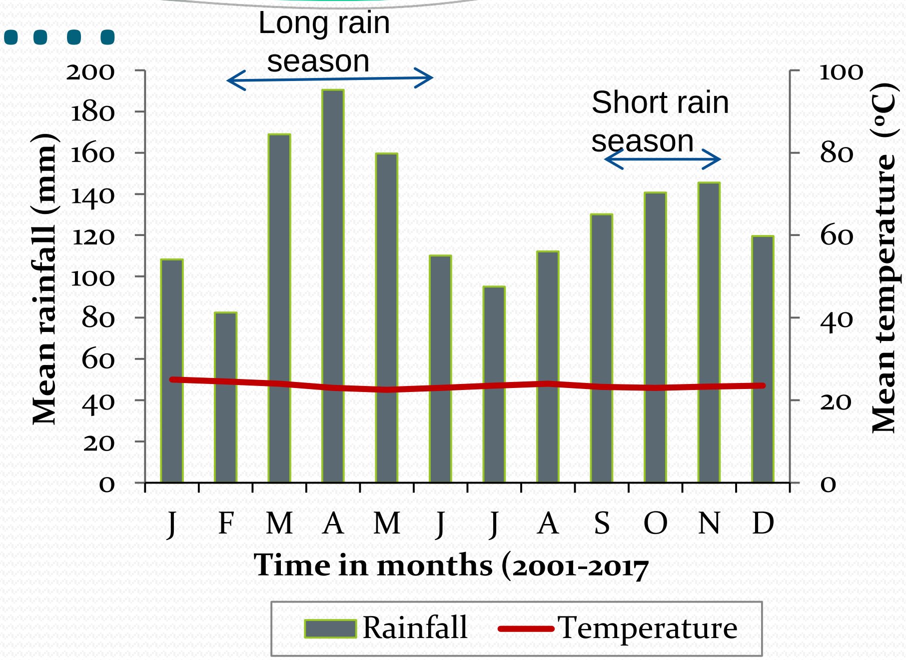
- Bi-modal rainfall:
  - 1400mm – 1900 mm
- Temperature:23^0C - 25^0C
- Mosaic of hills, valleys and plains
  - Altitude 1000m ->1800m
- Deep soils ideal for agriculture
  - Well drained -uplands
  - Poorly drained -low lands



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Data

- Average annual rainfall was obtained by summing the daily rainfall amounts and dividing by the number of days.
- Average annual temperature was also obtained by summing the maximum temperature and the minimum temperature and dividing by 2.
- Yield (tch) data was obtained from 1981 – 2017 which gave 37 point data points.
- Data was analysed in R-software

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Methods

- Time series plots were used to determine the trend for yield, rainfall and temperature over time.
- Karl Pearson's correlation analysis was then used to determine the presence and significance of relationship between yield and rainfall; and yield and temperature
- Significance was set at 95% CL and so the correlation coefficient was significant if its associated P-value was equal or less than 0.05

3. RESULTS AND DISCUSSION

- The time series plot (Figure 2) illustrates a constant decrease in yield over time.

- These findings are similar to those of Mutonyi, (2013), who attributed this decline to soil degradation and other environmental factors Mulianga et al, (2016); (Mulianga et al, (2013) & Shisanya et al., (2010).

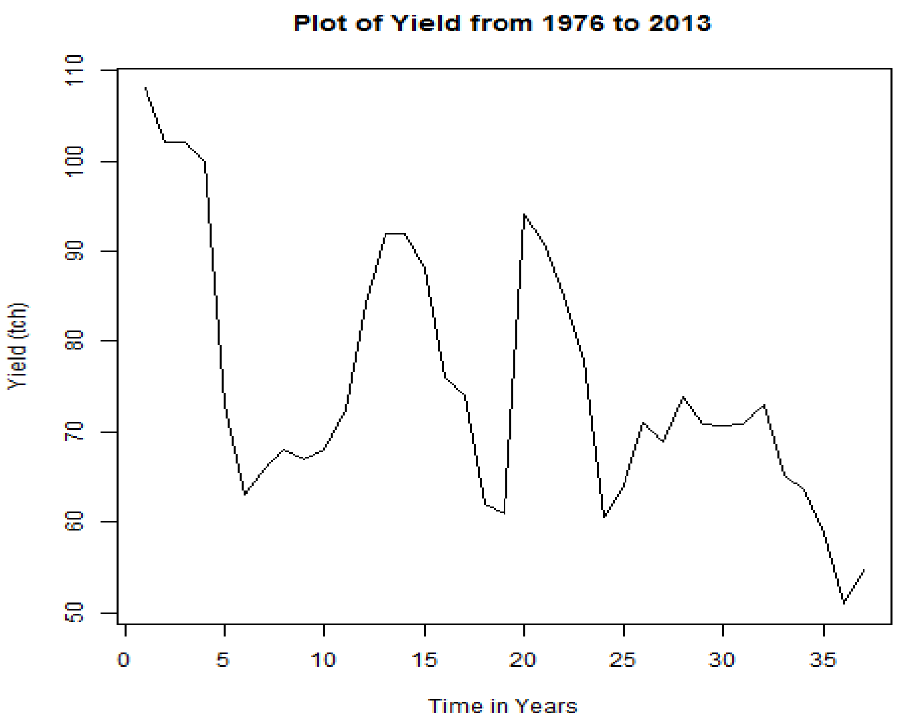

Figure 2: Yield trend from 1981 to 2017

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- there was a significant negative correlation of r= 0.36; P = 0.027 between yield and temperature at 95% confidence level.
- This shows that increase in temperature leads to decrease in yield due to water deficiency in the soil that limits the circulation of micro-organisms into the crop
- However, there was no significant relationship between rainfall and yield at the annual scale, implying seasonal forecasts are ideal to improve crop yield

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- When yield and rainfall data were aggregated at the seasonal level (January – June and July – December), a significant correlation was obtained ($r = 0.7$, $P=0.001$). Also found by Mulianga, et al., (2016).
- In their study, Mulianga et al., (2013) found significant correlation between rainfall and yield when yield and rainfall datasets were aggregated at the zonal scale ($r = 0.80$).
- Mulianga et al., (2013) concluded that the significance of this correlation was due to consideration of the agro environmental conditions in the different agro ecological zones.

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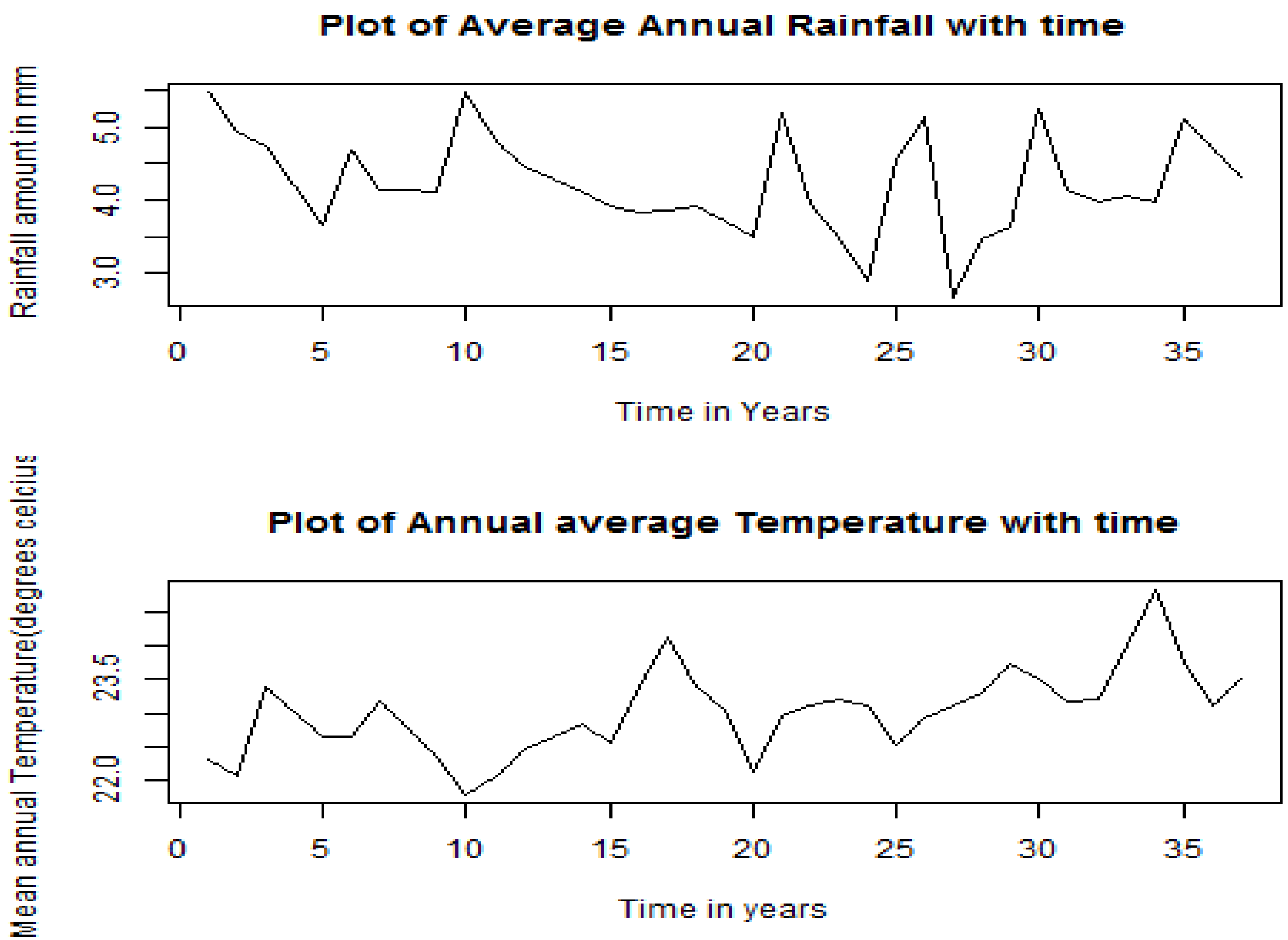
- This argument is supported by a different study which explained that rainfall was significantly correlated with biomass over a one month time lag (Shisanya et al., 2010).

- Table 1 significance of weather on yield.

- Table 1: Correlation coefficients for rainfall and temperature with yield (1981 – 2017)

	Yield (tch)	Average Temperature	Average Rainfall
Yield (tch)	1.000		
Average Temperature Significance	-0.3562** 0.0273	1.000	
Average Rainfall Significance	0.7015 0.0011	-0.2572 0.0981	1.000



- Figure 3: Time series plots of average annual rainfall and annual average temperature from 1981-2017

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- A linear regression model was then fitted to determine the effect of rainfall and temperature on yield over the period.
- It was found out that annual average temperature had a significant effect on yield at 95% CL, P= 0.04, R^2=0.54 with a regression coefficient of -7.768.

- The regression model is given below;

*Yield (tch) = 245.75+1.978*Rainfall – 7.768*Temperature*

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- Holding rainfall constant, the effect of average annual temperature was more significant at 95% CL, $P=0.03$, $R^2=0.13$ and a regression coefficient of -8.350. The equation below is the regression equation model derived from the results;

$$Yield\ (tch) = 267.513 - 8.35 * Temperature$$

- We infer that the long dry months in Kibos (December to March) affect productivity of sugarcane negatively.
- The over reliance on rain fed agriculture by farmers in the 21st century pose a threat on food security.

4. CONCLUSION & RECCOMENDATION

CONCLUSIONS

- The study has shown that there was a significant correlation between rainfall and yield at the seasonal scale.
- Moreover, there was great variability in annual average rainfall and yield.
- We concluded that when rainfall is normalized at the seasonal level, the effect of time lag and its impact on biomass is minimized.

RECOMMENDATIONS

- Irrigation to supplement the water requirement of the crop at the critical stage of its growth to enhance food security.
- Improved sugarcane varieties that require less consumptive use of moisture and have shorter growing period should be made available to farmers to counter the impact of temperature for enhanced productivity.
- The high significance in the yield versus rainfall at the zonal scale presents the need to educate farmers on the appropriate techniques that will ensure moisture availability that is crucial for sustainable sugarcane production.

Dank u wel!!