Climate Change and the Tea Sector in Kenya: Impact Assessment and Policy Action

National Multi-stakeholder Workshop

29-30 April 2013, Naivasha

ANALYSIS OF LINKS BETWEEN CLIMATE VARIABLES AND TEA PRODUCTION IN THE RECENT PAST AND GIS ANALYSIS OF TEA SUITABILITY UNDER FUTURE CLIMATE CHANGE SCENARIOS

Presented by:

Mrs. B.C. Cheserek

Environmentalist, Tea Research Foundation of Kenya

Research carried out under an Agreement between the FAO Trade and Markets Division and the Tea Research Foundation of Kenya

PRESENTATION OUTLINE

1. General Introduction
2. Project rationale
3. Project objectives
4. Methodology
5. Findings
6. conclusion

GENERAL INTRODUCTION:TEA IN KENYA

-Source of livelihood to (Directly and Indirectly) to about 3million Kenyans

-Contributes to the national economy (export earnings Ksh 112 billion in 2012; 4% GDP)

-A rural based enterprise & contributes to rural poverty alleviation (small scale farmers produce more than 65% of the crop)

-Contributes to Environmental conservation / Carbon sink- sequestration

Rationale of assessing CC impact on tea in Kenya

- Tea is grown in Kenya under rain-fed conditions, therefore depends heavily on weather stability
- Over the last few decades weather conditions in major tea growing areas of Kenya have become more unpredictable
- Tea growing areas in Kenya go through a regular 3-months drought between December and March
- Tea yields loss attributed to the drought period is estimated at in more pronounced droughts14-20% and up to 30%. This is prone to change in time-span and intensity due to climate change

Hail damage on tea

Frost damage on tea

- Frost bite, although a rare phenomenon in the past, is becoming a threat with tea yield losses of up to 30% for 3 consecutive months whenever it occurs
- In Kericho, Sotik and Nandi Hills, net loss of tea green leaf due to hail is estimated at 2.7 million kilograms per year (reports from large scale farmers only)

Rationale of assessing CC impact on tea in Kenya

- This study aims to build capacity within the Kenyan tea sector on cc impacts and vulnerability in Kenya
- It will assist GoK in policy making on cc mitigation/ adaptation to ensure vulnerable producers secure their future livelihoods sustainably

Project Objectives

1. To evaluate the relationship of weather variables and tea production in Kenya
2. To analyze and map the impacts of climate change in tea growing regions in Kenya

Methodology

Objective 1: To evaluate the relationship of weather and tea productivity in Kenya

- **Weather data from each of the following areas: Timbilil in Kericho, Sotik and Kangaita (courtesy of TRFK) were used**
- **The data on weather parameters at Kericho: air temperature ^{0}C, radiation (MJm^{-2}d^{-1}), rainfall (mm) and soil water deficits (mm)**
- **Only air temperature ^{0}C and rainfall (mm) data was used for Sotik and Kangaita**
- **The monthly data on tea yields were presented in kg gl. ha^{-1}m^{-1} while annual data was presented in kg gl. ha^{-1}yr^{-1}**
- **Monthly weather data and tea yields were correlated using MSTAT and GENSTAT softwares**

Methodology

Objective 2: To analyze and map the impacts of climate change in tea growing regions in Kenya

- **Most GIS data were obtained by digitizing existing maps**
- **World Geodetic System of 1984 (WGS84) projection was used as the reference for the datasets**
- **Additional location information for the project was obtained through the use of Mobile Mapper6 GPS receiver**
- **Data was captured and stored using ArcGIS 10.1 version.**
- **Each data layer was displayed separately using in ArcGIS ArcMap against the outline of the map of Kenya.**

Methodology Contd.

- **Summary output of 21 Global Circulation Models (GCMs) used by IPCC in their latest report to predict the annual changes in temperature and rainfall in EA region as in Table 1 (Herrero, *et al.*, 2010) was used to model future scenarios based on the current weather maps**

Table 1. ***East Africa predictions for climate change in Africa by the end of the 21st century***

Season	Temperature response (°C)					Precipitation response (%)				
	Min	25	50	75	Max	Min	25	50	75	Max
DJF	2.0	2.6	3.1	3.4	4.2	–3	6	13	16	33
MAM	1.7	2.7	3.2	3.5	4.5	–9	2	6	9	20
JJA	1.6	2.7	3.4	3.6	4.7	–18	–2	4	7	16
SON	1.9	2.6	3.1	3.6	4.3	–10	3	7	13	38
Annual	1.8	2.5	3.2	3.4	4.3	–3	2	7	11	25

Methodology Contd.

GIS data sets generated and used for the study:

- **Current Tea Growing Areas**
- **District Boundaries**
- **Annual Mean Temperature map of Kenya**
- **Annual Rainfall map of Kenya**
- **Rainfall and Temperature change projections from 2000 to 2075 (Herrero et al., 2010).**

Methodology Contd.

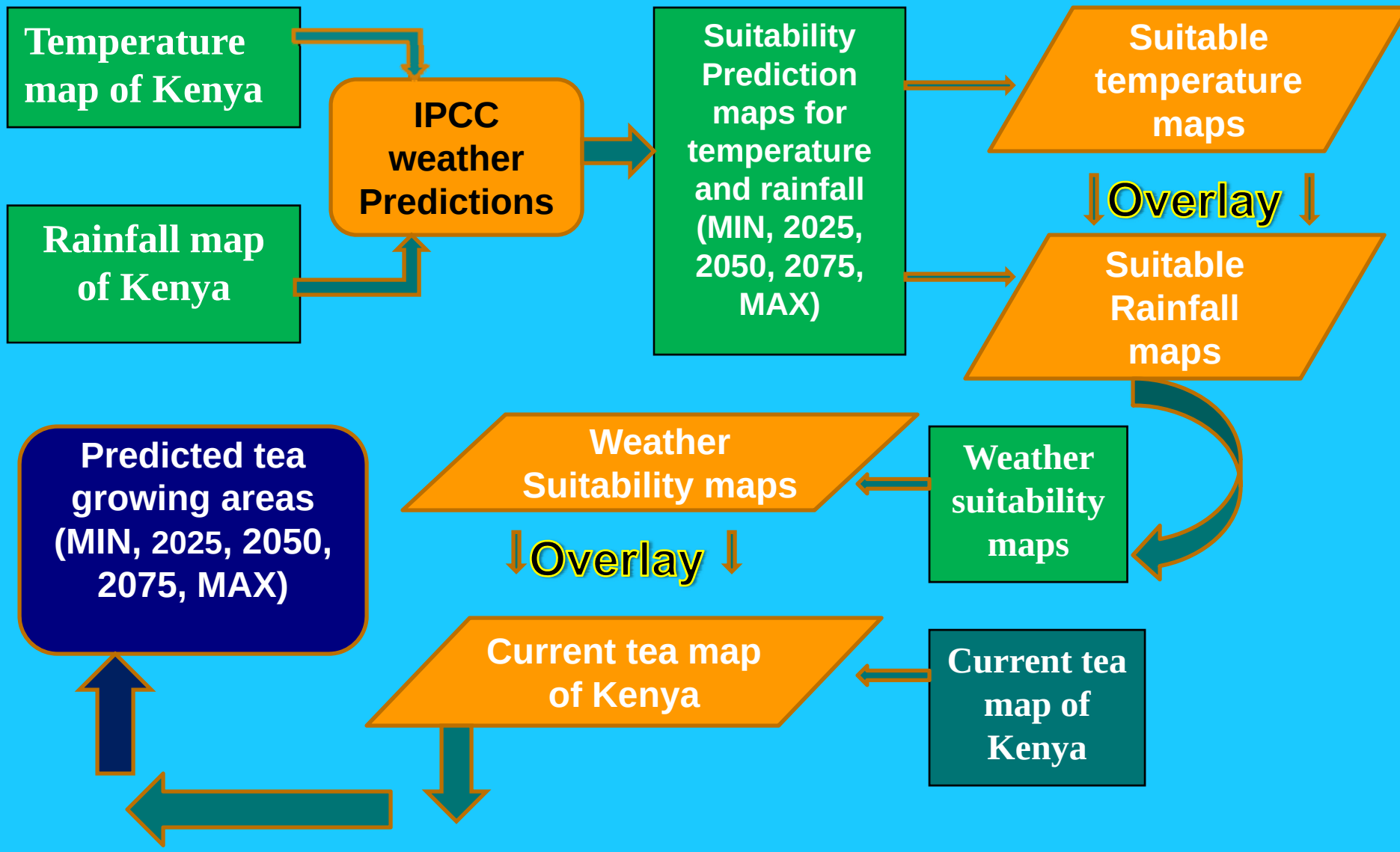
- **Raster Conversion Tool** in ArcGIS was used to convert the Temperature and Rainfall data to Raster files

- The raster files were then linked with the attribute table and classified in to **suitable and non-suitable temperature and rainfall zones**

- For rainfall, areas having annual precipitation of **less than 1100 mm are considered unsuitable**

- For temperature, conditions having **mean air temperatures lower than 13^0C** as well as those **above 23.5^0C** are considered unsuitable

Methodology Contd.



RESULTS: Kericho Temperature trend

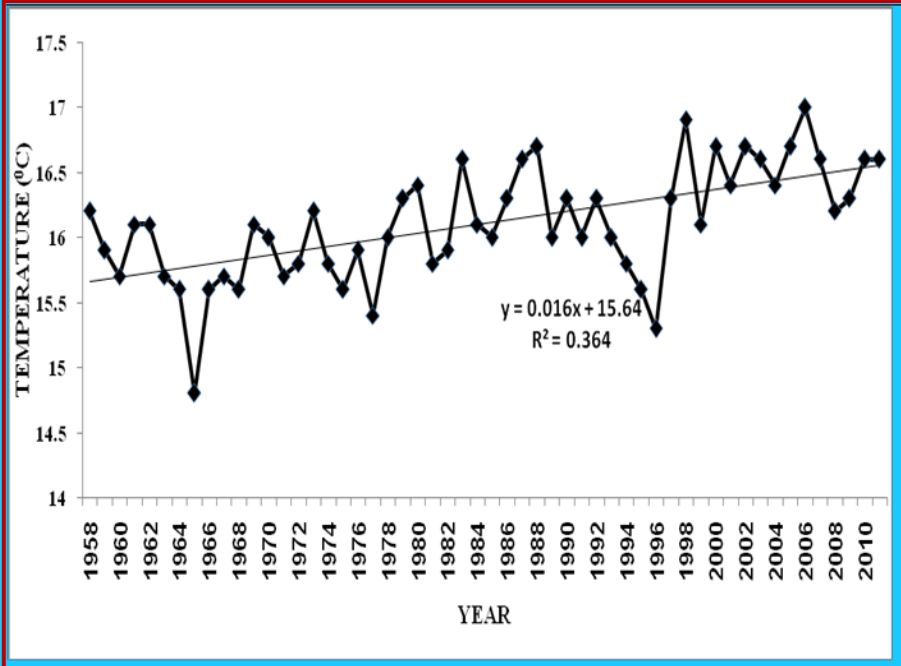


FIGURE 1(a): *Mean air temperature*

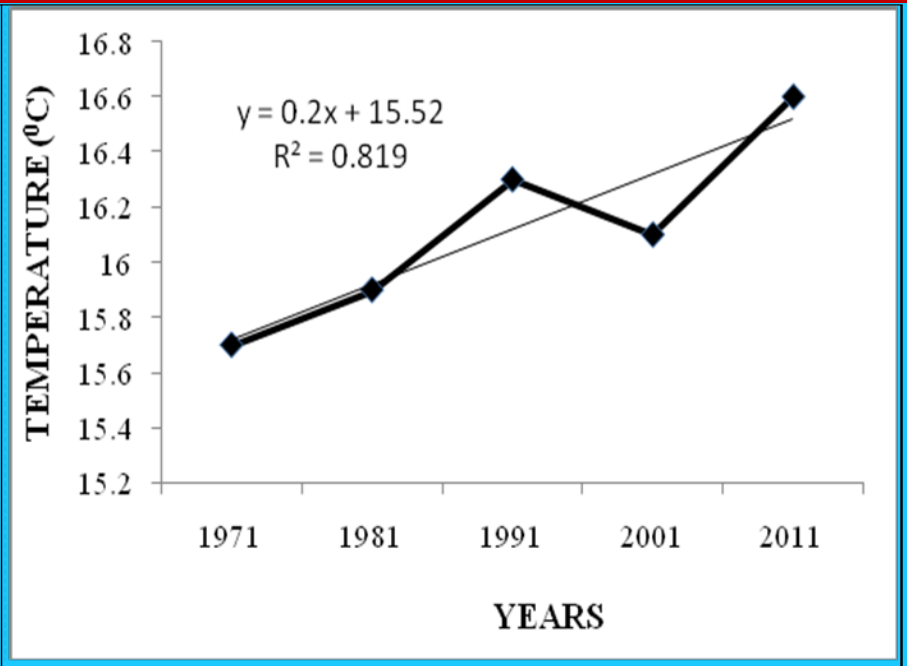


Figure 1(b): Mean air temperature in decades

- There is an increasing temperature trend of about 0.02^0Cy^{-1} ($r=0.5899$) from 1958 to 2011 (Figure 1(a))
- The air temperatures for every ten year showed a strong positive correlation with time ($r^2=0.819$) (Figure 1(b))

Kericho: Radiation trend

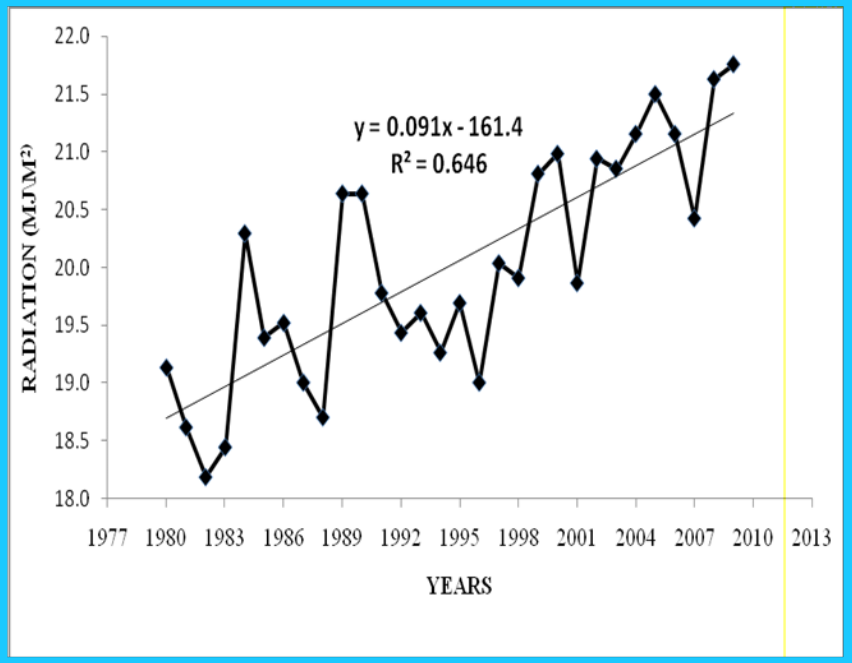


FIGURE 2(a): *Mean Annual radiation*

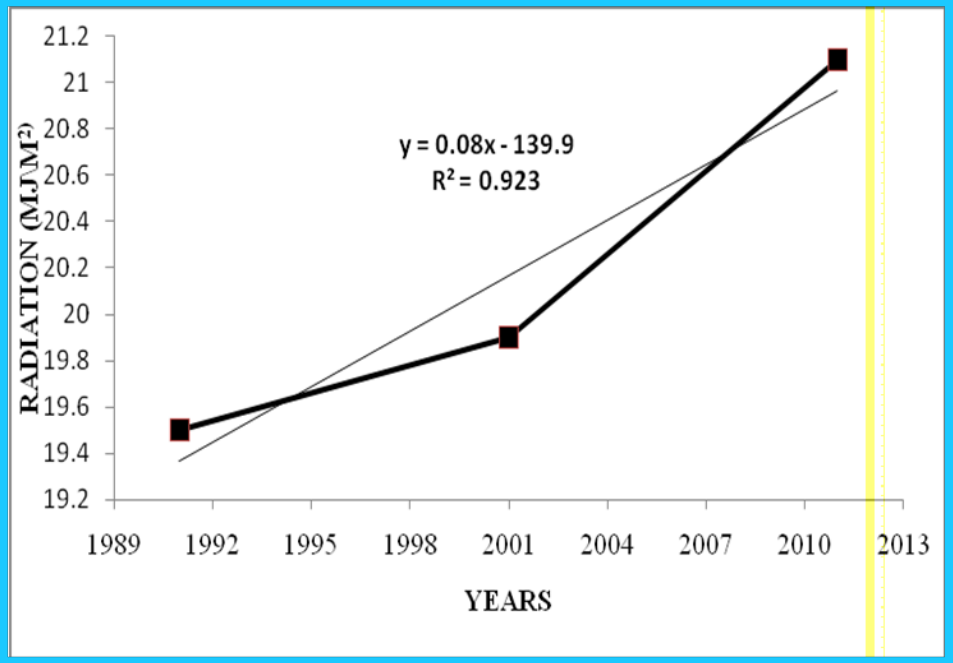


FIGURE 2(b): *Annual radiation in Decades*

- There is an increasing radiation trend of about 0.1MJm2^{-2}y^{-1} (r^2=0.0.646) from 1958 to 2011 (Figure 2(a))
- Radiation for every ten year has a strong positive correlation with time (r^2=0.923) (Figure 2(b))

Kericho: Rainfall trend

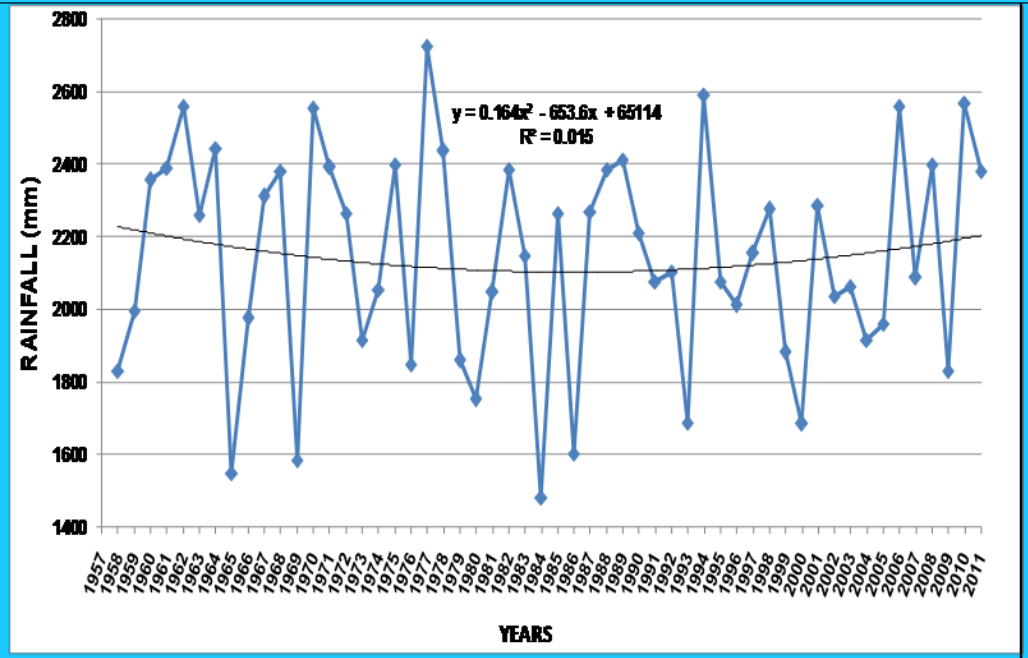


FIGURE 3(a): Annual rainfall

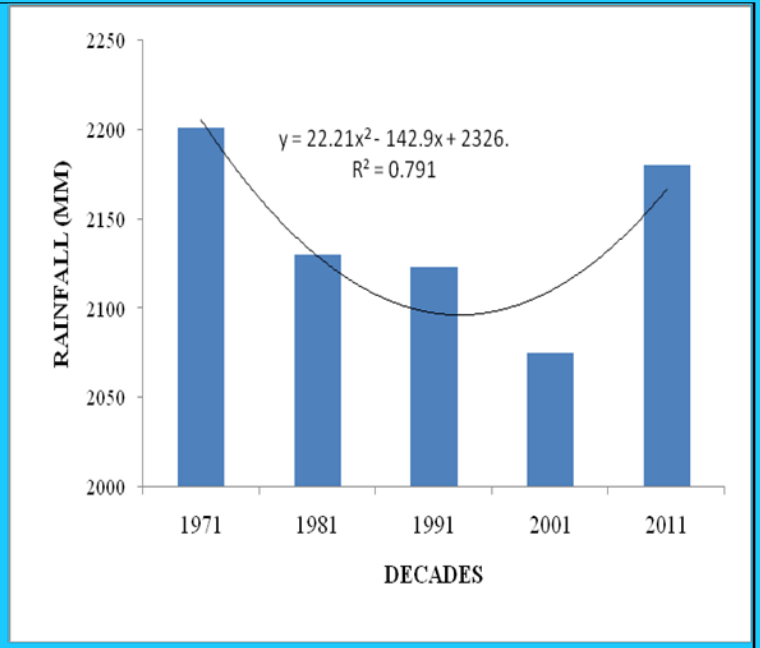
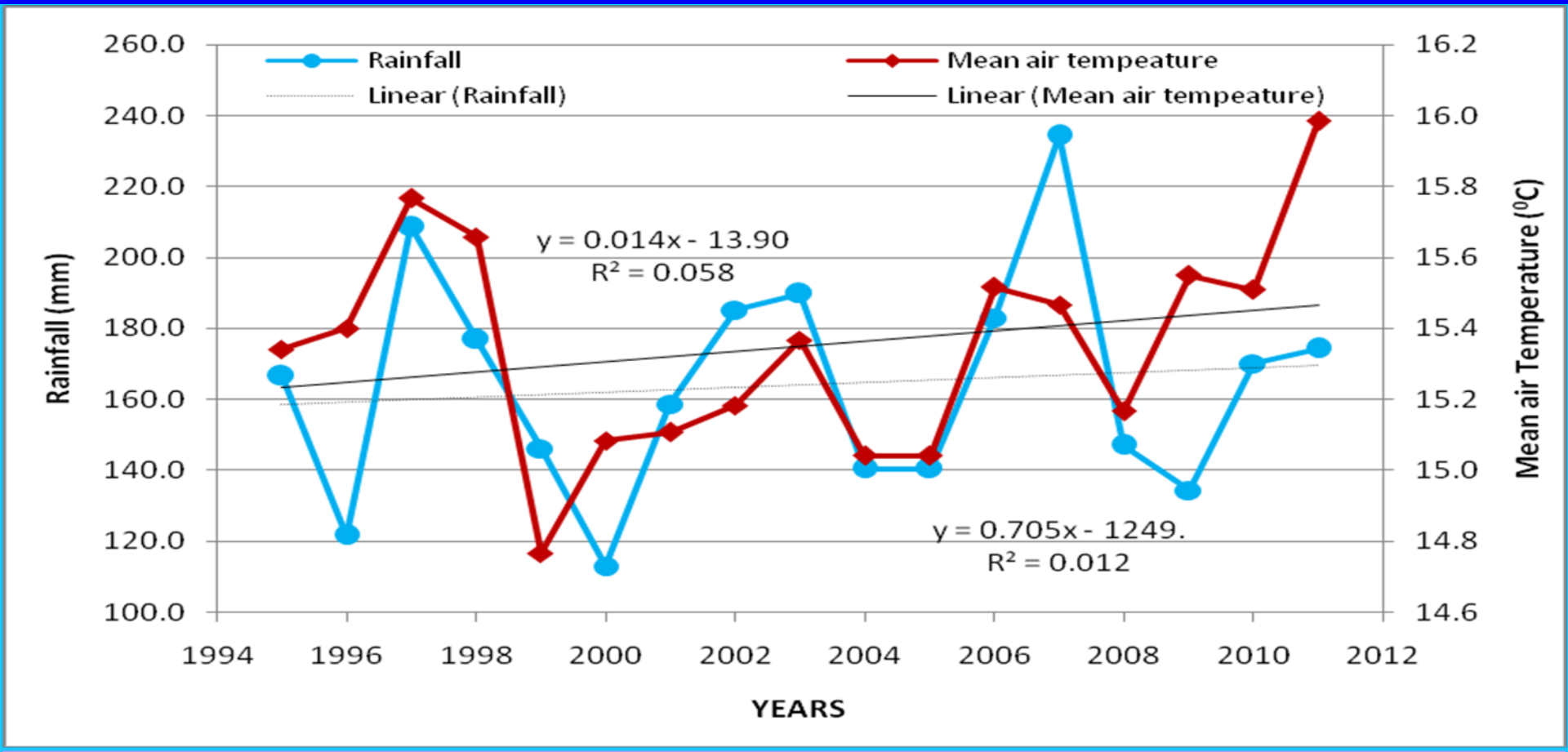


FIGURE 3(b): Mean Annual rainfall in Decades

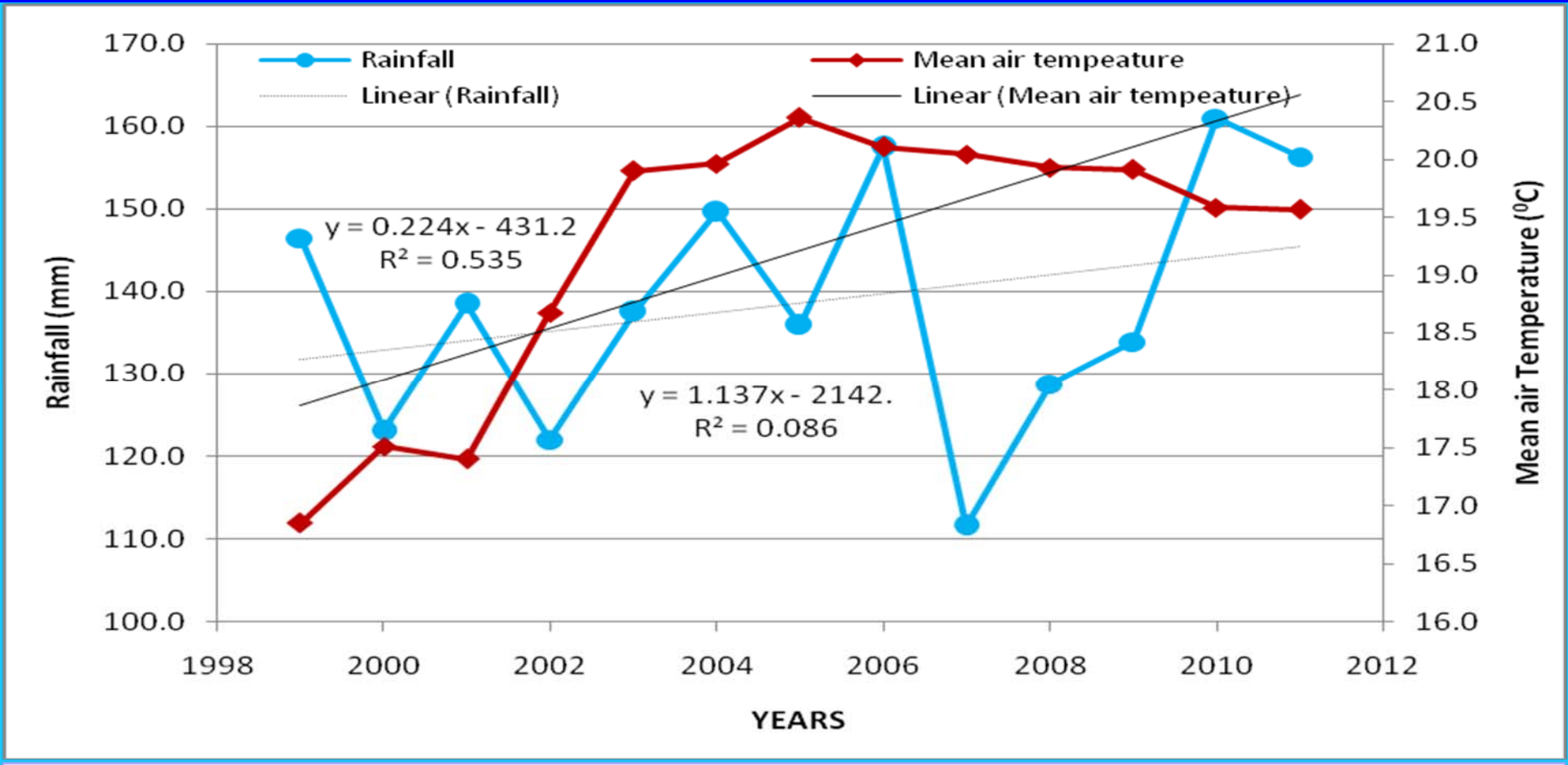
- Rainfall trend is rather different from temperature and radiation, depicting a quadratic relationship with time (Figure 3(a))
- Decadal rainfall trends shows a significant relationship with time (r^2=0.791) (Figure 3(b))

Kangaita: Temperature and Rainfall trends



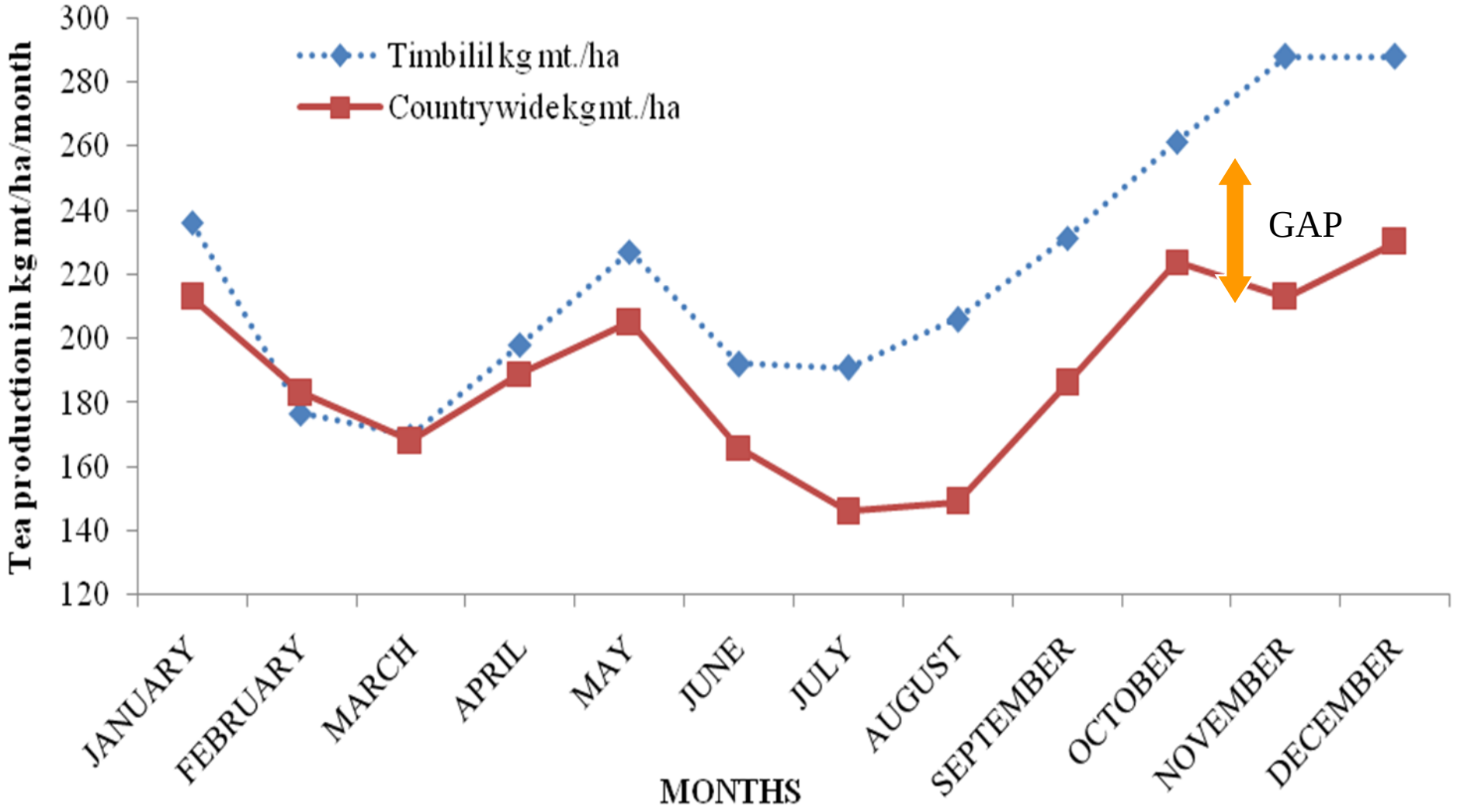
- Both temperature and rainfall indicates increasing trends with a temperature rise of about $0.01^{0}Cy^{-1}$ (r^2=0.058) from 1995 to 2011
- Although annual variation of rainfall does not relate with time (yrs), it shows an increase with about $1mmy^{-1}$ (r^2=0.012)

Sotik: Temperature and Rainfall trends



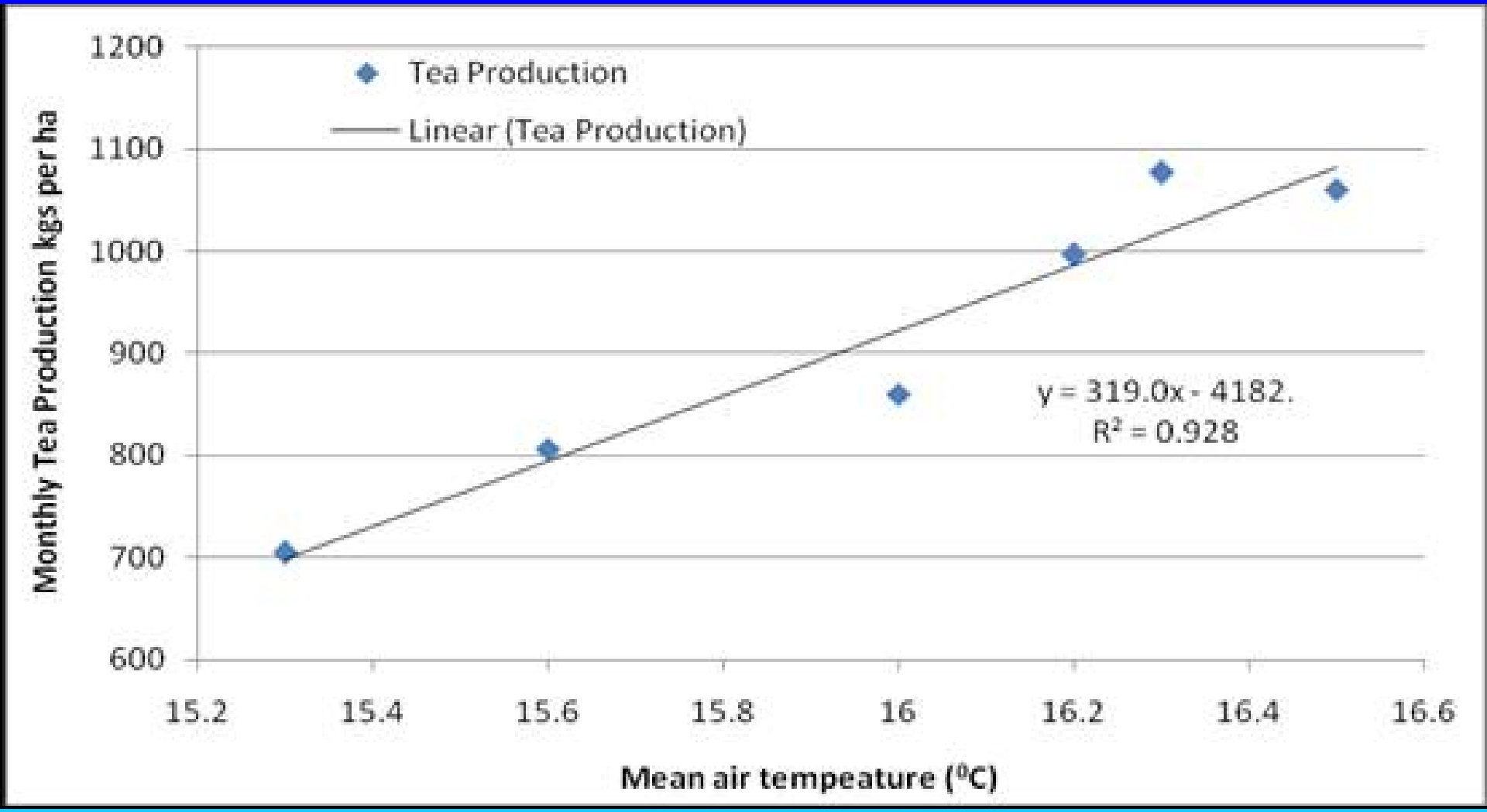
- An increasing temperature trend of about 0.22^0Cy^{-1} (r^2=0.535) from 1999 to 2011
- Although not significant rainfall appears to have been increasing with about $1.1mmy^{-1}$ (r^2=0.086)

Productivity- average in Kenya and TRFK



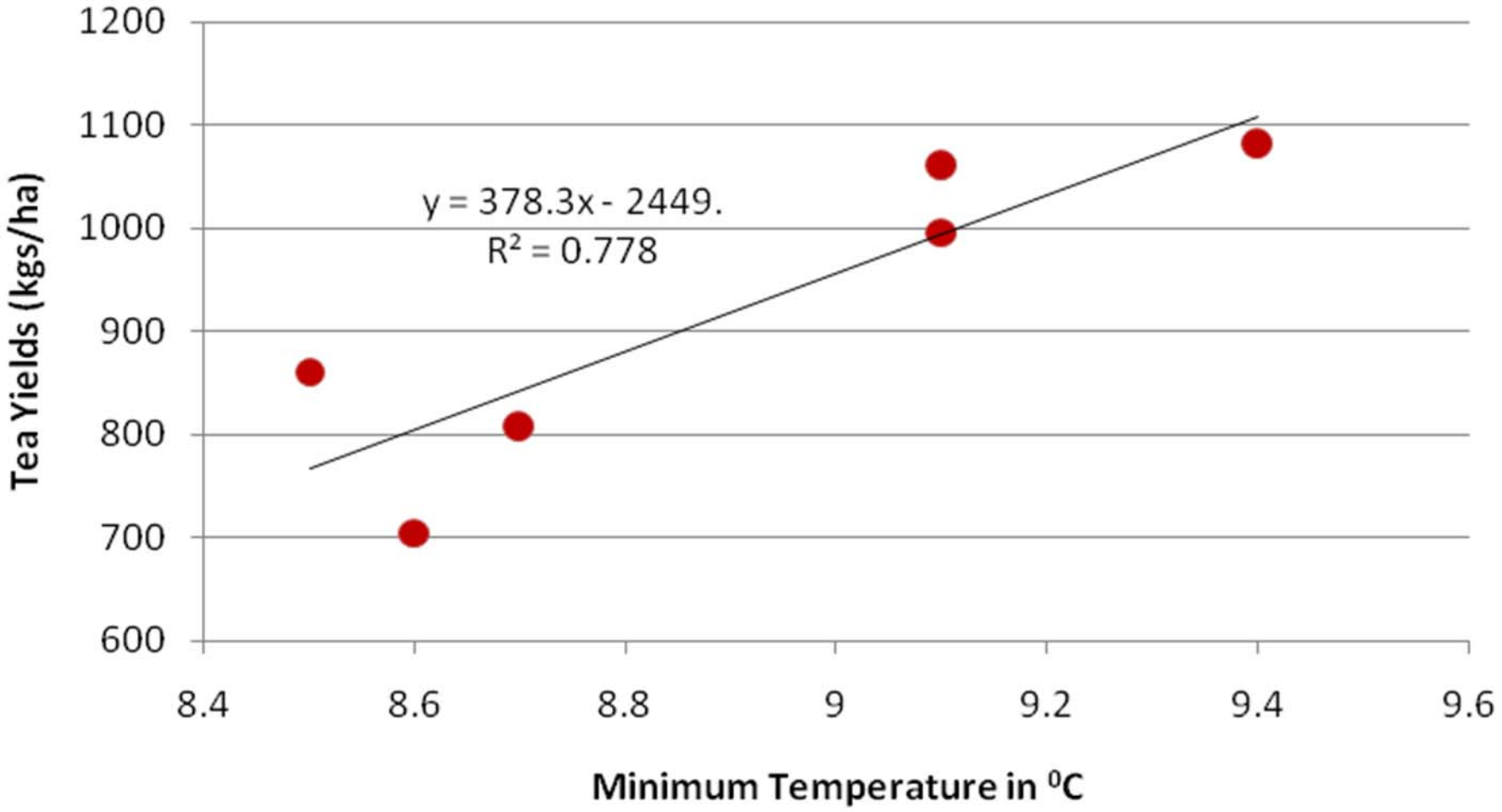
TRFK data can be used to extrapolate what happens at the national level

Regression analysis



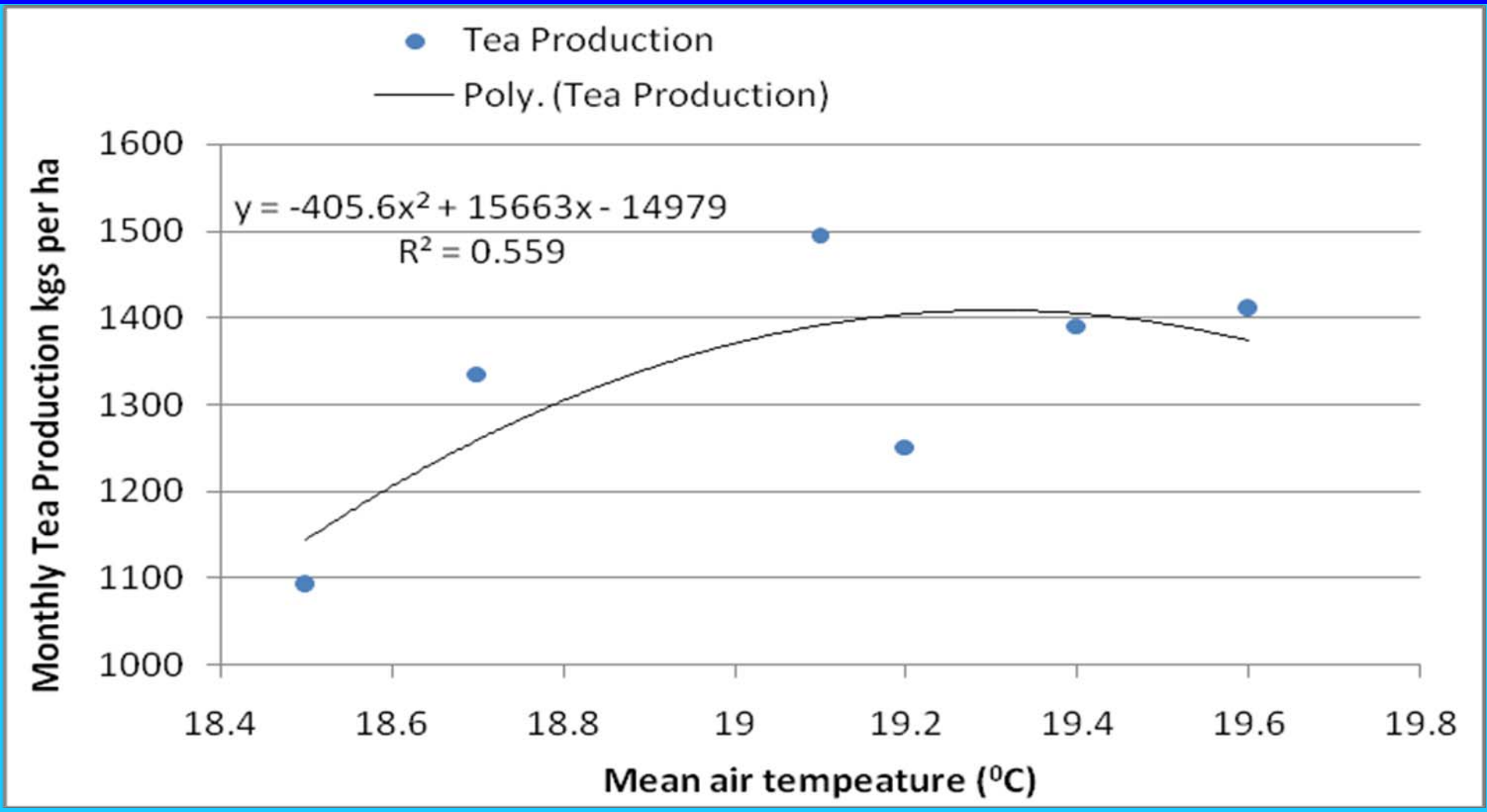
Relationship of tea production and mean temperature (319 kg ha^{-1}m-^{10}C^{-1}) when soil moisture is not limiting at Timbilil Tea Estate, Kericho (July to December).

Regression analysis



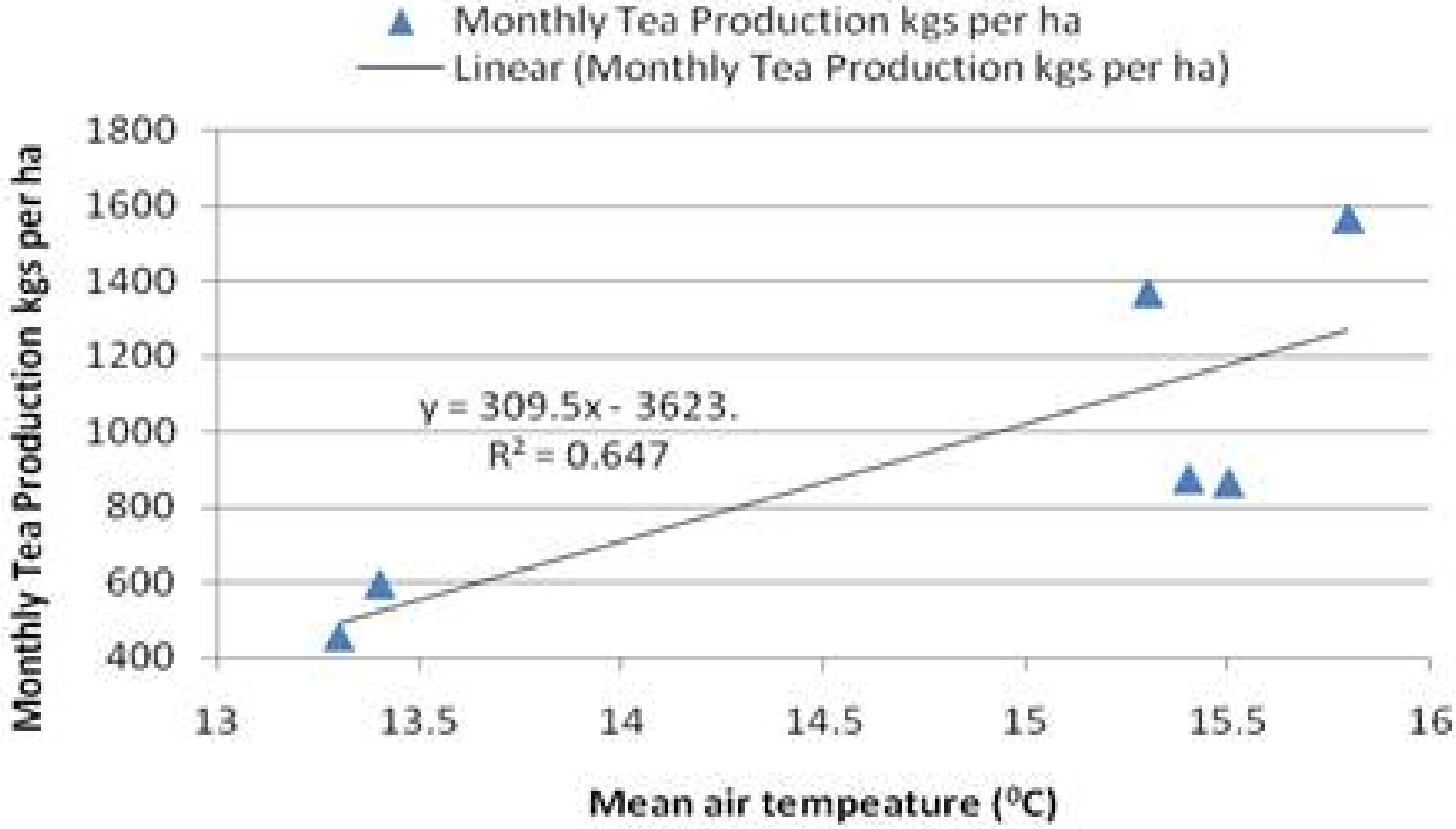
Relationship of tea production and min. temperature (378 kg ha^{-1}m-^{10}C^{-1}) when soil moisture is not limiting at Timbilil Tea Estate, Kericho (July to December).

Regression analysis



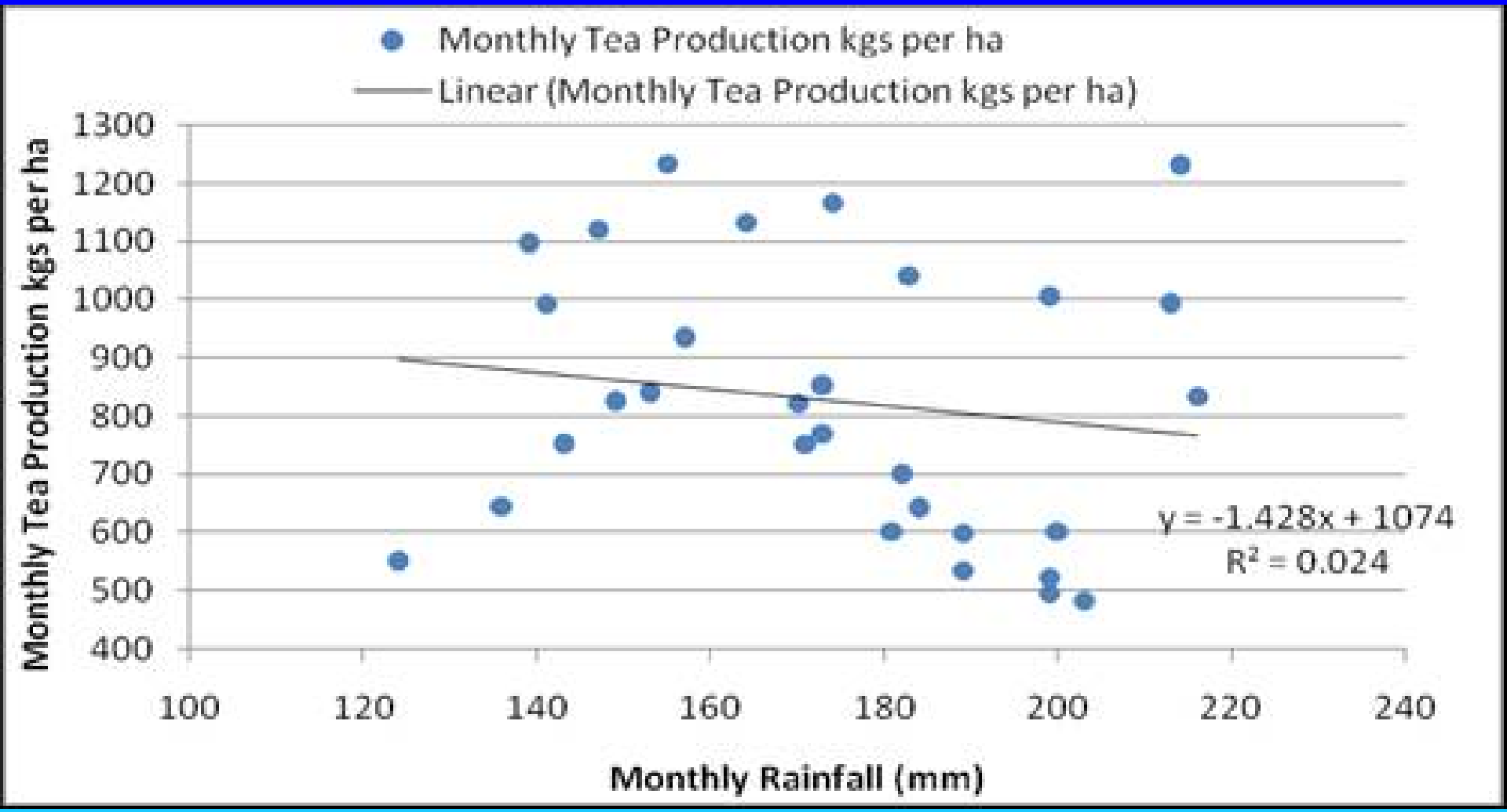
Relationship of tea production and mean temperature (220 kg ha^{-1}m^{-10}C^{-1}) when soil moisture is not limiting at Magura Tea Estate , Sotik (July to December).

Regression analysis



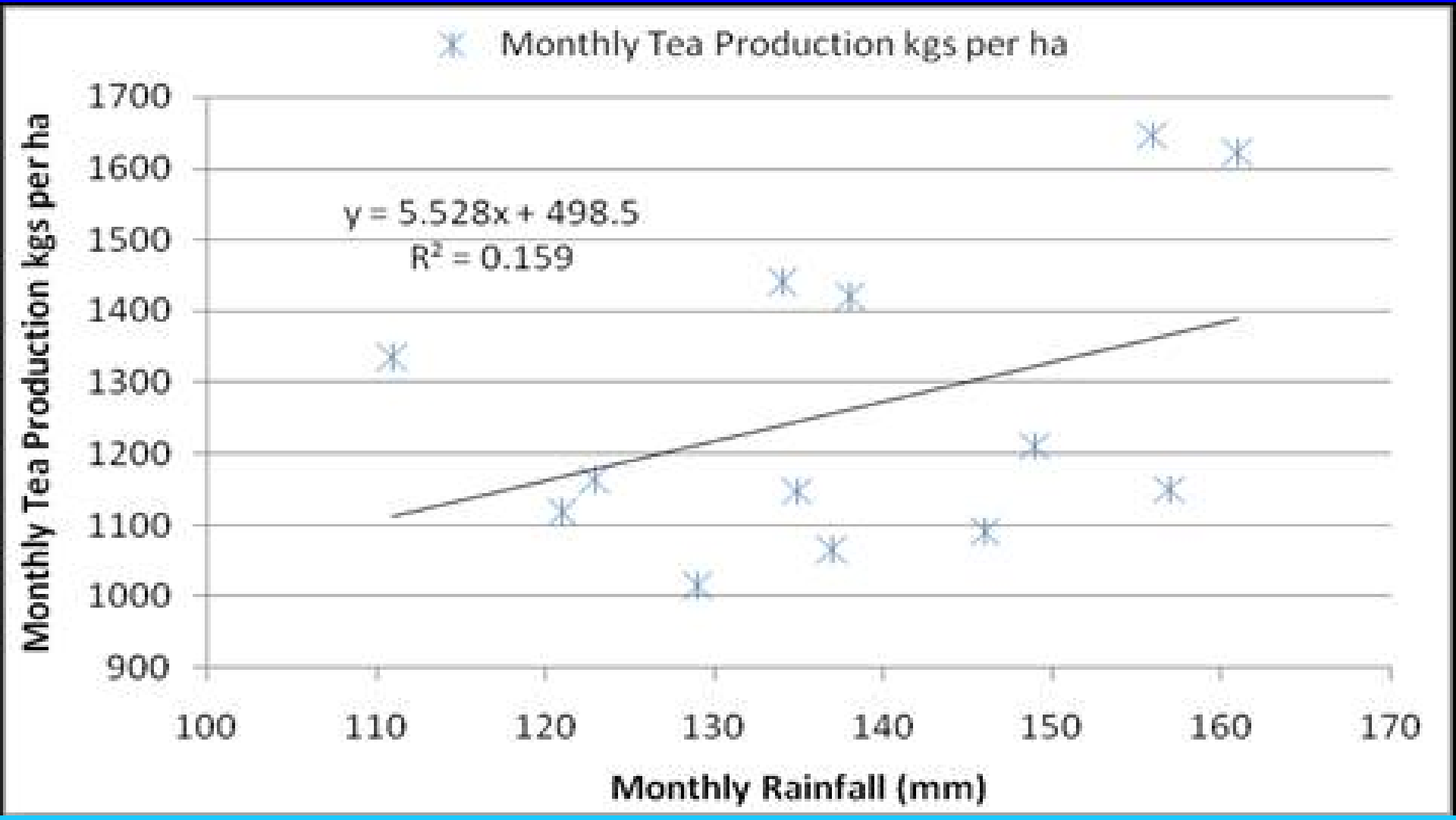
Relationship of tea production and mean temperature (310 kg $ha^{-1}m\text{-}^{10}C^{-1}$) when soil moisture is not limiting at Kangaita Tea Estate , Kirinyaga (July to December)

Regression analysis



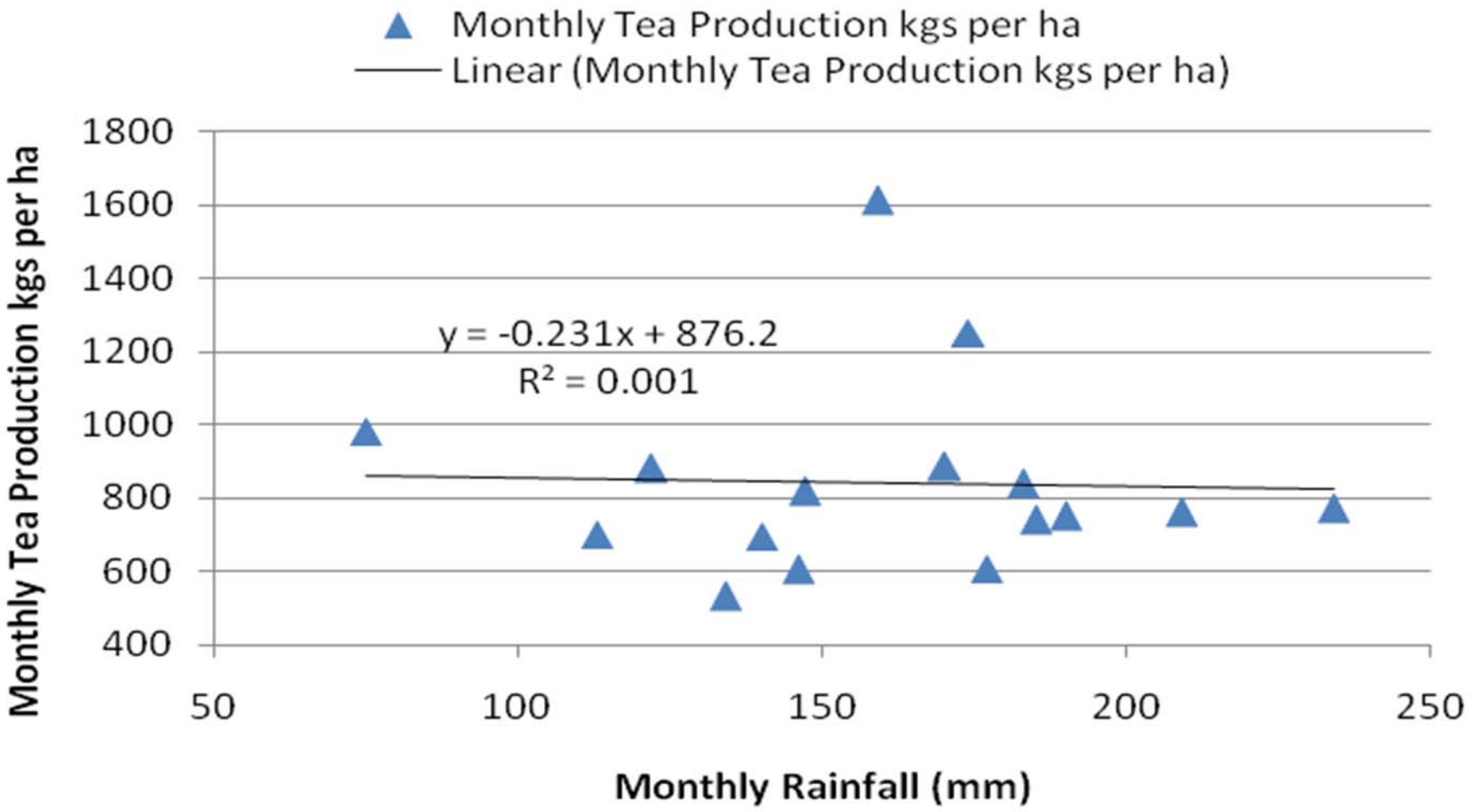
❖**Relationship of tea production and rainfall at Timbilil Tea Estate, Kericho (30 years)**

Regression analysis



❖Relationship of tea production and rainfall at Magura Tea Estate, Sotik (13 years)

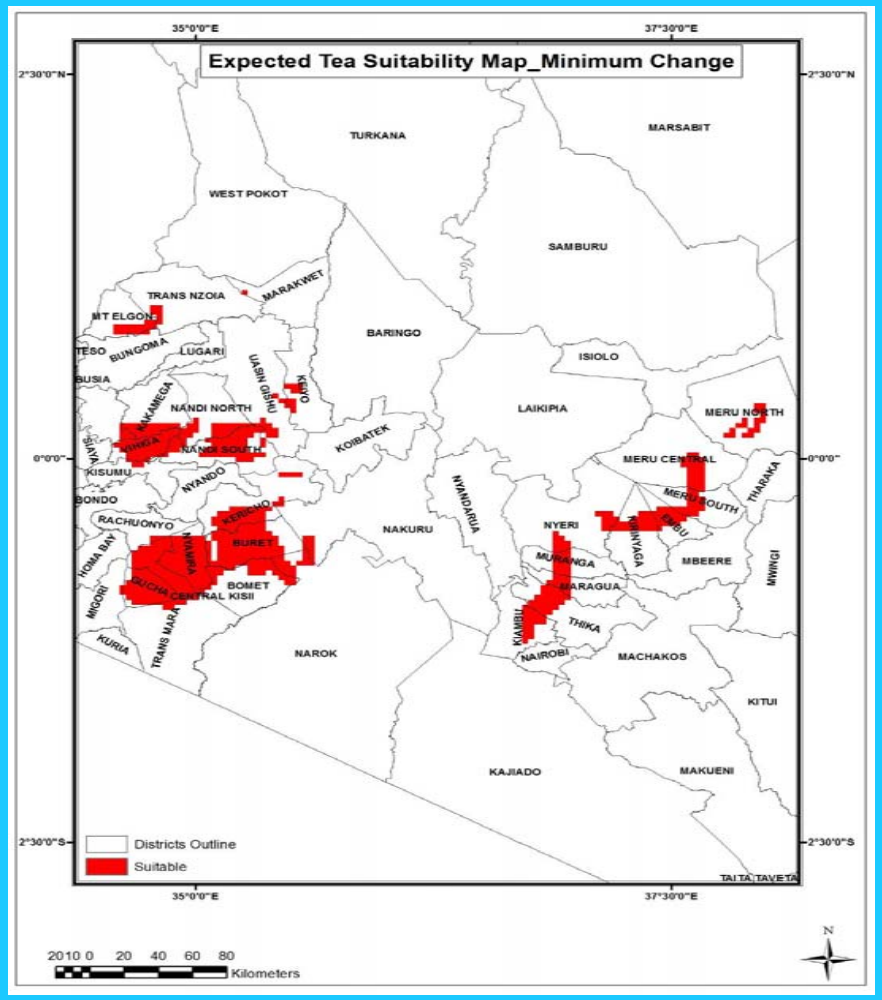
Regression analysis

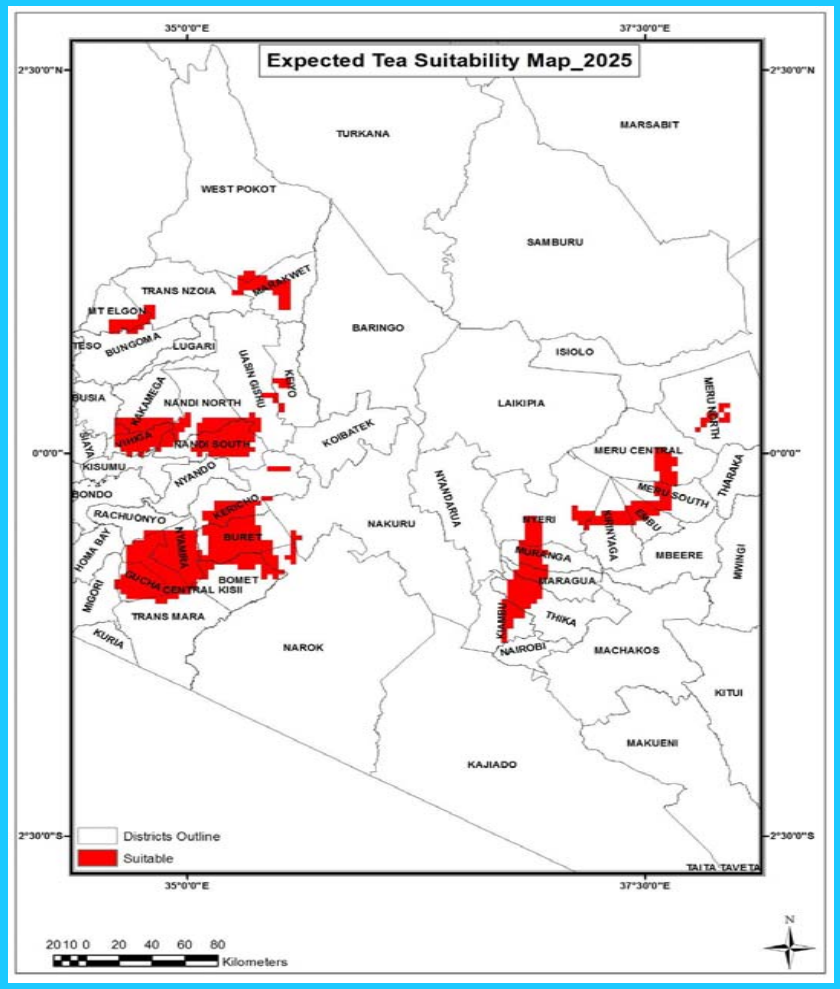


❖Relationship of tea production and rainfall at Kangaita Tea Estate, Kirinyaga (16 years)

FINDINGS: Objective 2

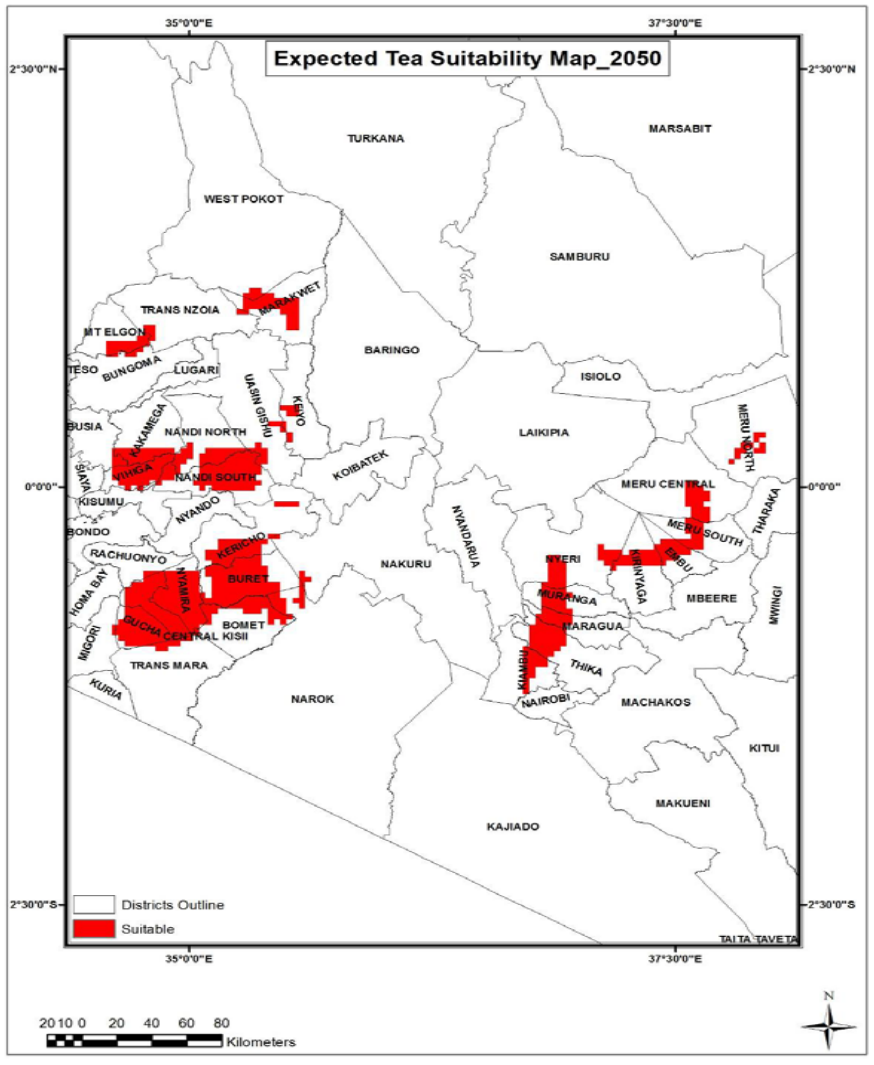
***Objective 2:* To analyze and map the impacts of climate change in tea growing regions in Kenya**

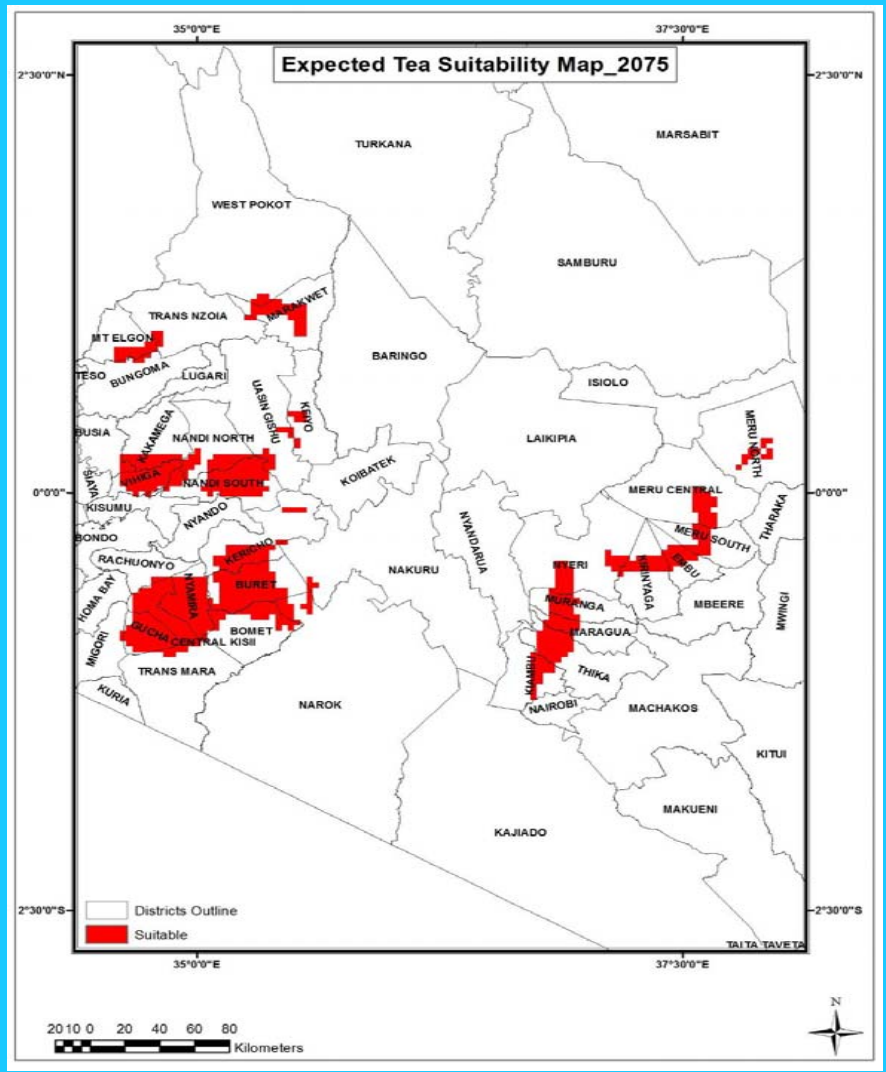




Expected tea growing areas suitability maps (minimum and 2025)

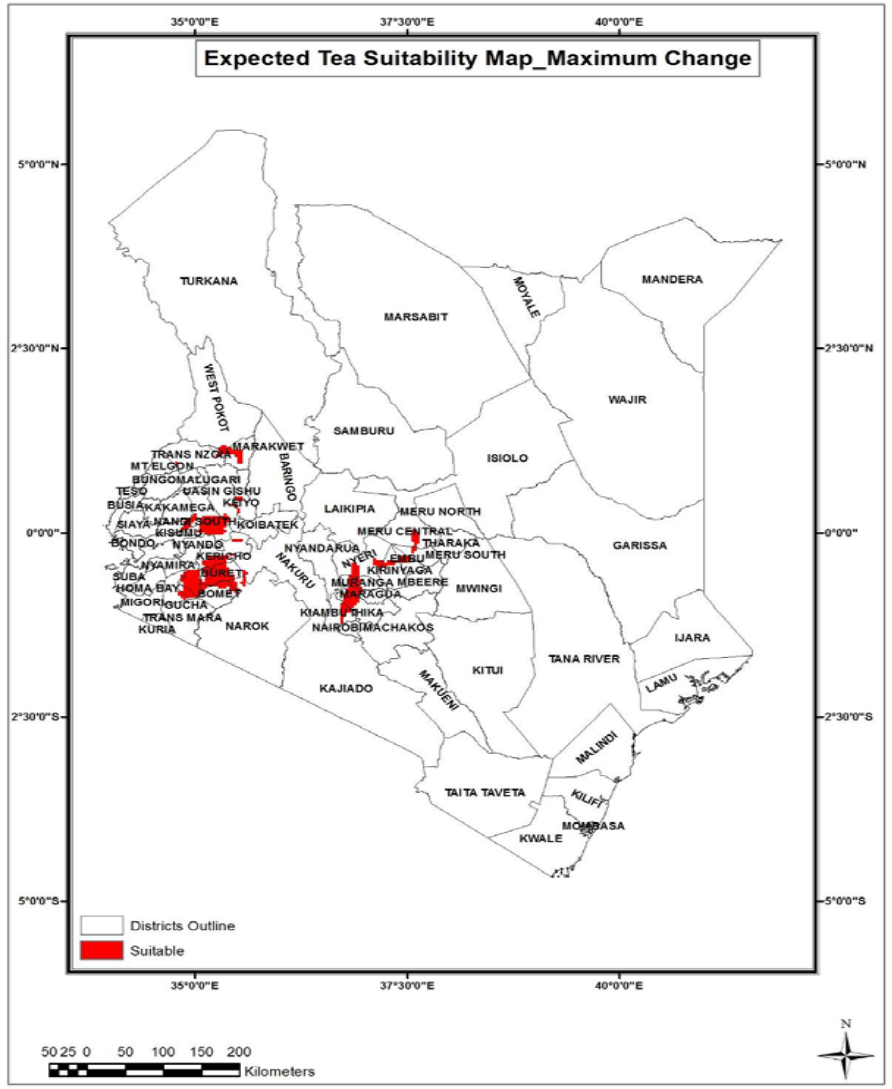
FINDINGS: Objective 2

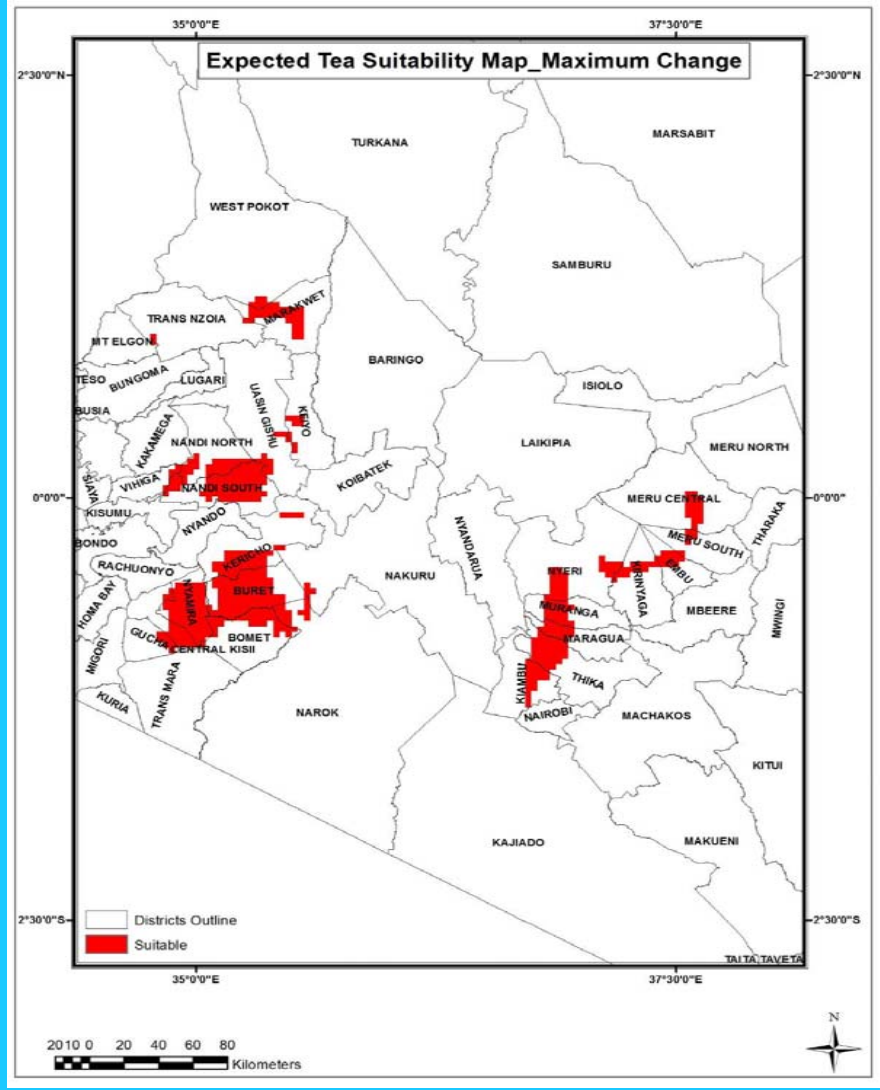




Expected tea growing areas suitability maps (2050 and 2075)

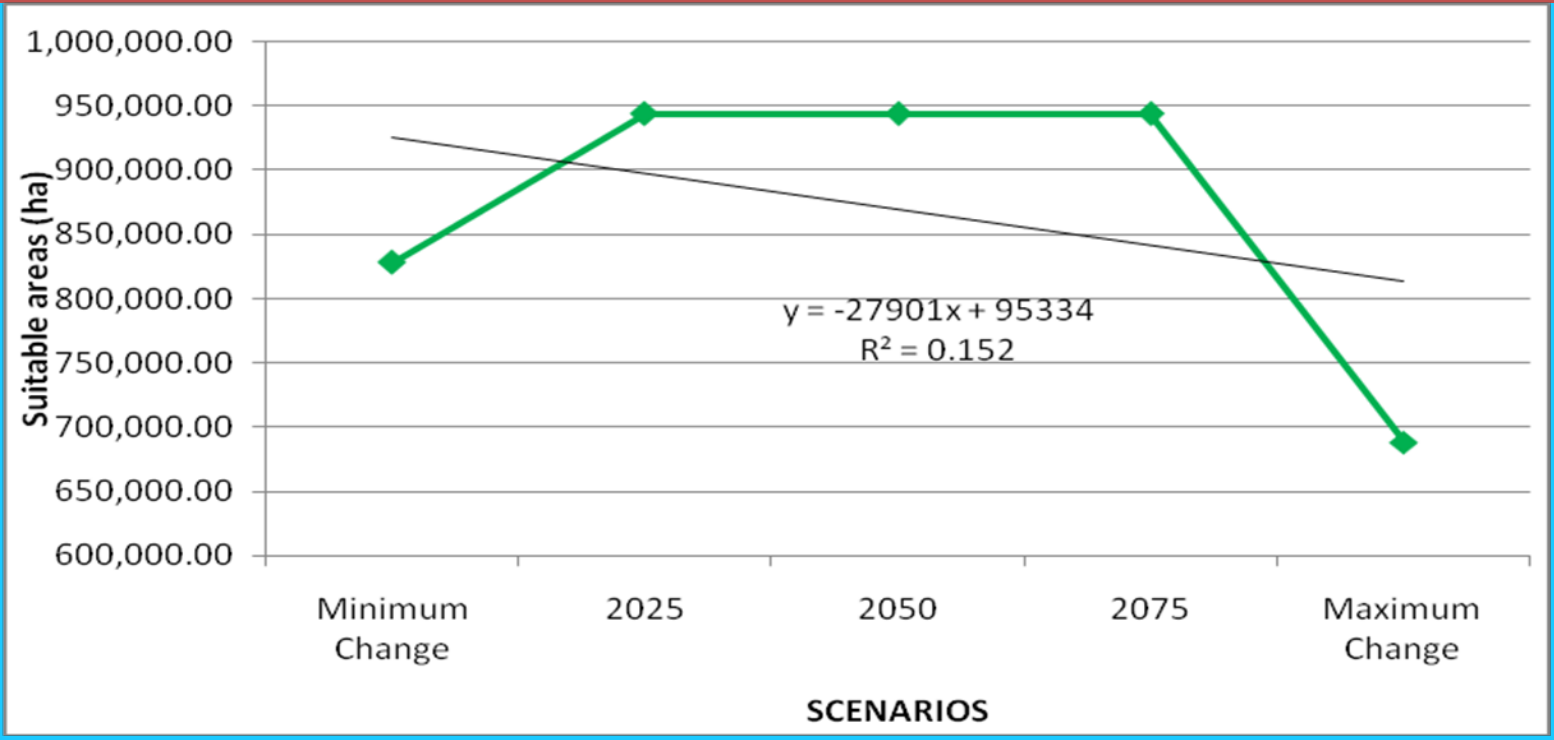
FINDINGS: Objective 2





Expected tea growing areas suitability maps (maximum)

A summary of GIS analysis findings				
Scenarios	**Change expected**		**Suitable areas in Hectares (Ha)**	**% area change**
	Temperature(^{0}C)	Rainfall (mm)		
Minimum Change	1.8	-3	828,065.80	(5.50)
Current suitable areas	0	0	876,710.80	100.00
2025	2.5	2	943,860.80	7.60
2050	3.2	7	943,860.80	7.60
2075	3.4	11	943,860.80	7.60
Maximum Change	4.3	25	688,563.30	(21.50)



CONCLUSION

- It is concluded temperature especially when coupled with radiation is a key weather parameter that affects tea production when soil moisture is not limiting
- The correlations also show that rainfall may not be an important factor in promoting better yields as long as soil moisture and mean air temperature are not limiting.
- In Kenya the rainfall and mean air temperature is predicted to increase progressively over the years in the 21st Century
- From the study, the distribution of suitability within the current tea-growing areas in Kenya for tea production in general will decrease drastically after 2075