THE 7TH AFRICAN TEA CONVENTION & EXHIBITION

Theme: Beyond the Leaf

Session 3: Climate Resilience

CLIMATE CHANGE AND ITS IMPACT ON TEA PRODUCTION REGIONS

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Scope of the Presentation

- ✓ Climate Change Trends
- ✓ Tea Production Regions
- ✓ Impacts on Tea Production
- ✓ Causes of Climate Change
- ✓ Possible Adaptation and Mitigation Measures
- ✓ Research and Innovation
- ✓ Future of the Tea Industry



Tea and Climate Change

- **Climate Change**: is the statistically detectable change in mean state of climate normally extending over three decades or longer

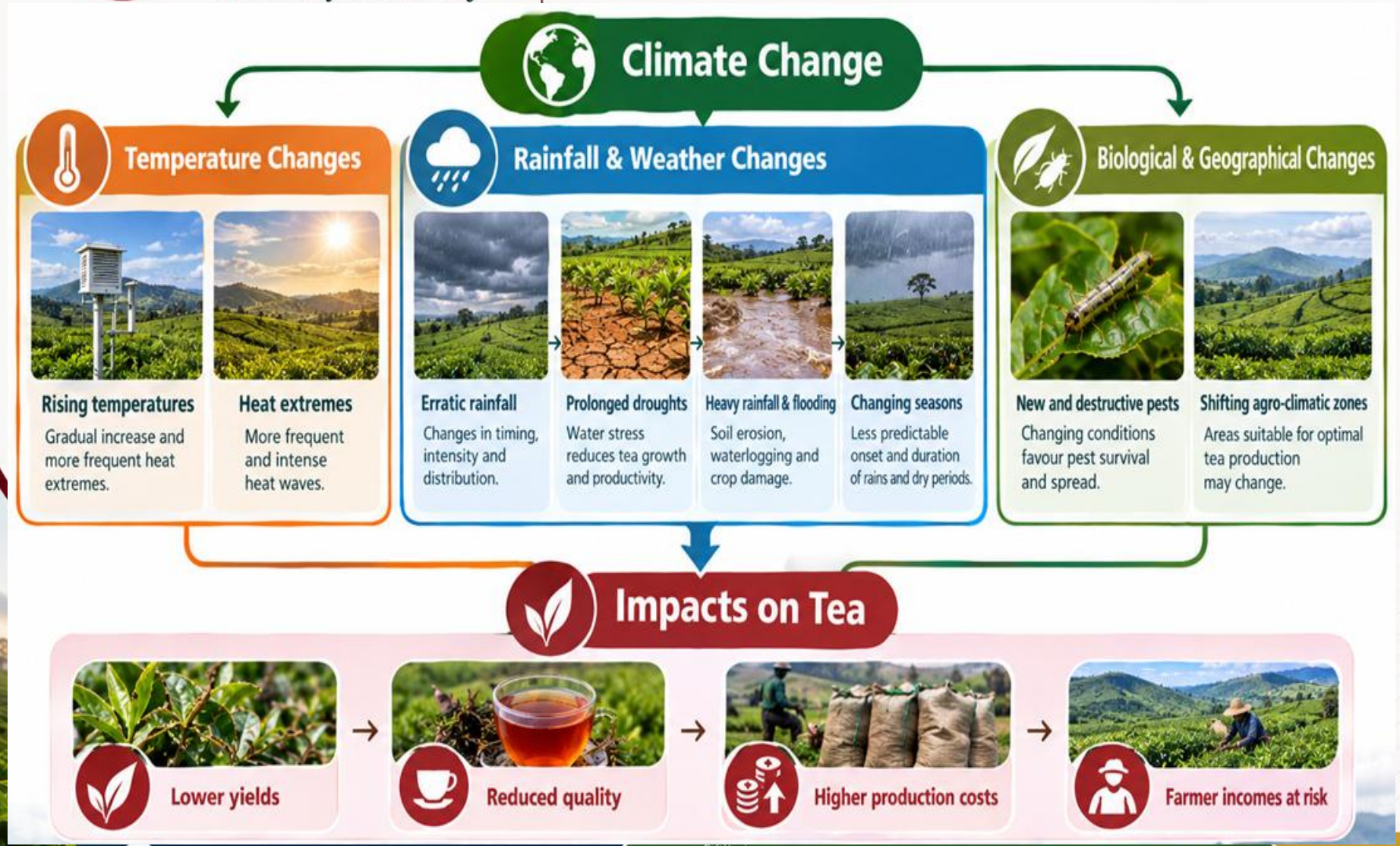
- Tea plants are highly sensitive to climate variability, needing very specific climate conditions for high production and quality, thus, are grown in exceptional agro-climatic zones

- The tea cultivation in Kenya is largely mono-cultural, making it extremely vulnerable to the impacts of climate change



Figure 1:Comparison of (A) a healthy tea crop and (B) a tea crop showing climate change-related stress and (C) adverse effects of hail damage.

Climate Change Trends



- The IPCC reports indicate that the world will experience ***more heatwaves, longer warm seasons, heavy and erratic rainfalls, prolonged droughts, increased incidences and severity of hail and frosts***

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Causes Of Climate Change

1 NURSERY & FERTILISER USE (73%)



- Nitrogen fertiliser application
- N_2O & NO emissions
- Increase with N application rates
- $N_2O \approx 300\times CO_2$ warming potential
- Ozone-depleting effect

2 FARMING PRACTICES



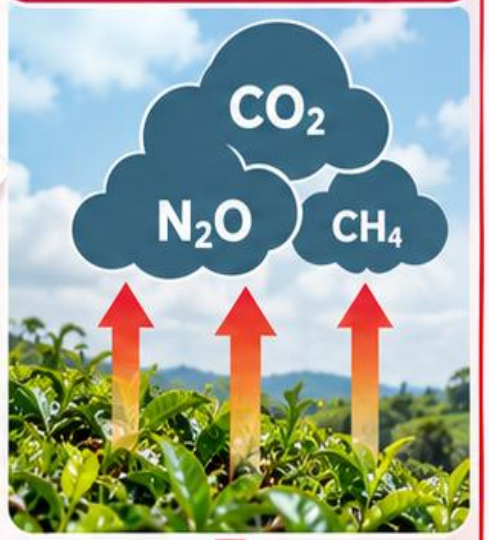
- Pesticides & chemicals
- Weed management
- Fertiliser application
- Pruning & plucking
- Farm to factory transport
- Irrigation (water & electricity)

3 FACTORY (Different made tea types)



- Energy (firewood & electricity)
- Waste (solid & water)
- Exhaust fuels (boilers, transport, lubricants)
- Thermal energy use (11%)
- Electricity use (consumers' kettles)
- Low biodiversity

GHG EMISSIONS (from all stages)



CLIMATE CHANGE

KEY DRIVERS

Fertiliser use (73%) + Farming practices + Factory operations

CLIMATE CHANGE AND TEA

- **TRI** collects daily weather data, analyses for change detection, monitoring, prediction and early warning and shares this information with tea industry stakeholders and global community via publications, seminars, workshops and conferences.
- Indicators of climate change include changes in: temperatures, rainfall patterns, glacial extents and extreme weather events e.g. hail, frost and drought.
- Tea farmers are vulnerable to CC mainly due to inadequate rainfall (unpredictable) and prolonged drought periods coupled with heat stress to the tea bushes.

Climate Change Surveillance at TRI



Ground Agro-meteorological station



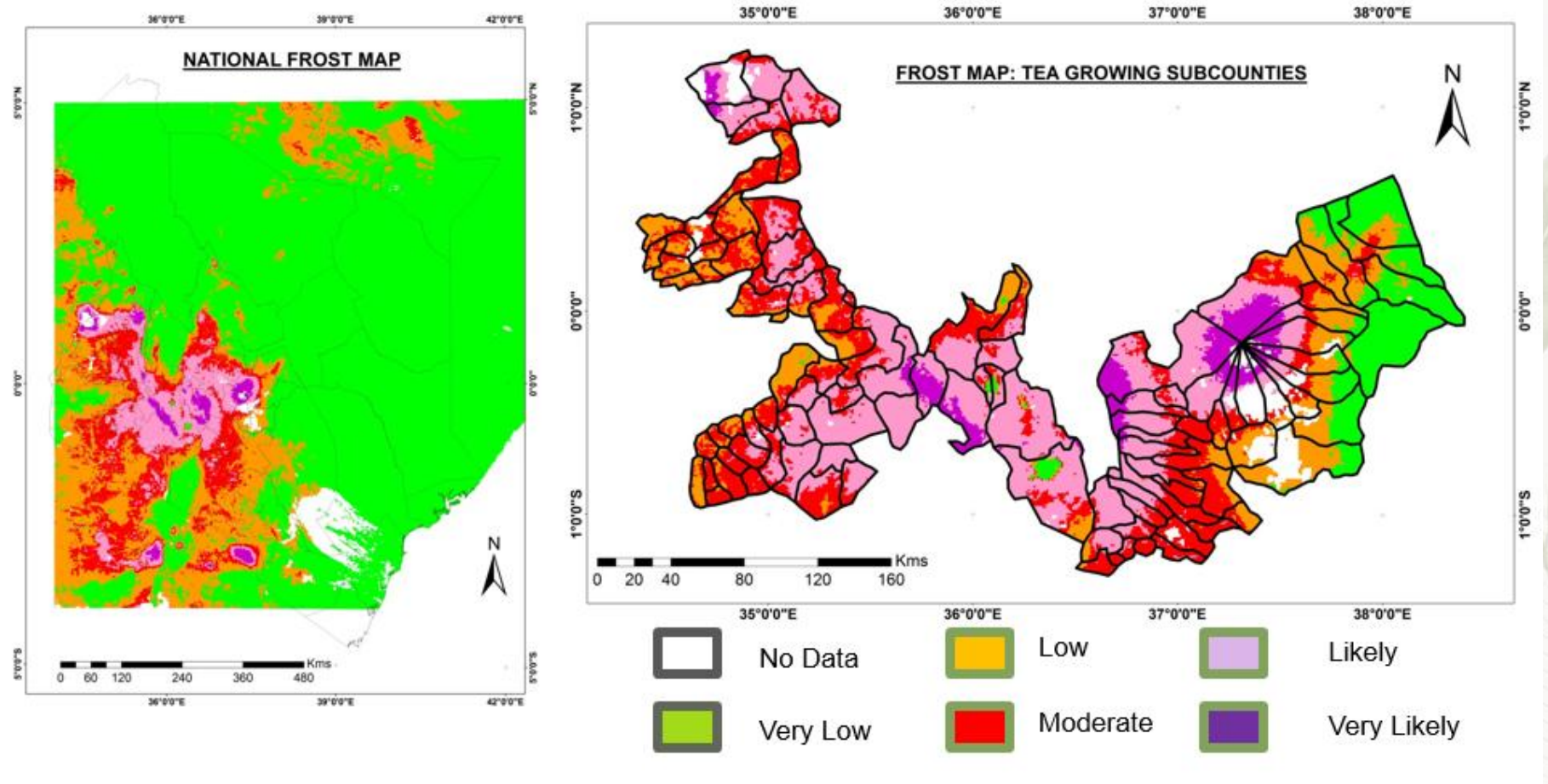
Automatic weather station

- At TRI, agrometeorological data is monitored from our ground station and via remote sensing technologies
- The X-band Doppler radar at KALRO–TRI, Kericho, is the first MicroStep-MIS weather radar installed in Kenya.
- Positioned about 11 m above the tea plantation and more than 2,000 m above sea level, it can scan rainfall and storms across a radius of up to 200 km, supporting early warning and climate-smart agriculture.
- Collaboration involving Kenya Meteorological Department (KMD), KALRO–Tea Research Institute, TAHMO, MicroStep-MIS and the TEMBO Africa Project

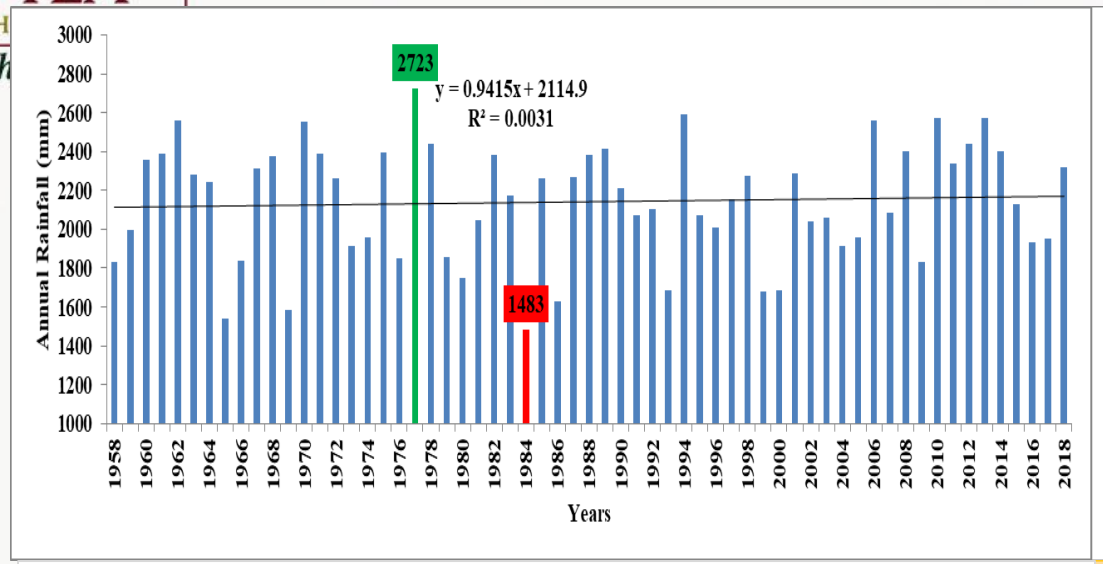


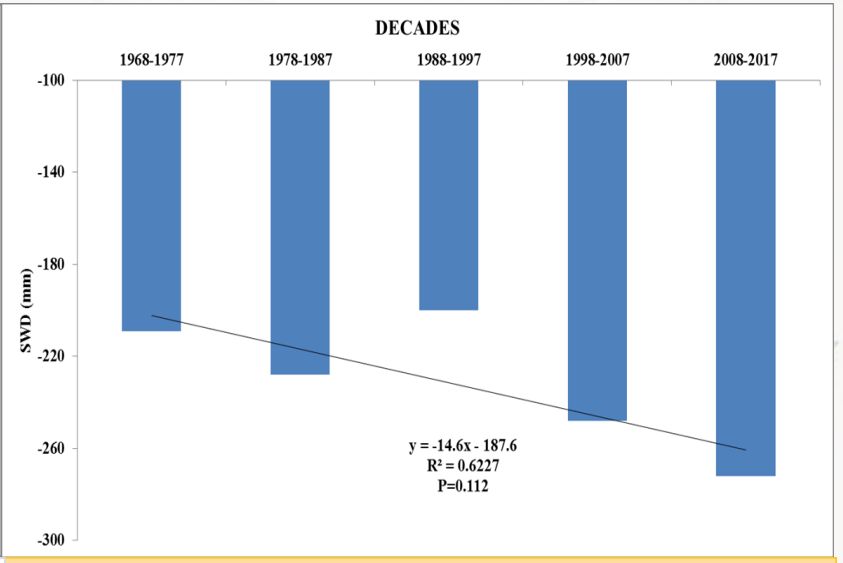
MicroStep-MIS X-band Doppler radar next to

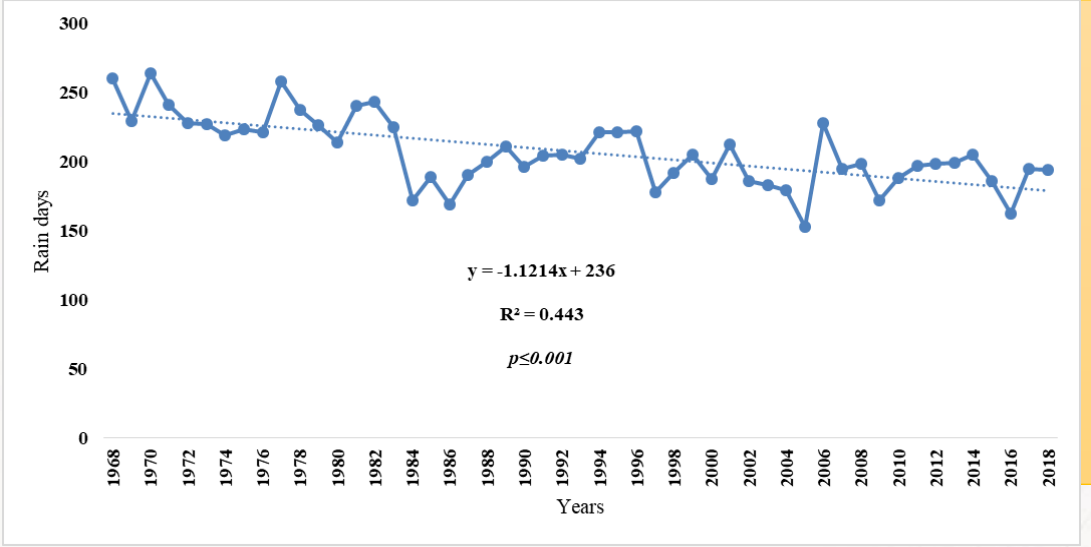
Through our collaboration with RCMRD, we developed early warning system for frost incidences for tea-growing counties of Kenya



Rainfall Trend

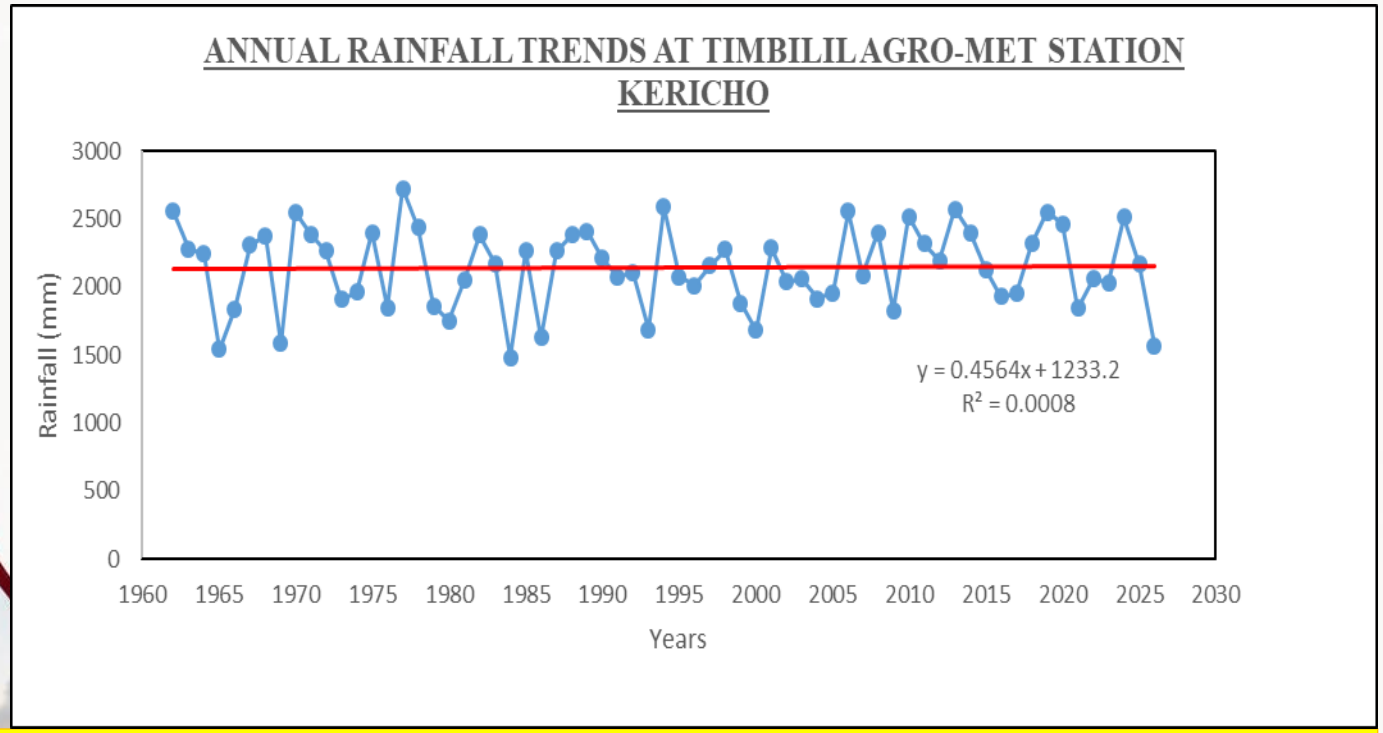




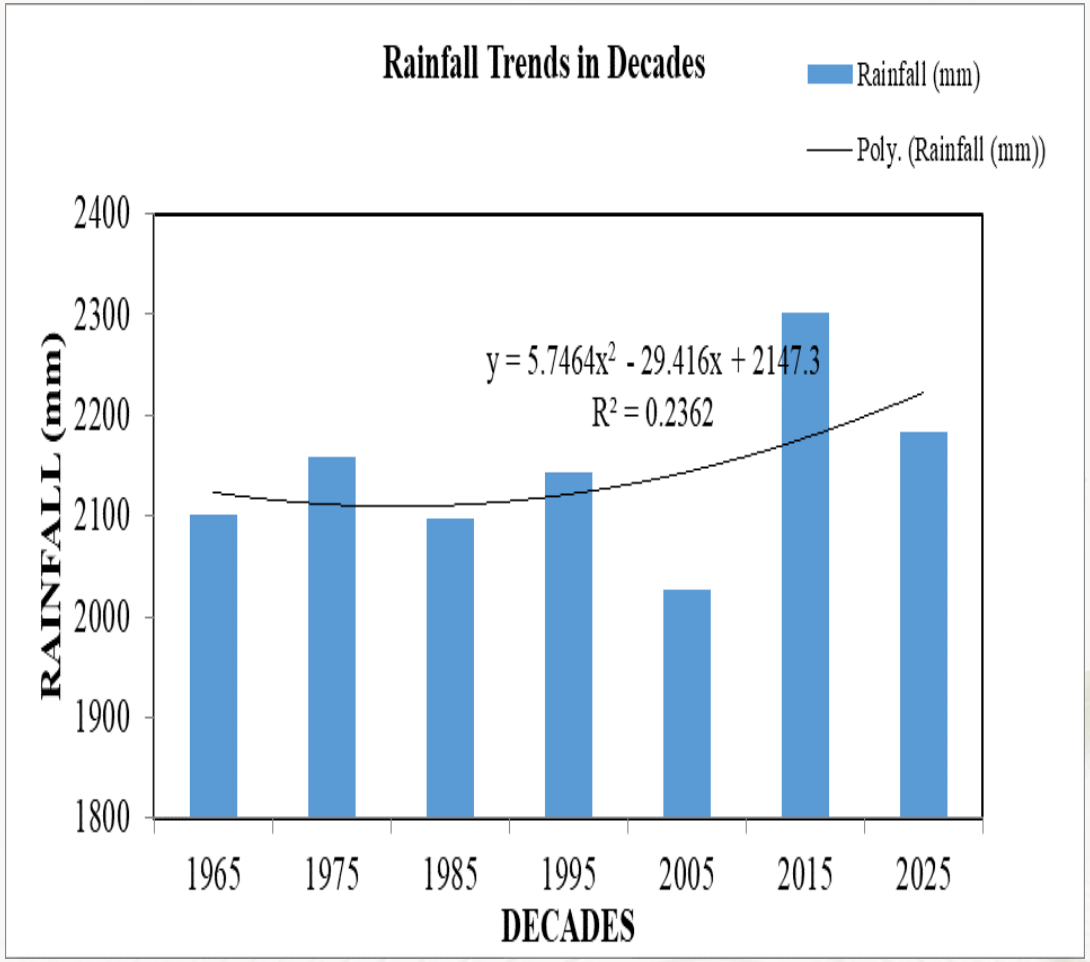


With no trend in annual rainfall and significantly declining trend in annual rain days, there is evident rise in SWD over time. This exposes the plants to water stress.

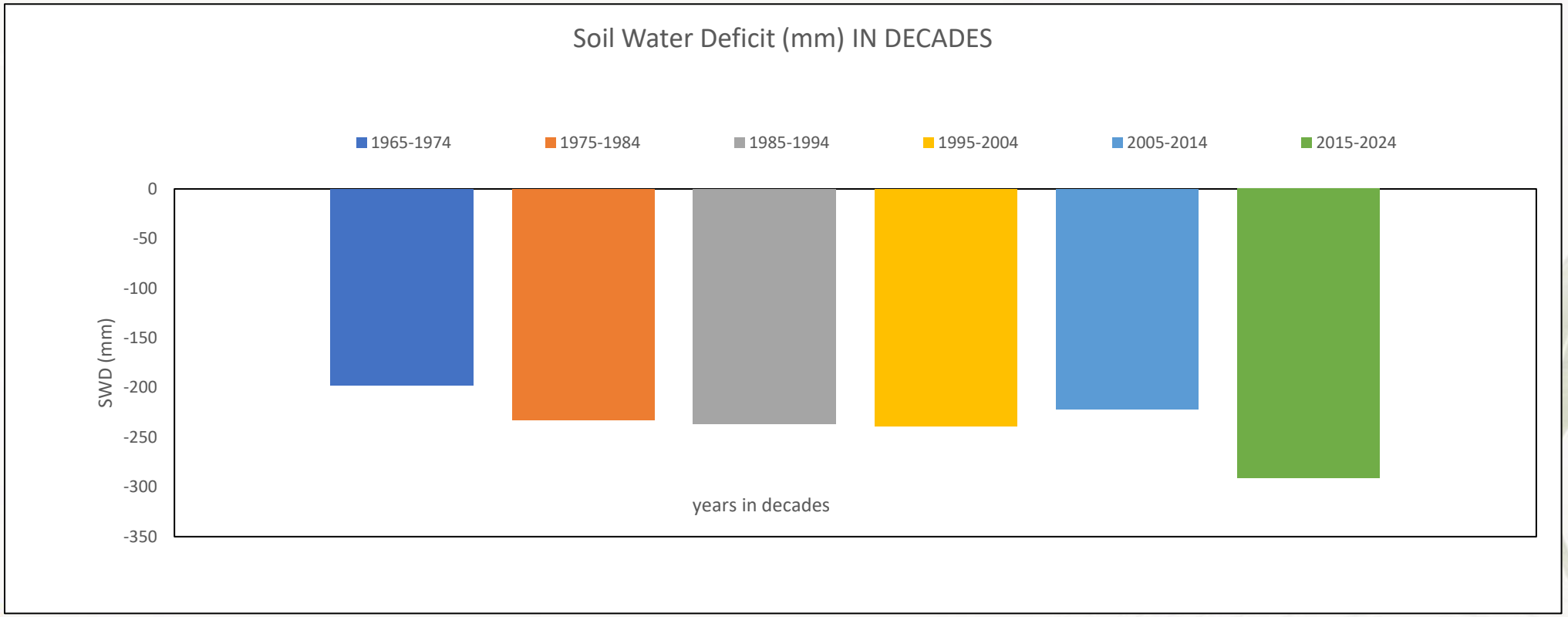
Trend of Total Rainfall Experienced in TRI In the Last Decades



With no trend in annual rainfall and a significant decline in annual rain days, SWD has clearly increased over time. This exposes the plants to water stress.

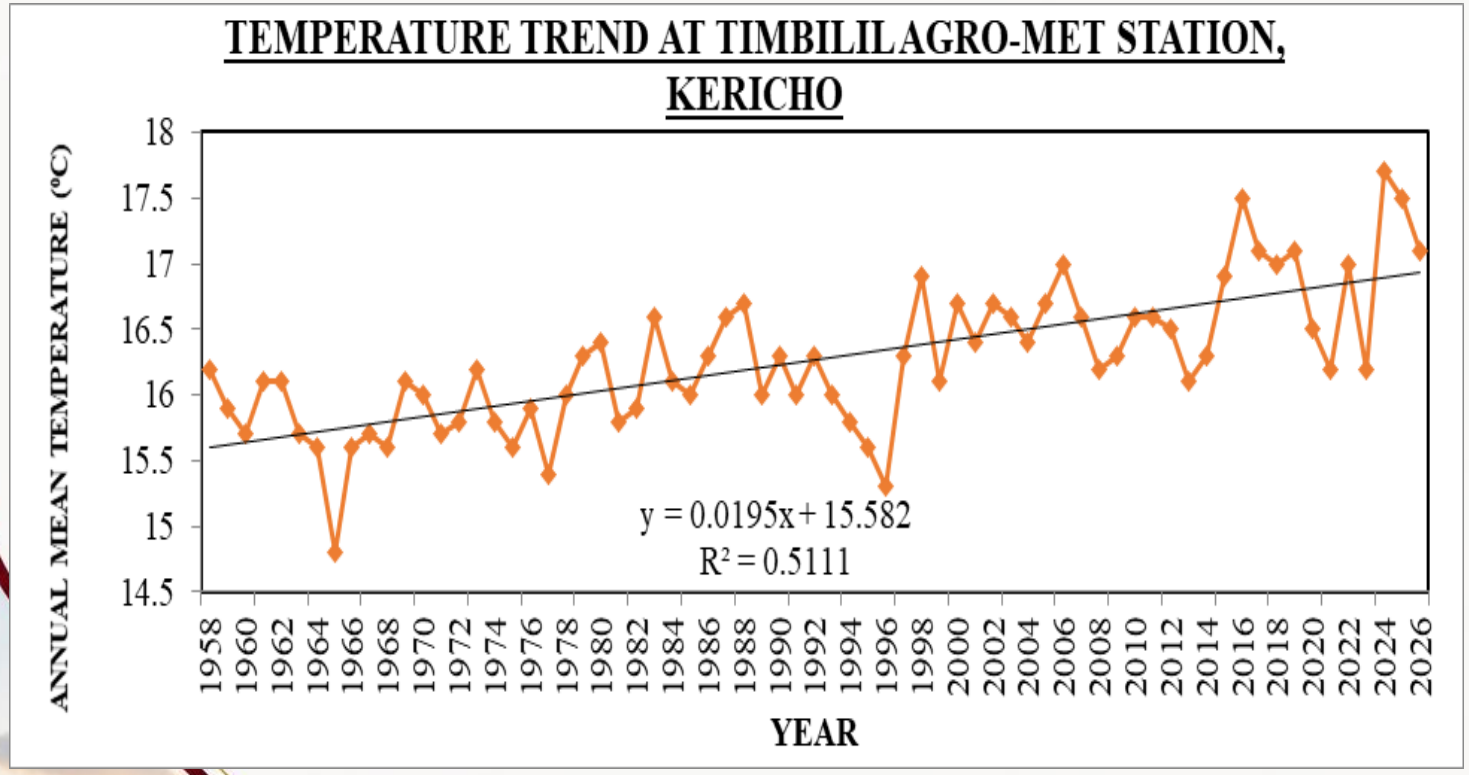


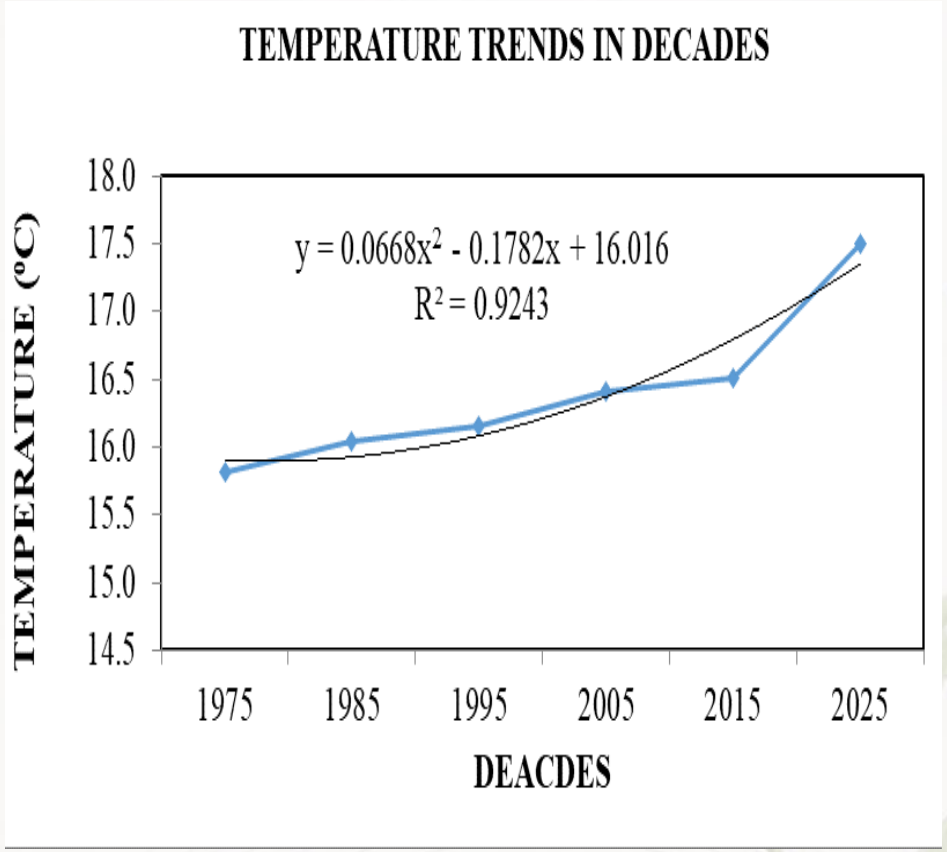
EVIDENCE OF CLIMATE CHANGE: TRI Soil Water Deficit (SWD)



Despite the general decline in annual rain days, soil dryness has increased over the past decade, even though annual rainfall hasn't changed significantly. This supports reduced infiltration of water into soils due to the air-lock effect.

Mean Air Temperature Over The Years In Timbilil Estate- KALRO TRI



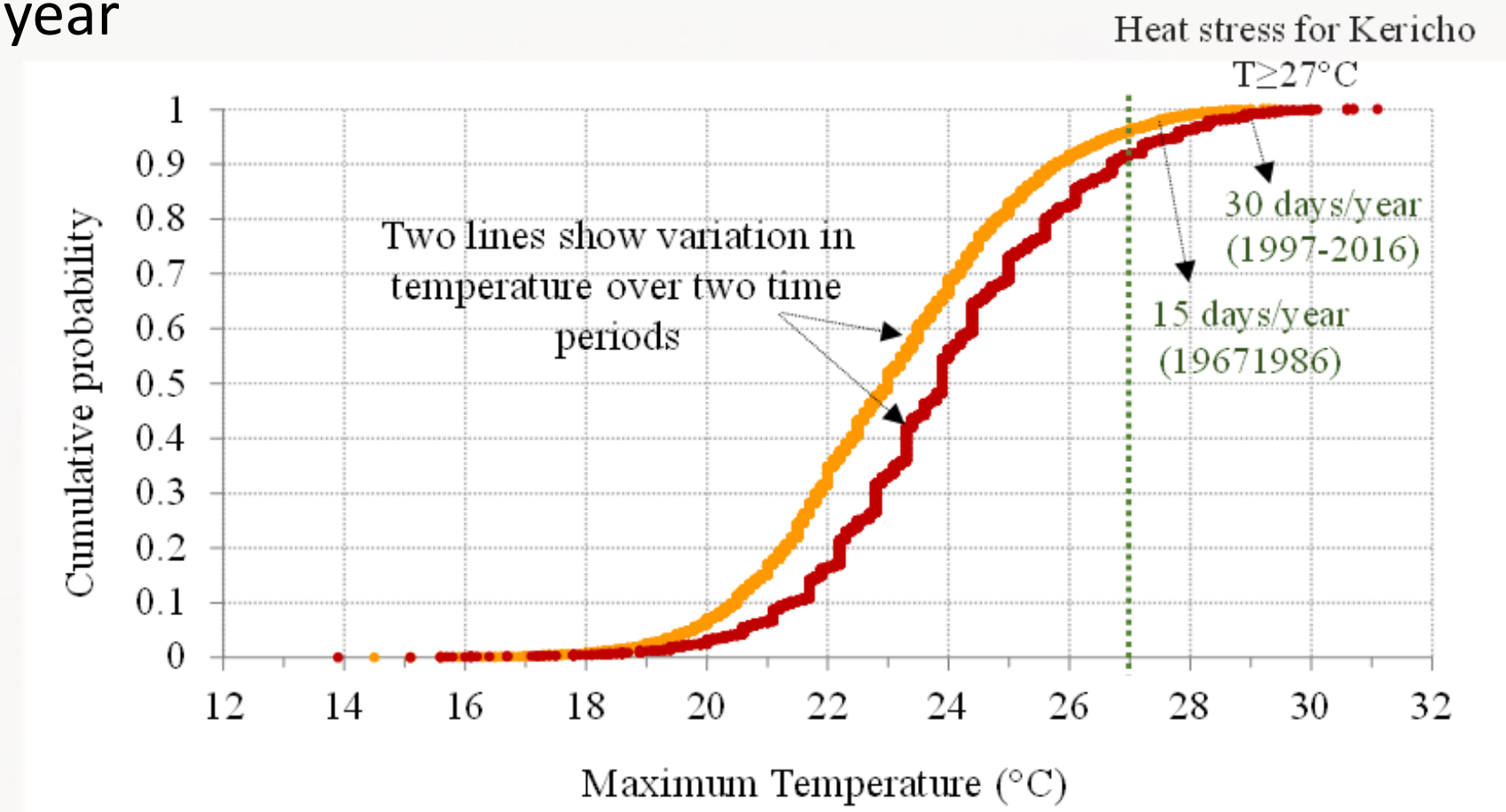


There is significant ($p \leq 0.001$) increase in Tmax at about 0.02°C per year.

Tmin is also significantly ($p \leq 0.001$) increasing over time at a rate of about 0.03°C per year

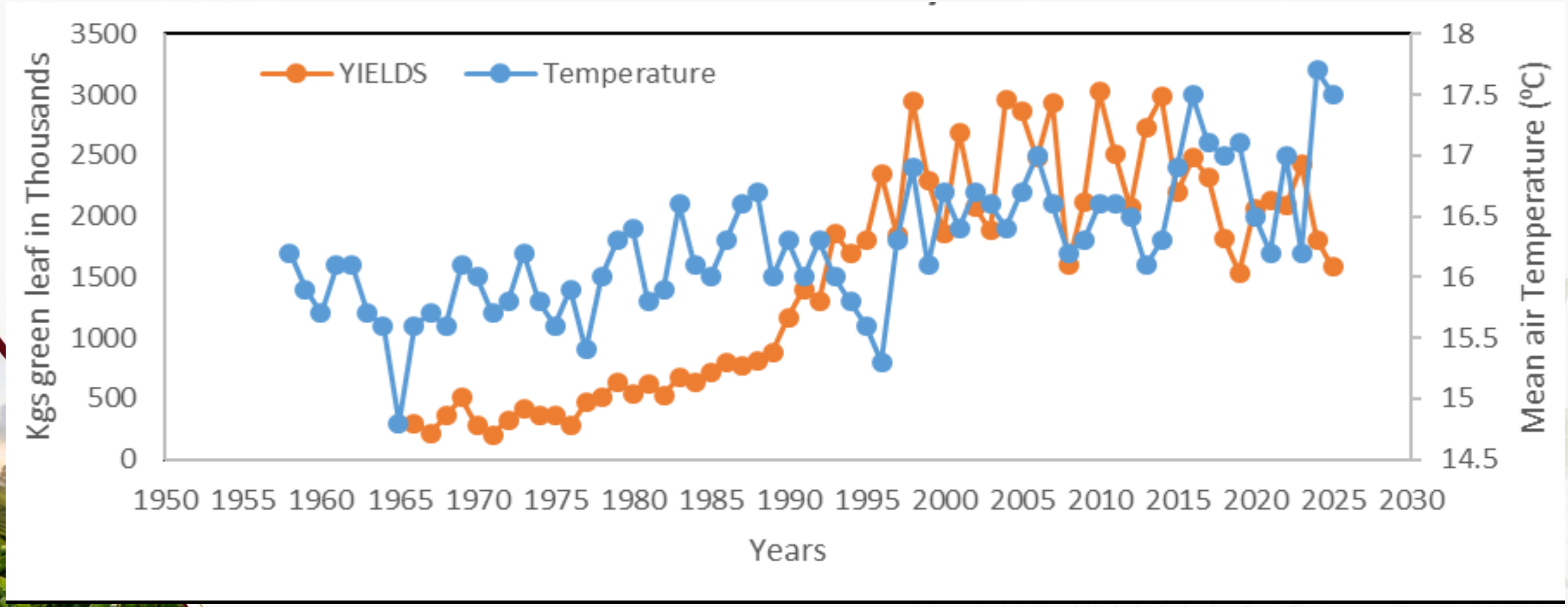
Time-step change in Tmax

- Currently, heat stress days to the tea plant have increased from 15 to 30 days per year

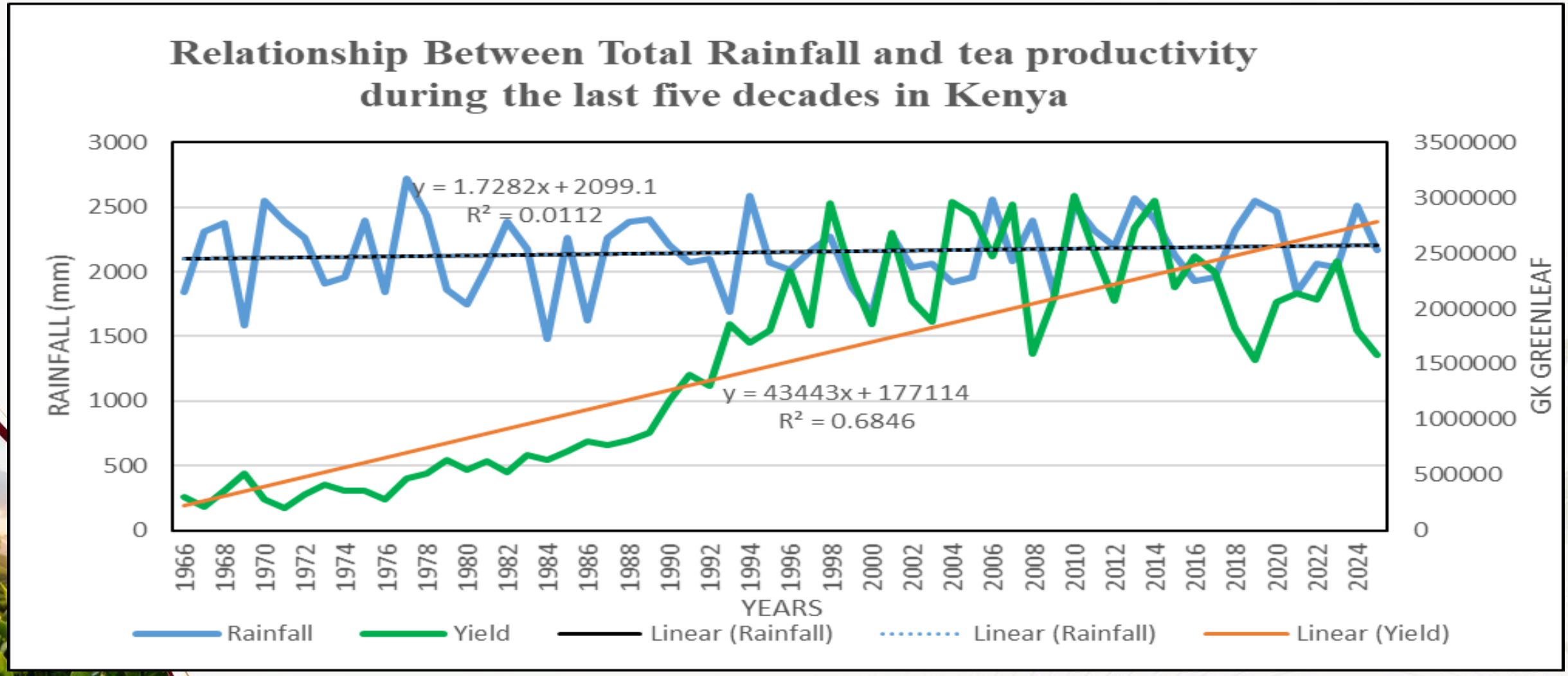


Impact of Climate Change- Temp and tea productivity

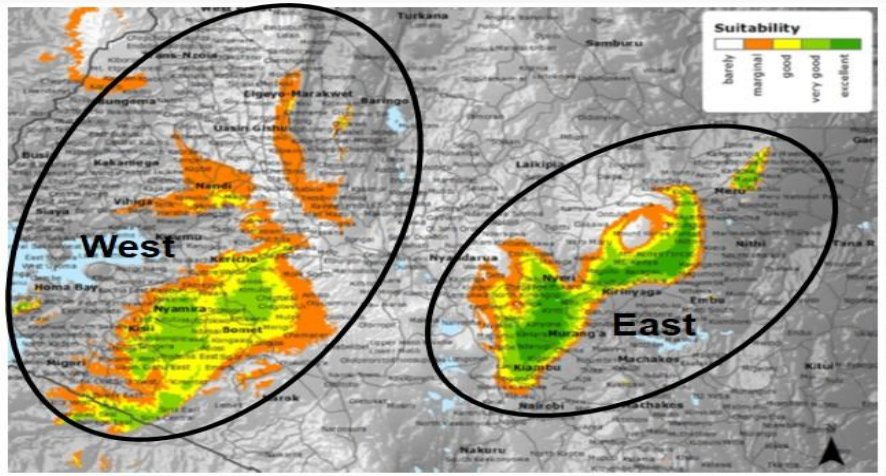
Relationship between long-term (~56years) mean air temperature and tea productivity in kenya



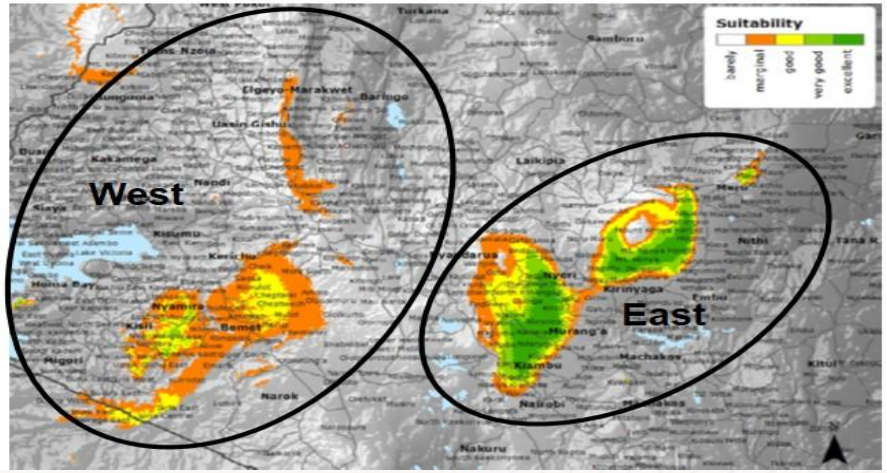
Impact of Climate Change- Rainfall and tea production



Projected suitable areas for tea growing in Kenya



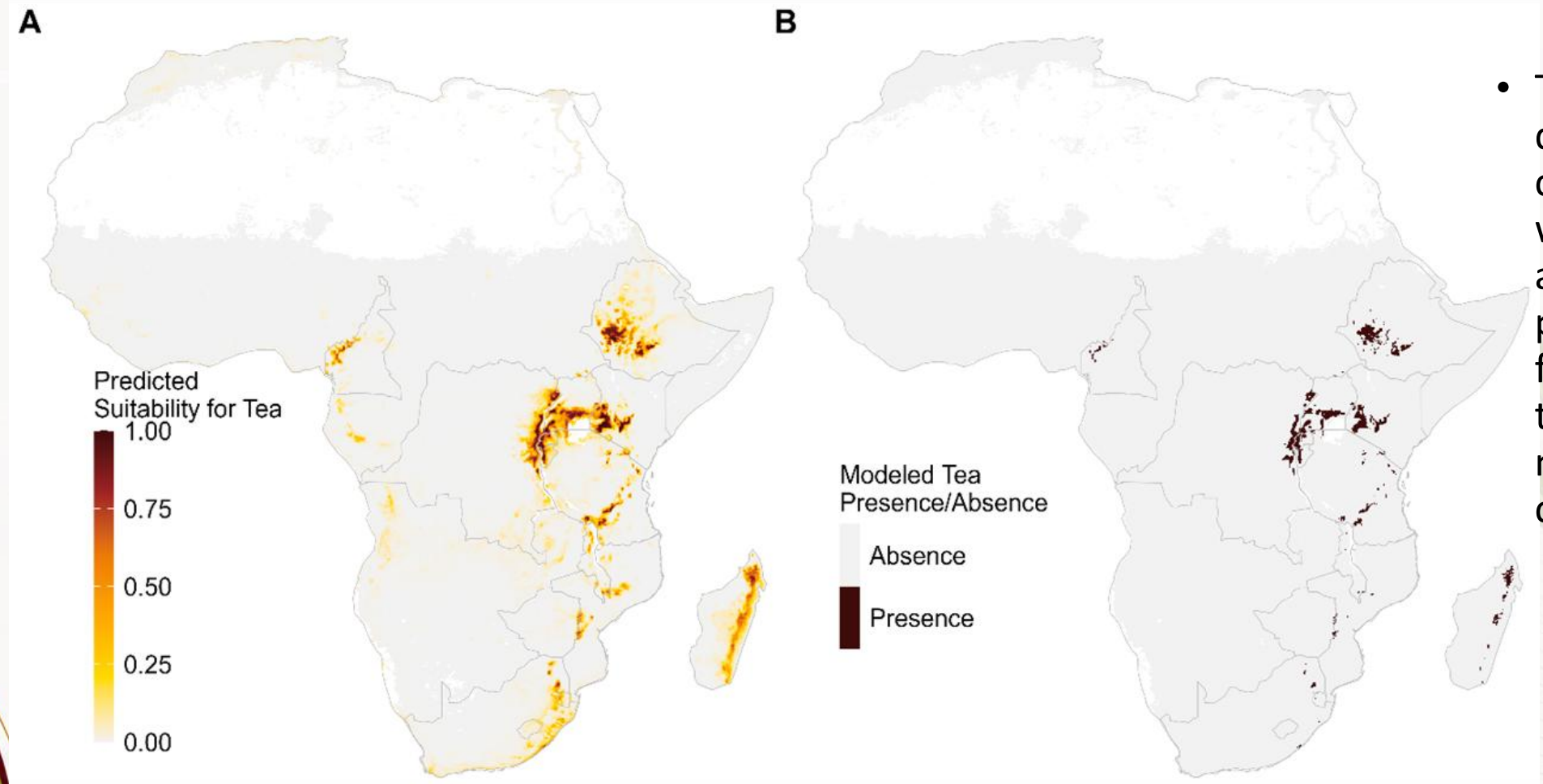
2020



2050

Land footprint suitable for growing tea in Kenya is shrinking by 2% per annum and could be reduced by 42% by 2050.

Tea map for Africa



- This year, we developed a continent-wide map of all tea plantations at fine resolution to help monitor the crop

Source: Oluoch et al., 2026

Change in habitat suitability for tea

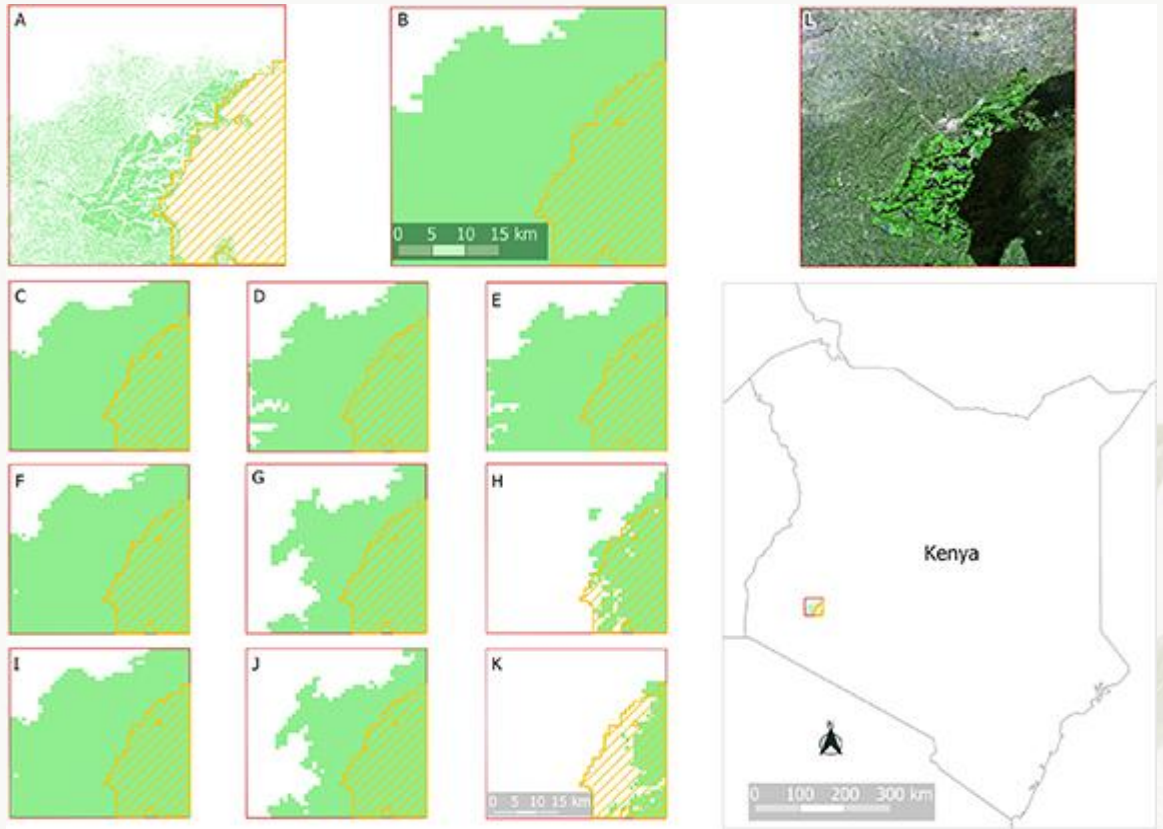
- Based on that map, and projected climate scenarios we have quantified the potential change in habitat suitability for the crop

The Threat:

Climate change is lowering tea productivity and pushing tea into protected areas

The Solution:

Intensify in existing fields, explore value addition, or tea tourism to cushion income and sustain the industry



Source: Oluoch et al., 2026

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2024 EXPERIENCE & 2026 EL NIÑO OUTLOOK

Lessons from 2024 | Outlook for 2026

2024 – A Mixed Picture

El Niño brought higher rainfall in early 2024, supporting tea production, but excessive rainfall later in the year caused losses.

Jan – Apr 2024
- Higher rainfall linked to El Niño.
- Supported tea growth and production.

Jan – May 2024
- Production increased by **22.89%** (277.14 million kg vs 225.52 million kg in 2023).

May 2024
- Excessive rainfall (125–300%) and hail in Kericho.
- Production fell by **5.8%** compared to May 2023.



2026 – A Stronger El Niño Expected

NOAA forecasts an **exceptionally strong El Niño** in 2026, with a very high probability of being **among the strongest on record.**

Potential impacts on Kenyan tea
- Heavier and more variable rainfall (flooding and waterlogging).
- Soil erosion and nutrient loss.
- Increased disease and pest pressure (e.g. fungal diseases).
- Difficult harvesting and transportation due to poor field and road conditions.
- Variable yield and quality (affecting tea grades and prices).

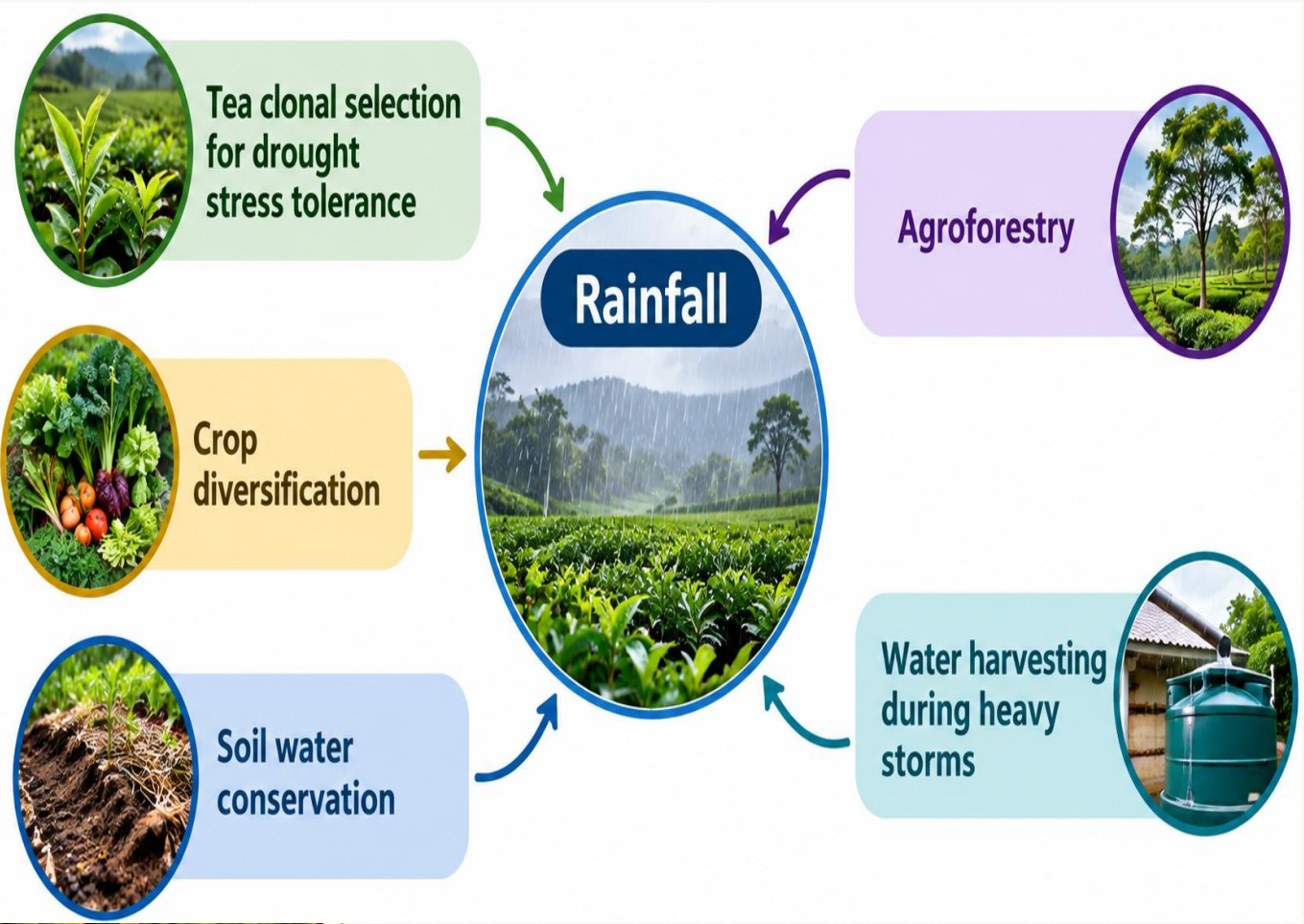


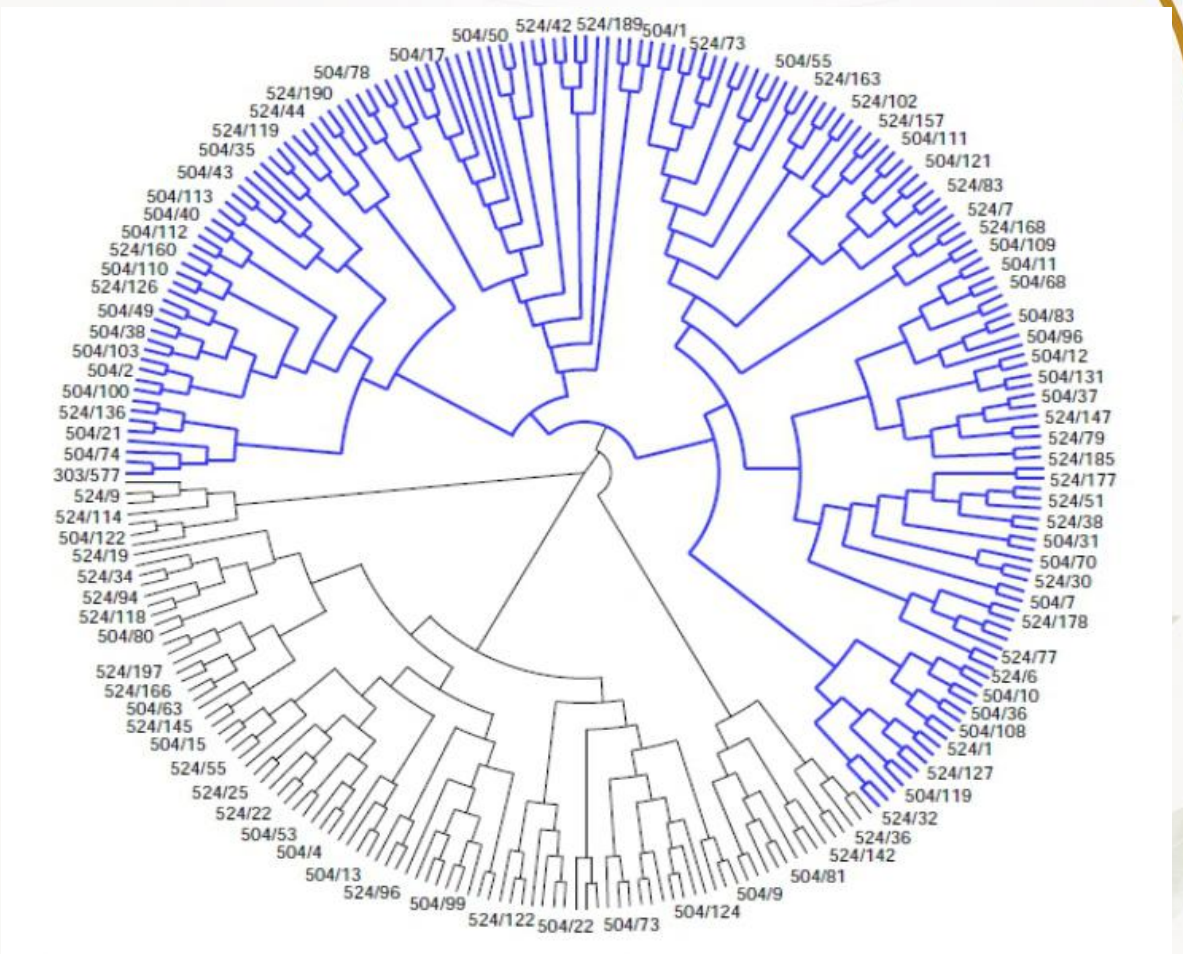
The 2026 El Niño will likely bring highly variable conditions — with both risks and opportunities for Kenyan tea production.

Bottom line: The 2024 experience shows that El Niño can boost tea production, but excessive rainfall can quickly reverse those gains. With 2026 forecast to bring an exceptionally strong El Niño, **climate variability — not just rainfall quantity — will be the biggest determinant of tea yield and quality.**

Possible Adaptation and Mitigation Measures

Rainfall



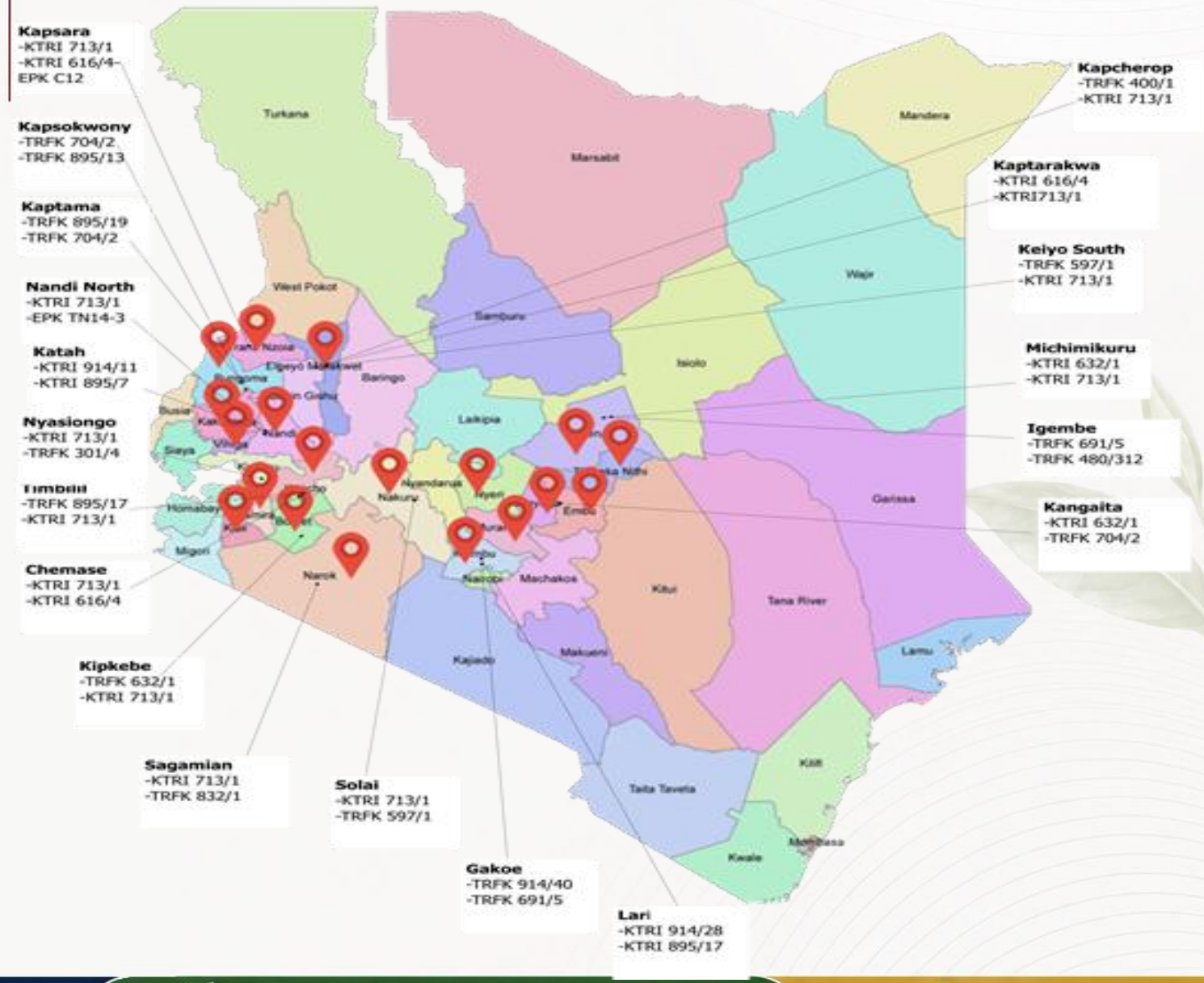


Source: Koech et al., 2019

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Cultivar-Site Matching in Kenya



Possible Adaptation and Mitigation Measures

- Site selection (avoiding frost paths)
- Balancing soil water content
- Ground cover and mulches
- Planting Climate smart tea clones in consultation with TRI.
- Embracing GIS and RS technologies such as in reporting hail/frost e.g. RCMRD frost map at http://apps.rcmrd.org/frostmap/



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The global warming potential of production and consumption of Kenyan tea

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ABSTRACT

Kenya is the third largest producer of tea in the world, the majority of which is exported, contributing 20% to the total national income from exports. Yet, its environmental impacts are currently unknown. This study considers for the first time one of the impacts – the global warming potential – of production and consumption of Kenyan black tea. The system boundary is from 'cradle to grave'. Both small- and large-scale production of tea is considered. The functional unit is defined as 1 kg of dry tea and the tea is assumed to be consumed in the UK. The results suggest that the total impact of tea is equal to 12.45 kg CO_2 eq./kg of dry tea for the large-scale and 12.08 kg CO_2 eq./kg for the small-scale production, indicating that the scale of production does not influence the impact. The main contributor is tea consumption which is responsible for 85% of the impact because of the electricity used to boil water. Tea cultivation and processing contribute around 10% to the total. The contribution of transport is relatively small (4%). The global warming potential from waste management is negative because of the credits for recycling of post-consumer tea packaging. The results are most sensitive to consumer behaviour, with the impact almost doubling with doubling the amount of water boiled for each cup of tea. Drinking tea with milk has even greater impact, increasing the total impact by up to three times. Appropriate consumer engagement programmes are needed to encourage behavioural change.

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TRI CLIMATE SMART TEA CULTIVARS

TRFK 914/28



Green/black orthodox

KTRI 895/17



Green orthodox

TRFK 914/39



Green orthodox

TRFK 914/11



Black orthodox

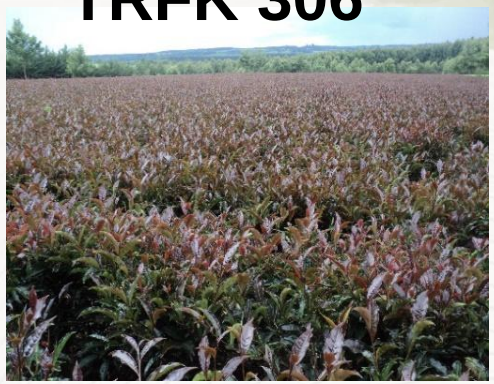
TRFK 895/7



Black CTC

TRFK 306

TRFK 306



PURPLE TEA

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Research & Innovation for Climate-Resilient and Sustainable Tea Production

Organic & Inorganic Fertilizers



- Higher nutrient use efficiency
- Lower N_2O emissions

Biochar + Inhibitors



- Right N rate
- Higher yields & profits

Biodiversity in Tea Gardens



- Native & agroforestry trees
- More pollinators & food security

Integrated Soil Fertility Management (ISFM)



- More organic inputs
- Healthier soils

Circular Economy



- Reduce waste
- Regenerate soils

Sustainable Fuelwood & Riparian Protection



- Renewable fuel
- Protect water sources

Efficient Energy Use



- Energy audits
- Lower emissions

Climate Resilient Cultivars



- High use efficiency
- Product diversification

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Beyond The Leaf: Product Diversification for Climate Resilience





When climate change threatens the leaf, diversification protects the value of tea

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Theme: Beyond the Leaf

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WE CHANGED CLIMATE

WE CAN

CHANGE

CLIMATE CHANGE






THANK
YOU!