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Policy Brief No. 27

Trinidad & Tobago: Assessing the Impact of Climate Change on Cocoa and Tomato

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Key messages

- *By 2050, Trinidad & Tobago is expected to show a significant reduction in the area suitable for growing tomato. Alternative crops such as cassava, sweet potato, and yam are good diversification alternatives.*
- *The cocoa crop is expected to be more resilient to climatic changes; nonetheless, as a high value perennial crop, precautions should be taken to ensure plantations have access to irrigation during infrequent, severe dry periods.*
- *By 2050, the climate suitability of all of the crops analysed is expected to increase in the upland areas and surrounding mountain ranges. As these areas are mainly forested, there is a risk of agricultural encroachment into protected forest areas.*
- *There is great potential to reduce possible negative impacts of climatic changes through targeted policy recommendations (outlined below).*

Climate change is expected to result in a warmer, drier climate in the Caribbean region. The altered climate is expected to have wide-reaching impacts on agriculture. This policy brief describes work carried out by the International Center for Tropical Agriculture (CIAT) in partnership with the University of the West Indies (UWI), which used climate predictions and crop suitability models to assess the likely impact of climate change on crops grown in Trinidad & Tobago.

By 2050, the area of land suitable for growing tomato and other annual crops is expected to be reduced due to higher temperatures. The largest reductions in suitability are expected in low-lying areas, particularly the south-west of Trinidad. Cocoa, a perennial tree crop, was found to be more resilient to climate impacts, although the crop is vulnerable to instances of severe drought during the dry season.

The possibility of mitigating the expected loss of area suitable for growing tomato through planting alternative crops was also assessed. All of the crops analysed showed a loss of suitability in the warmest, driest regions. However, cassava, sweet potato, and yam were found to be more resilient than tomato.

The following recommendations are outlined: promote diversification of crop species in low-lying areas; improve water supply and water use for farms in dryer areas; initiate testing of climate resilience in new crop varieties and provide this information to growers; enhance protection of forested upland areas to prevent encroachment due to changes in land suitability at lower altitudes.

Socioeconomic situation

The Republic of Trinidad & Tobago is a twin-island country situated in the Caribbean Sea, close to the northeast edge of South America. The islands cover a land area of 5,130 square kilometers. Over 95% of its 1.3 million inhabitants live on the island of Trinidad. Trinidad & Tobago is considered a high-income country, with a GDP of US$24.6 billion and a GNI per capita (PPP) of US$26,220 in 2013.

Agriculture

Trinidad & Tobago's economy is dominated by the oil and natural gas industries, and more than 70% of its population lives in urban areas. Dating back to the days of colonial rule, the agricultural economy is

characterised by a dual structure, comprising a large-scale export-oriented sector, and a small-scale sector that produces for the local market. Smallholders are perhaps the most vulnerable to natural hazards, not least because the majority are resource poor and cultivate marginal lands.

Currently only 10.5% of the total land area is categorised as agricultural land and the country is highly dependent on food imports. Agricultural production accounts for 0.6% of GDP. Fruits (65%), vegetables (17%), roots and tubers (8%), and cereals (7%) are the main crops produced. Tomato accounts for 12% of vegetable production and is grown as an annual crop throughout the country, both in the open and under protected agriculture. Cocoa is typical of the perennial plantation crops and is amongst the most important agricultural exports in value terms (typically >US$2500 per tonne). Although cocoa production declined throughout the last century there is an increasing international demand for the fine-flavoured beans produced in Trinidad & Tobago.

Natural hazards

Trinidad & Tobago has a tropical climate with a distinct wet and dry season. Localised flooding is common during the wet season. In the dry season, drought is a regular occurrence in the low-lying areas and wildfires are also a common occurrence.

Both islands are south of the hurricane belt, and tropical storms and hurricanes are not a common hazard for agriculture. The area is seismically active, but hazardous earthquakes have not occurred in recent years.

Climate change

This policy brief explores the consequences of climate change on cocoa and tomato production in Trinidad & Tobago. Small island states such as Trinidad & Tobago are expected to be severely affected by climate change because of their small land mass, fragile ecosystems, and concentration of infrastructure along the coast. Climate change models predict a temperature increase for the coming decades. At the same time, annual rainfall is expected to decrease and the risk of natural hazards to increase, significantly affecting agricultural practices and already vulnerable rural livelihoods. Climate change is not only likely to cause a decline in yields of the island states' most important crops, but the distribution of crop suitability within the current production areas will change as well.

General impact of climate change in Trinidad & Tobago

According to analysis of climatic data for scenario emission RCP 8.5 (one of four representative concentration pathways describing increase of radiative forcing values for the year 2100, for this scenario 8.5 W/m^2, which is compared to the other scenarios the highest increase), derived from the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC, AR5), several changes in climatic characteristics on the island of Trinidad & Tobago are to be anticipated:

- In comparison to current annual daily mean temperatures of 26.5 °C, by 2050 the annual mean temperature will have risen by between 2 and 2.1 °C.
- The average temperature of the warmest month will potentially increase by 2.1 to 2.2 °C by 2050; while in the coldest month, the minimum temperature is forecasted to increase by between 1.8 and 1.9 °C.
- It is very likely that by 2050 the average annual rainfall will have decreased (currently c. 2000 mm).
- The wet seasons will become drier, and the dry periods will become even drier.

Climate predictions forecast a gradual increase in temperature and a moderate decrease in rainfall. Predicted water shortages and increases in evapotranspiration will present a problem for agricultural production.

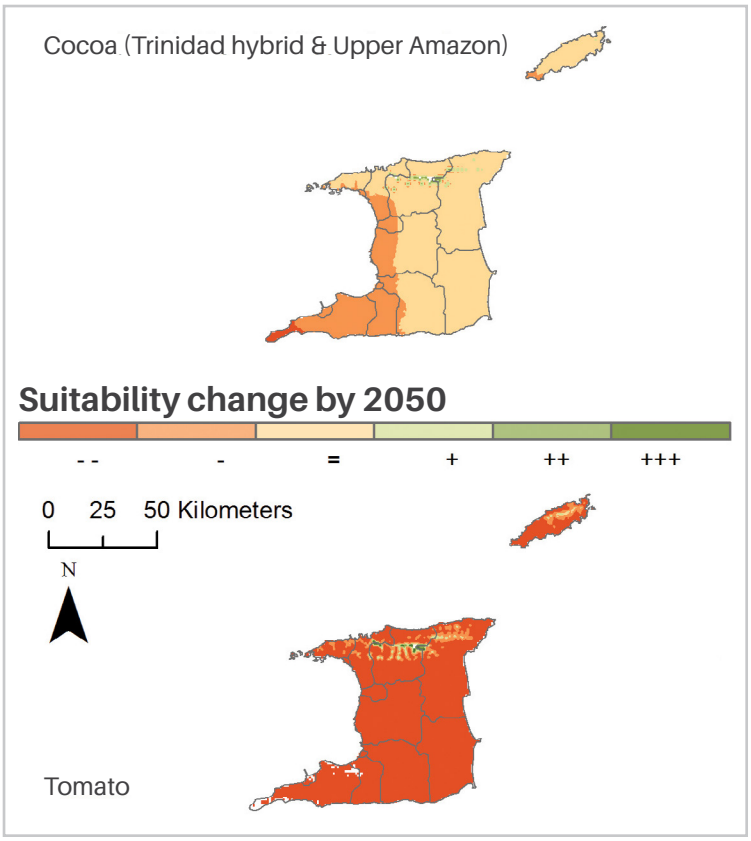


Figure 1 Modelled suitability change of cocoa and tomato in Trinidad & Tobago by 2050. Green-coloured areas are predicted to have increasing (+ signs) suitability change in the future, red areas are predicted to decrease (- signs) its suitability for the specific crop. Number of signs shows magnitude of increase/decrease, equal sign (yellow areas in the map) means no predicted future change of suitability.

Slight changes for cocoa in driest zones

According to our crop model, under the influence of climate change, the cocoa-growing areas will not have significant suitability changes. In most areas, cocoa will maintain its current suitability level and will, at most, suffer suitability losses of less than 15% in the drier, lower zones. Due to the temperature range of cocoa, the expected temperature increase is not expected to have significant effects under the current production system (cocoa grown under shade). Reductions in dry season rainfall and changes in precipitation patterns are the most likely direct causes of declining crop yield. To reduce the impact of climate change, cocoa growers should implement efficient irrigation systems to ensure trees survive during times of prolonged drought. Other indirect impacts of changes in climate, such as changes in pollination or disease prevalence, were not included in this work.

Expected higher impacts on suitable land for tomato

In Trinidad & Tobago, the tomato crop is grown on a relatively small scale, often with the assistance of greenhouse systems. While the precipitation rates render large parts of the islands suitable for the production of rainfed tomato during the wet season, the major limiting climate factor is the high temperatures. In contrast to cocoa,

more than 80% of the currently suitable areas for tomato growing will experience negative changes in suitability as a result of climate change, with losses that exceed 30%. Temperature is likely to be an even greater stress within greenhouse systems.

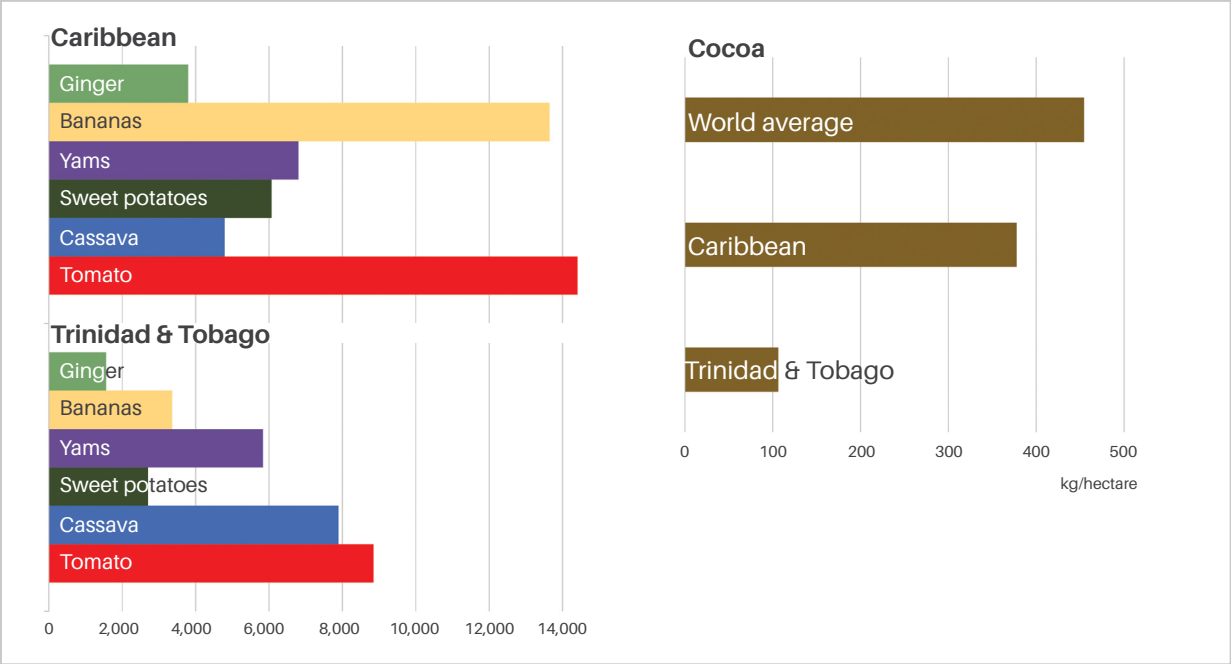


Figure 2 Comparison of average of historical yield (2008–2013) for cocoa, tomato, and alternative crops in the Caribbean.

Majority of farmers believe Caribbean climate is changing

Community-level surveys were carried out with farmers operating in established cocoa- and tomato-growing regions in Trinidad & Tobago. The surveys were aimed at collecting a range of baseline information – including data on existing agronomic practices and challenges associated with growing certain varieties of tomato and cocoa. Results indicate that the majority of farmers believe that the climate is changing. Approximately 64% of cocoa farmers stated that rainfall had increased over the last 20 years. Most farmers who indicated that rainfall had in fact increased over the period also stated that their crop production was negatively affected by this increase (46%).

Perceived production challenges

Major environmental threats to the farming sector include hurricanes, droughts, floods, and pests and diseases. In terms of production challenges, 91% of all farmers indicated that their crops had been affected by disease in the past, and 62% had experienced at least one major crop failure in the last 10 years. Cocoa farmers ranked drought as their highest threat, followed by floods and pests and diseases. The highest ranked threat to tomato farmers was pests and diseases. In contrast to other Caribbean islands, hurricanes were ranked as the least threatening factor by both tomato and cocoa farmers surveyed.

Assessment of climate change on alternative crops

With the aim of providing efficient crop diversification strategies to ensure farmers' food security in the face of eventual climate change, five other crops of economic importance were identified on the basis of the islands' national production data reported by the Food and Agriculture Organization of the United Nations (FAO). The crops selected were yam, banana, sweet potato, cassava, and ginger. By calculating the climatic suitability index based on temperature and precipitation ranges (optimal, absolute) for each crop, an analysis was performed to estimate potential suitable areas and the impact of climate change on these areas.

The climate suitability assessment under the RCP 8.5 scenario shows that only the highest zones in the mountainous regions will gain suitability. In contrast, low-lying areas show decreased climate suitability for more than three crops, coinciding with the driest areas of the island (annual rainfall < 1500 mm), i.e., much of the south-western region.

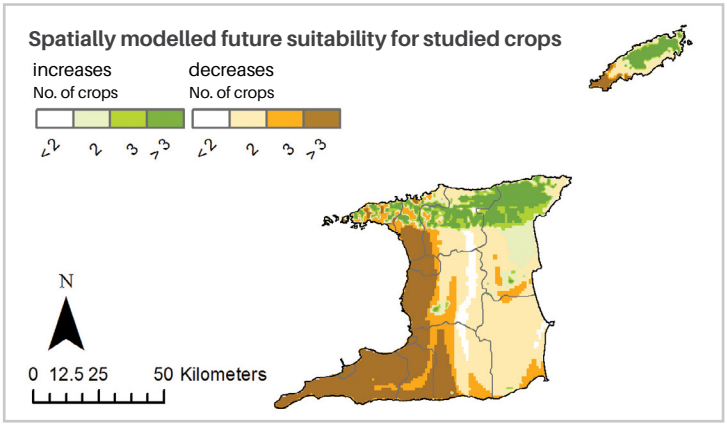


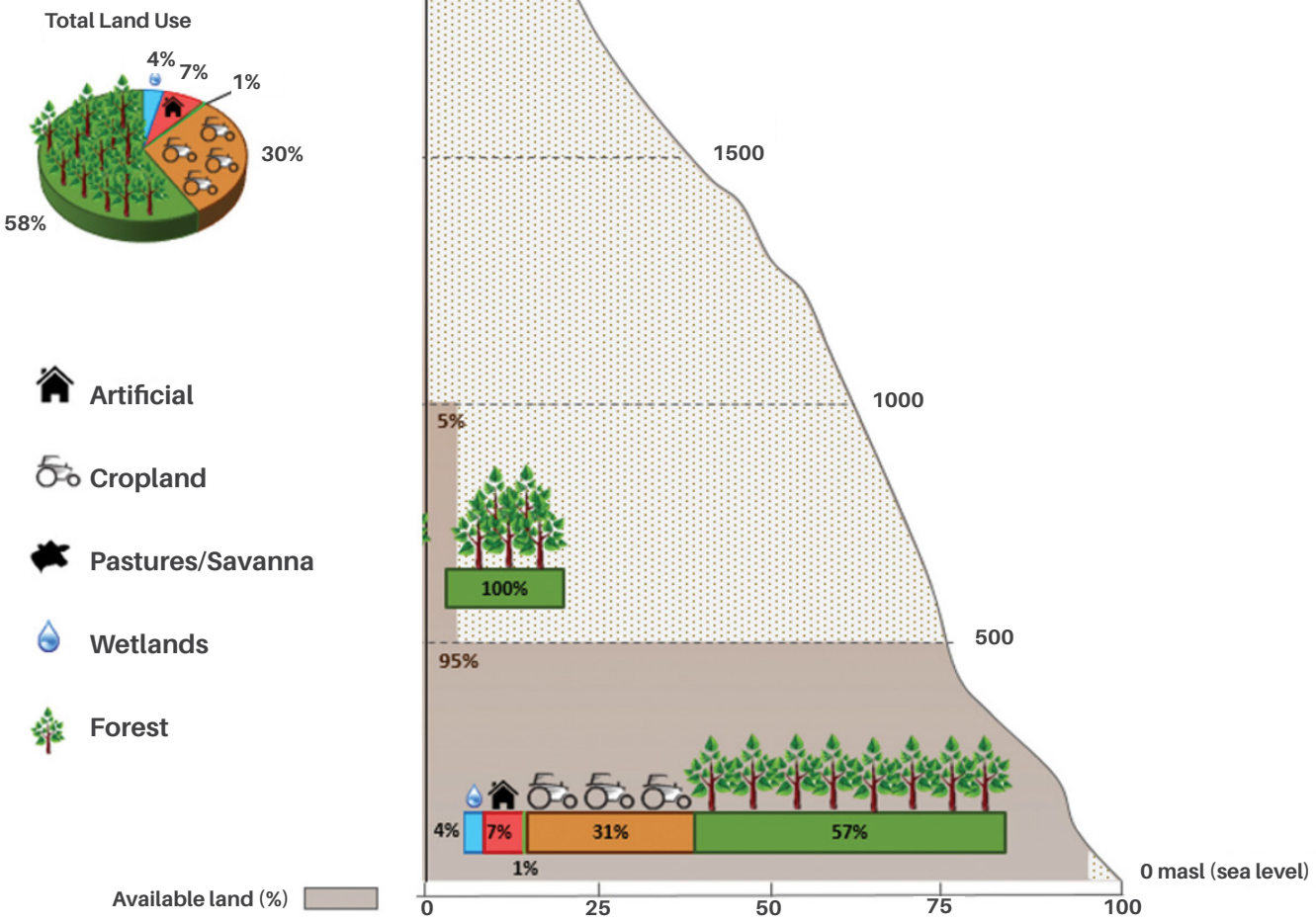
Figure 3 Spatially modelled future suitability of alternative crops in Trinidad & Tobago showing areas where most crops are increasing (green colour gradients) and decreasing (orange colour gradients) its climate suitability by 2050.

In order to identify the agricultural potential in the soil–plant–atmosphere interactions, the climate suitability results obtained in relation to the percentages of land area used and available for use were analysed (Box 1). The results indicate that climate change could result in negative impacts for agriculture, as four of the analysed crops lose suitable growing area bewtween 0–500 masl. Overall, 95% of the island is expected to see some reduction in climatic suitability, particularly for growing tomato. Climatic suitability for the production of yam, cassava, and sweet potato is expected to remain the same or increase within the same altitudinal range.

Box 1 Change in crop suitability across altitudinal ranges and land cover.

Trinidad & Tobago

maximum altitude ~900 masl



Country	Altitude	< 500 m			500–1000 m			1000–1500 m		
	Crops/Land use	Croplands	Forest	Pastures	Croplands	Forest	Pastures	Croplands	Forest	Pastures
T&T	Cocoa	–	–	–		+				
	Tomato	– –	– –	– –		++				
	Banana	–	–	–		+				
	Cassava	=	=	=		+				
	Sweet potato	=	=	=		+				
	Yams	=	+	–		++				
	Ginger	–	–	–		+				

Current suitability

>=75

50–75

<50

Change

= Without change
\+ Low gain
++ High gain
– Low loss
– – High loss

The graph in this box shows the current distribution of land cover and climate suitability with losses (-) to gains (+) coupled with the availability of land (%) in each altitudinal range.

Generally crops show a minimal suitability loss for territories located below 500 masl. Above 500 masl, it is expected that this cultivation will be maintained, and some areas may see small improvements. Considering that over 98% of the higher altitude areas are currently intended as forest cover, the potential change in land use could increase the pressure on the forests. In the future, there is a risk that forested land will be converted for the purpose of agricultural production. According to numbers reported by FAO, the current land use of Trinidad & Tobago is characterised by a division of over 50% for forestry or forest protection purposes and about 30% for agricultural production. It is expected that climate change will alter this allocation by offering incentives for converting forest areas into land for crop

production. This change could have negative consequences for carbon sequestration, soil protection, and other ecosystem services. An effective strategy to avoid this situation is to diversify the crops planted in the current agricultural areas, in particular favouring crops that are resistant to high temperatures, such as yam, cassava, banana, and sweet potato.

Further recommended actions

The Governments of Trinidad & Tobago should seek to:

- Promote crop diversification as a short-term risk management strategy and a long-term bridge to full crop substitution. This could be achieved by increasing the availability and awareness of alternative crops through the agricultural extension system and through the marketing of these crops to consumers. Crops such as cassava, sweet potato, and yam are good diversification alternatives.
- Strengthen the provision of irrigation water to low-lying areas during the dry season, e.g., through expansion of the water storage system within the south-west of Trinidad.
- Promote the use of water-efficient technologies (e.g., water storage, landscaping, drip irrigation, night-time watering, crop monitoring, etc.).
- Initiate testing of alternative crop species and varieties to ensure that the most climate resilient crops are available to farmers. This could be achieved by introducing testing for heat and drought resilience as part of the Caribbean agricultural research programme, e.g., by systematic consultation with growers to determine the resilience of available varieties under production conditions, or by direct testing of new crop varieties under experimental conditions (this system is currently under development at the University of the West Indies (UWI)-St. Augustine).
- Monitor changes in climate to determine the most suitable growing practices into the future, e.g., to inform farmers of optimal planting dates for annual crops given the increased risk of severe droughts in the dry season.
- Maintain and expand participatory environmental strategies and policies to ensure the preservation of forested areas. This approach has produced numerous benefits for climatic resilience, in particular for protection of soil and water resources (e.g., the Tobago Main Ridge Forest Reserve has been recognised by UNESCO as a leading example of conservation with benefits for ecosystem services).

Further reading

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