water-limited and attainable yields in high- and low-input systems with farmer yields. There are considerable yield gaps on all farms, with water-limited yield gaps much larger than attainable yield gaps. Relative yield gaps are substantial, and driven mostly by management practices, cocoa tree density and (lack of) black pod control. Improved agronomic practices could substantially increase production of current cocoa plantations (Asante et al. 2022).

How will projected climate change affect cocoa yield?

We used a cocoa crop model to project how cocoa yields might change by 2060 under different climate scenarios. Surprisingly, many areas may see higher cocoa yields, especially if future carbon dioxide levels benefit cocoa plant growth and if rainfall increases. Countries like Nigeria and Cameroon could gain more suitable land and see bigger yield increases, while Côte d'Ivoire and Ghana might face some losses. Particularly under hot-dry scenarios, losses in Côte d'Ivoire could be substantial. Despite projected warming and precipitation changes, many current cocoa growing areas may maintain or increase their productivity, particularly if full effects of elevated CO2 concentrations are assumed (Asante et al. 2025).

Way forward

- Improve our understanding of yield determinants in interaction with climate, for example climate and management effects on pod harvest index.
- Seek additional funding to investigate sink-source relationships to improve the cocoa physiological simulation model.
- Assess the potential of agroforestry designs to improve the microclimate in marginal climatic conditions.

Further reading & more information

Asante et al. (2021) Unravelleing drivers of high variability of on-farm cocoa yields across environmental gradients in Ghana.
Asante et al. (2022) The cocoa yield gap in Ghana: A quantification and an analysis of factors that could narrow the gap. Asante et al. (2025) Climate change impacts on cocoa production in major producing countries of West and Central Africa by mid-century.

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CocoaSoils

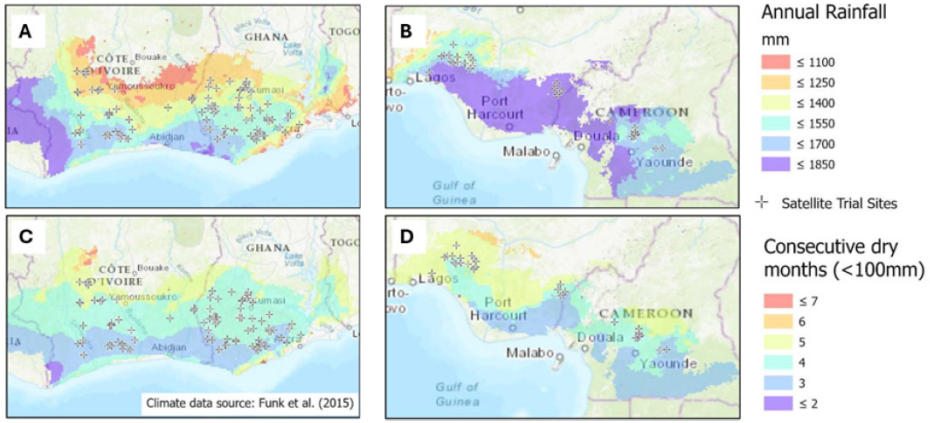
Climate Resilient Cocoa Fact Sheet

July 2025

IITA · CGIAR · Norad · CGIAR Sustainable Farming · Wageningen University & Research

Background

Cocoa yields are determined by genotype x management x environment effects. The environmental niche determines where cocoa can be grown successfully, while climate variability affects cocoa phenology, pest and disease pressure and potential yields from year to year. The cocoa growing areas in West and Central Africa differ from each other primarily in the rainfall distribution, with the CocoaSoils satellite trials well represented for the range of climatic conditions. Increasing temperatures, changes in rainfall patterns and increasing frequency and severity of extremes due to climate change are putting increasing pressures on cocoa production. CocoaSoils is well positioned to contribute to the knowledge base required to adapt cocoa to climate change.



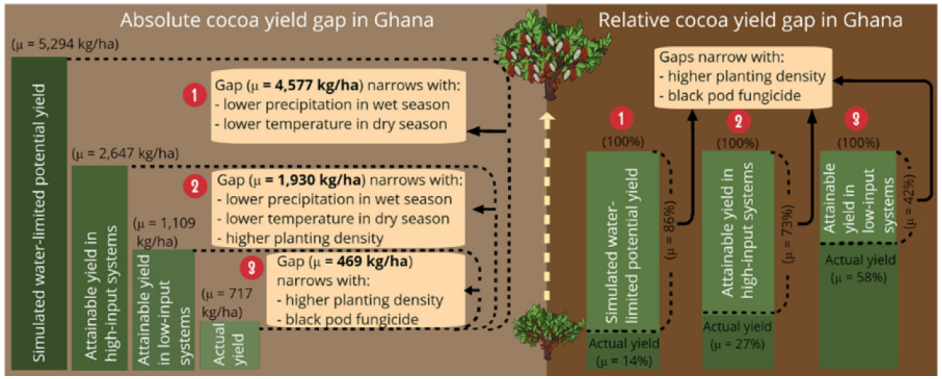
Cocoa is grown in a wide range of climatic conditions with large differences in total annual precipitation (A, B) and dry season length (C, D).

Given the current low productivity of smallholder cocoa in West and Central Africa, there is much scope to increase yields through integrated soil fertility management as well as adapted agroforestry designs. Such practices that contribute to closing the yield gaps are an integral part of climate change adaptation and CocoaSoils provides essential means to provide the scientific evidence base for contextualized recommendations across the different agroecological conditions.

Within this context, the CocoaSoils program has contributed critical insights into cocoa yield and climate relationships. Based on large datasets of yields and management in combination with a cocoa physiological simulation model, our work focused on the following research questions:

- What environmental drivers affect cocoa yields and what is their relative importance
- What are the current cocoa yield gaps on farms across cocoa growing areas?
- To what extent and how do environmental and management factors explain these yield gaps?
- How will projected changes in climate and the underlying rise in atmospheric carbon dioxide concentrations affect waterlimited potential cocoa yield?
- How will variations in projected changes in climate affect interannual cocoa yield variability?
- How much cocoa could be produced under future climatic conditions without expansion of the land area under cocoa cultivation?

We quantified the extent to which environmental (i.e., climate and soil) conditions drive cocoa yields and how this differs for farms achieving on average low- and high mean production levels based on an unprecedented dataset of 3,827 cocoa farms spanning the environmental gradients of Ghana. We calculated the cocoa yield gap as the difference between potential yield (i. water-limited potential (Yw) quantified using a crop model, ii. attainable yield in high-input systems (YE), iii. attainable yield in low-input systems (YF)) and actual farmer yield. Both absolute and relative yield gaps were calculated. Finally, using a crop model, we simulated potential water-limited cocoa yields (Yw) to evaluate effects of warming and precipitation changes based on five plausible general circulation models (GCMs) climate-change scenarios, with and without elevated atmospheric CO2 concentration. We examined how variation in Yw was associated with that of climate and estimated total cocoa production on current plantation area under current low-input and high-input scenarios.



Key findings

What environmental drivers affect cocoa yields in Ghana?

Cocoa farms with high yields are more sensitive to environmental conditions than farms with low yields. Climate effects on cocoa yields were stronger than soil effects, but management effects were most important. Most influential climatic variables were precipitation during the minor dry season, solar radiation during the main dry season and minimum temperature during the minor wet season of the previous year. Yet, good agricultural practices are a critical means to adapt cocoa to changing climatic conditions (Asante et al. 2021).

What are the current cocoa yield gaps across cocoa growing areas in Ghana and what are the main drivers?

Increasing cocoa yields per unit area can help meet growing demand, secure food security and reduce pressure on forests. We quantified cocoa yield gaps by comparing simulated