Abstract

"Where are the technical parameters for cacao agroforestry systems?"

Scientific analyses and reflections

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Cocoa production, a vital global industry supporting millions of farmers, faces significant challenges due to climate change. Rising temperatures, erratic rainfall, and prolonged dry periods threaten yields and farmer livelihoods, particularly in key producing regions like West Africa, South America, and Southeast Asia. Agroforestry systems, which integrate different (ideally native) tree species with cocoa crops, offer promising solutions by improving microclimate regulation, enhancing water cycling, and increasing resilience to climate variability. However, a critical knowledge gap exists regarding optimal agroforestry designs tailored to local conditions and future climate scenarios.

How cocoa agroforestry systems can reduce climate-related production risks

This article advocates large-scale investments in research and development to establish a "gold standard" for cocoa agroforestry systems, ensuring environmental sustainability and better livelihoods for farmers. Public private partnerships are essential to close this gap and transform the cocoa sector into a more inclusive and climate-resilient industry. As part of this article, the authors provide an extensive literature review (including approximately one hundred studies and reports on the availability of agronomic data on cocoa production in the public domain). Ultimately, there is a lack of accessible research on adapting cocoa production to new climatic conditions through innovative agronomic practices.

Data and scientific information in the public domain on cocoa agroforestry systems

One of the key challenges seems to stem from agroforestry trials with sun-tolerant cocoa varieties. Obviously, these plants may develop severe health threats in a shaded forest-like design. Also, many clonal varieties experience stress when confronted with extended periods of drought or with excessively intense and prolonged heavy rainfall that can flood entire areas.

Theobroma cacao is highly susceptible to changes in temperature and rainfall, which makes it particularly vulnerable to the vagaries of climate change. As a tropical plant native to the Amazon rainforest, the species thrives in warm, humid climates with a maximum annual average of 30 to 32 °C and a minimum average of 18 to 21 °C. Besides temperature, rainfall influences yield variations more than any other climatic factor; soil moisture-holding capacity, for instance, is only relevant during dry spells, and is not an issue in regions where rainfall is evenly distributed throughout the year. Cocoa needs plenty of rainfall – 1,500 to 2,000 mm per year – and within that range, rainfall seasonality and the length of the dry seasons significantly limits cultivation. A dry period with less than 100 mm of rainfall over more than three months is considered a critical threshold for cocoa growth and yield.

The impact of water deficit on early cocoa pod development is not well understood.

Prolonged dry periods, like other climate-related events, can significantly reduce cocoa bean size and yield due to higher flower termination rates and increased withering. Extended drought periods adversely affect flower production and lead to flower abortion, thereby reducing the survival of pollinated flowers, pod sizes and dry bean yield. Drought also diminishes the number of beans per pod, as well as bean size and weight. The impact of water deficit on early cocoa pod development is not well understood. Cocoa seeds convert sucrose to oil and lipids, but under water stress, it is suggested that reduced carbon uptake could limit sugar transport and lipid deposition. This may explain the lower seed weight observed in water-deficit conditions.

Closing the knowledge gap is crucial to transition from planting trees for compliance to mitigating production risks and improving profitability in the cocoa supply chain.

In a nutshell: Without significant investment in research, the technical levers for climate-resilient, sustainable cocoa production remain unclear – with all the consequences for farming communities, the entire cocoa supply chain and ultimately the environment.

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