



# Managing Trade-Offs in Coffee Agroforestry

Final project fact sheet

**In India, coffee is still grown under native shade tree canopy. These biodiversity-rich agroforestry systems are believed to be more sustainable. Yet diverse shade tree canopies are being replaced by the exotic, fast-growing marketable silver oaks, and the implications of such changes are not well understood. This project found that a diverse native tree shade cover improves coffee production and quality, pest management, soil fertility, and resilience to climate change.**

## Motivation

Coffee is one of the most valuable and widely cultivated crops in the tropics. Traditionally, it is grown under the shade of native trees in agroforestry systems that provide multiple ecosystem services beyond coffee. Diverse shade tree canopies are being replaced by one or few exotic fast-growing marketable species to increase short-term productivity of the agroforestry system. This reduction in shade tree diversity might, however, also negatively affect the functioning of the agroforestry system and its resilience to climate change.

## Objective

The project aimed to assess the effects of shade tree diversity reduction on ecosystem services in agroforests in Kodagu, south India, and to understand the arising management trade-offs for coffee production in the face of climate change. Kodagu, a highly biodiverse region, is the main coffee production district in India. Here, diverse shade tree canopies are being replaced by the fast-growing exotic silver oak, *Grevillea robusta*, due to its value as a timber resource, and to support pepper vines. In addition, climate change is expected to cause longer dry periods and more intense rainfall, adversely impacting coffee production.

## Research Highlights

The study revealed that maintaining a diverse native tree shade cover helps to preserve not only native tree diversity but also to enhance coffee production and quality, pest management, soil fertility, and resilience to climate change. Researchers studied 25 agroforests that varied in their shade tree diversity, from canopies containing multiple native species to canopies dominated by silver oaks, and management systems (conventional vs. organic) across a broad rainfall gradient. Results showed that agroforests with a diverse tree shade cover contained many rare tree species and had a higher coffee bean production per hectare than agroforests dominated by silver oaks. Increasing shade tree diversity led to larger coffee beans and fewer plants attacked by the coffee berry borer, a major pest to coffee crops across the world (see Figure 1). Organic systems produced as much coffee as conventional systems and organic plantations showed more diverse shade canopies and less silver oaks than conventional plantations.

This project also showed that diverse shade tree canopies increased nutrient cycling and soil fertility. In silver oak-dominated agroforests tree litter was of lower quality, with less micro- and macronutrients released to the soil. Soil fertility was directly affected with reduced soil carbon and micronutrients. To simulate changes in rainfall pattern researchers experimentally manipulated the amount of rainfall reaching the forest floor. Reduced rainfall led to drier soils with more plant available nitrogen, which in turn resulted in fewer coffee berries dropping prematurely before harvest in all agroforests. These benefits on soil moisture and coffee yield were stronger in diverse shade agroforests, probably due to their higher soil carbon content and lower nutrient leaching. Diverse shade agroforests are thus more likely to buffer climatic changes than silver oak-dominated agroforests.

### Relevance to Stakeholders:

The study revealed important co-benefits of maintaining diverse shade canopies for biodiversity conservation, coffee production and ecosystem functioning. Diverse native shade tree canopies can not only help farmers to increase their yields and income but also to increase the system's resilience in the face of climate change by reducing pest attacks and increasing nutrient cycling, soil fertility, and soil moisture. Conversion from conventional to organic management could help farmers to cut fertilizer expenses without affecting coffee production or quality.

### Media

Keller, J. [Indo-Swiss Coffee Connections](#). *swissnex India* [Online], **June 2016**.

Perinchery, A. [More the forest trees, the better the coffee](#). *The Hindu* [Online], **30 September 2017**.

Jayaraj, N. [An agroforestry scientist's notes on Kodagu, coffee and climate change](#). *India Mongabay* [Online], **04 September 2019**.

Jayaraj, N. [Kodagu, coffee, climate change: an agroforestry scientist's notes on the connection](#). *Tech2* [Online], **05 September 2019**.

Video [How to protect the environment \(and drink better coffee\)](#). *World Food System Center, ETH Zurich*. **19 April 2019**.

### Workshops

Interaction on trade-offs in coffee agroforestry systems. Farmer workshop. Ponnampet, Kodagu, India, April 2014.

Farmers interaction on coffee agroforestry systems in Kodagu.

Farmer workshop. Ponnampet, Kodagu, India, November 2015.

Perceiving the future of Kodagu landscape: Coffee, shade trees and bees. Stakeholder workshop. Bittangala, Kodagu, India, June 2016.

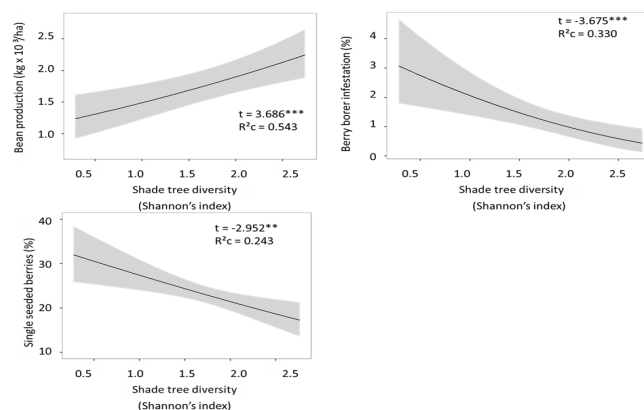


Figure 1. Relation between shade tree canopy diversity and coffee bean production, coffee berry borer (pest) incidences and single seeded (small) beans (Source: Nesper, M.)

### Selected Publications

Nesper, M.; Kueffer, C.; et al. [Shade tree diversity enhances coffee production and quality in agroforestry systems in the Western Ghats](#). *Agric. Ecosyst. Environ.* **2017**, *247*, 172-181.

Nesper, M.; Kueffer, C.; Krishnan, S.; Kushalappa, C. G.; & Ghazoul, J. [Simplification of shade tree diversity reduces nutrient cycling resilience in coffee agroforestry](#). *J. Appl. Ecol.* **2019**, *56*(1), 119-131.

Dainese, M.; Martin, E. A.; Aizen et al. [A global synthesis reveals biodiversity-mediated benefits for crop production](#). *Science advances*. **2019**, *5*(10), eaax0121.

Nesper, M.; Kueffer, C.; Krishnan, S.; Kushalappa, C.G.; Ghazoul, J. [Microclimate affected by the alien \*Grevillea robusta\*, Proteaceae, increases the effect of climate change in coffee agro-forests in the Western Ghats, India](#). *In preparation*.

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**Project Duration** 2012-2017

**Funding** WFSC Mercator Research Program

**Food System Challenges Addressed** Resilience, climate change and agroecosystems, alternative markets/ certification

[www.worldfoodsystem.ethz.ch/research/research-programs/MRP/moca.html](http://www.worldfoodsystem.ethz.ch/research/research-programs/MRP/moca.html)

The WFSC would like to thank the Mercator Foundation Switzerland and the ETH Zurich Foundation for supporting this project.

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