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Trees are pivotal in the agroecological management of coffee pests and diseases

The presence of trees within and in the vicinity of coffee stands impacts pest and disease development. **Trees may stimulate three agroecological pathways: (i) they modify the physical environment and directly or indirectly curb pest and disease development by enhancing the development of natural enemies or changing the physiology of crop plants; (ii) they modify the biological environment and favor natural enemies (birds, certain arthropods and microorganisms); and (iii) they create physical barriers that hamper pest and pathogen movement.** It is essential to gain insight into these different pathways so as to be able to effectively use trees as a lever in the agroecological management of pests and diseases of coffee or other crops.

Some diseases are almost absent in coffee-based agroforestry systems because the trees regulate extreme ambient temperatures (e.g. brown eyespot disease caused by *Cercospora coffeicola*). Shade trees help regulate fruit load on coffee trees, while avoiding imbalances conducive to the development of other diseases such as dieback, associated with *Colletotrichum* spp., or coffee leaf rust caused by *Hemileia vastatrix*. Trees host predators of insect pests, such as birds and ants, while providing moist and shady conditions that are favorable for fungal natural enemies (*Beauveria bassiana* and *Lecanicillium lecanii*). In this way, trees enable the regulation of the coffee berry borer (*Hypothenemus hampei*) and rust. Moreover, tree windbreaks help avoid coffee blight caused by *Phoma costarricensis*, which penetrates coffee leaves via wounds inflicted by cold winds. Finally, the presence of forest stands in coffee landscapes reduces the impact of coffee berry borer, probably by making it harder for this pest to access resources during non-fruit bearing periods. Trees can have complex and sometimes unwanted impacts on pests and diseases, some of which are unstable due to interactions with the environment. Moreover, not all trees are equivalent. A current research challenge is to identify trees with functional traits that will help curb unwanted impacts while maintaining the sought-after effects.

▲ Croton *windbreaks in coffee plots under Inga tree shade, Apaneca, Salvador.* © *J. Avelino*

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Rubber agroforestry systems in Kalimantan, Indonesia

A survey was conducted by CIRAD in 2019 on the evolution of rubber agroforestry system (RAS) trial plots that had been set up in the 1990s in West Kalimantan as part of the Smallholder Rubber Agroforestry Project[3]. In 1994, most farmers relied mainly on jungle rubber, i.e. a seedling-based agroforestry system with low crop productivity (500 kg/ha/year) but high biomass and biodiversity. Most farmers wanted access to clonal rubber planting material to improve land productivity (expected yields of up to 1,800 kg/ha/year) while retaining the advantages of their agroforestry practices.

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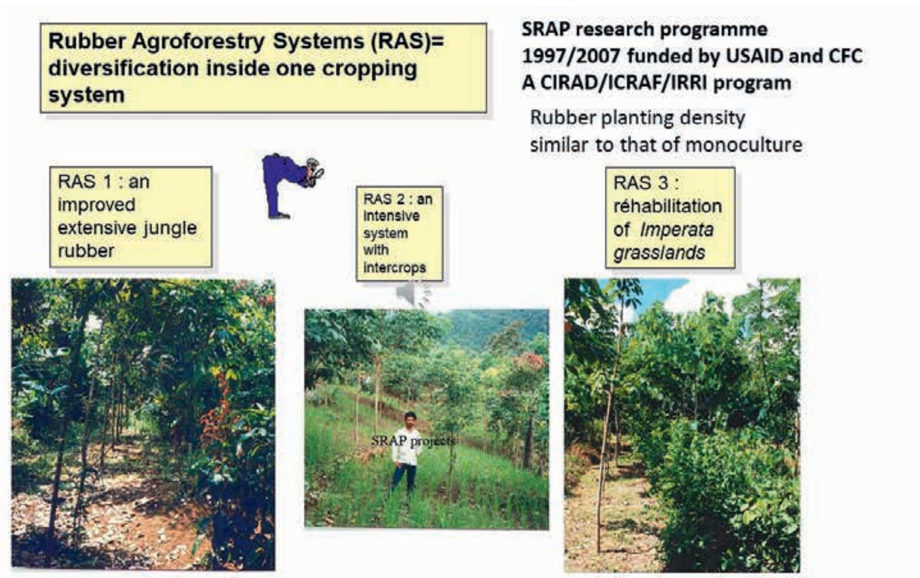

Farm trials were originally set up with local farmers for multiple reasons: (i) to provide clones and generate high rubber yields; (ii) to maintain agroforestry practices to benefit from positive externalities and ecosystemic services in the long run; and (iii) to diversify income via timber, fruit, resin and other forest products. In 1997, oil palm emerged in the landscape through the very rapid development of private concessions, which provided local farmers with an opportunity to gain access to good quality oil palm plots (2 ha) in exchange for land for the estate concession (5 ha, mainly oil palm). Oil palm became the priority crop for most smallholders in the 2000s. All forest and most jungle rubber stands have disappeared. In 2019, roughly two-thirds of the area was cropped with oil palm and one-third with clonal rubber. Meanwhile, smallholder farmers' interest has shifted away from rubber cultivation due to the low rubber prices prevailing since 2013—they are now relying on several crops yet have not abandoned rubber definitively. Rubber is still planted for income diversification, mainly in monoculture and RAS 2-type systems (i.e. with 550 rubber trees/ha, and 250 associated fruit/timber trees/ha in the inter-rows). Most local farmers favor agroforestry practices as long as they do not jeopardize the rubber production potential and can significantly increase their gross margin/ha (by 30% on average in 2020). **The long-term sustainability of RAS systems is recognized.** The recovery of wood from rubber and associated timber trees at the end of rubber lifecycle helps cover replanting costs. RAS therefore significantly contributes to the agroecological transition and provides a serious alternative to oil palm monoculture.

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Implementing farmer-centered approaches to scale agroecological principles in smallholder systems in Niger and Kenya

Smallholder farming is a critical contributor to global food security but is highly threatened by land degradation, loss of soil function/fertility and corresponding low crop yields. Land degradation must be addressed through active engagement of farmers to integrate restorative agricultural practices on their farms. Farmers in Kenya and Niger implemented planned on-farm comparisons to test and innovate land management practices able to restore agricultural productivity and ecosystem health. These planned comparisons—which differ radically from past development approaches—embed research into the development[1] and scaling process, while empowering farmers to restore degraded lands. Research in Development ensures colearning for multiple stakeholders throughout the project cycle to ensure adaptive management. Farmers and local communities compare the performance of promising practices across differing contexts.

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▲ ***Farmer centred planned comparison approach.*** *© S. Chesterman.*