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ABOUT

Why a Catalog?

Rising temperatures, distorted rainfall patterns and emerging challenges with pests and disease caused by climate change are affecting coffee production around the globe. With the recognition that retaining and replanting trees in coffee landscapes will be a critical strategy to climate change adaptation, farmers are exploring the need to maintain or re-introduce canopy cover in and around production systems, creating agroforestry settings that can play a central role in combating the effects of climate change and supporting income diversification strategies. However, farmers and practitioners often lack the information needed to select shade trees that are **good for coffee**, **support and diversify household incomes** and provide **benefits to wildlife** and **ecosystem services**.

The Shade Catalog is meant to do just that – provide coffee farmers and technical assistance teams key information about tree species that have been found in and around coffee landscapes. From the main attributes of the species, to the use and benefits, through to propagation and management tips, the catalog is a useful guide for whole-farm planning.

This catalog is intended to promote the diversity of shade trees within Indonesian coffee farming systems with applications for any group propagating shade trees or providing trainings about the importance of shade trees as a component of sustainable coffee management.

Why Indonesia?

Indonesia is one of the world's largest producers and exporters of coffee, with nearly 2 million smallholder coffee farmers managing 1.2 million hectares of coffee land[1]. The country is also one of the most biodiverse areas on the plant, although many of the endemic plant and animal species face extinction due to habitat loss[2]. Coffee is grown primarily in remote villages, and sustainability of the farming system impacts the wellbeing of coffee farmers, rural communities, the economy, and the environment.

Shade trees on coffee farms are an integral part of this sustainability and provide resources to farmers, wildlife, and the coffee crop itself. However, availability of most shade tree species is low. Government agencies, NGOs and international coffee trading companies distribute some trees for free, but the frequency and distribution can be inconsistent. These groups primarily provide nitrogen fixing shade trees—especially Lamtoro (Leucaena spp.)—timber trees, and fruit trees. This catalog should serve as a reference to select, propagate and promote additional tree species throughout Indonesia's vast coffee growing regions.

Indonesia primarily produces two coffee species—arabica (Coffea arabica) and robusta (Coffea canephora)—which are often grown under different tree species given different elevational and regional distributions. Robusta, which has a higher caffeine content but less desirable flavor profile than Arabica, is concentrated in Southern Sumatra, Lampung, and Bengkulu at elevations ranging from 40 to 900 meters above sea level. These regions produce ~60% of all of Indonesia's coffee. Arabica coffee grows at higher elevations, ~1,000 to 1,500 meters primarily in North Sumatra, Aceh, and Java[3].

How are shade trees currently used in Indonesian coffee farms?

Smallholder farmers cultivate coffee in diverse farming systems that can be categorized as complex agroforestry, simple agroforestry, and monoculture[4]. Complex agroforestry, which includes most traditional agroforestry systems, typically include 6 to 30 tree species per farm that form multi-layered strata and provide shade for the coffee. These systems are typically located close to the farmer's house, require low levels of maintenance, and have irregular spacing of both coffee and shade trees. Additional annual and perennial crops are cultivated together with the coffee, and can be used for household subsistence, for ceremonial or religious purposes, or sold. Despite producing low coffee yields, complex agroforestry systems are considered productive and sustainable at the farm level.

To boost coffee production, simplified agroforestry systems are also implemented by smallholder farmers. These systems typically maintain less than 5 shade tree species per farm that form a single shade stratum. The shade and coffee plantings are more regularly spaced than in complex agroforestry system and benefit from regular maintenance. The shade canopy is primarily dominated by leguminous shade trees (Family Fabaceae) that fix nitrogen, regulate the intensity of sunlight to the coffee, and may provide forage for

livestock. Leguminous species also provide biodiversity benefits ecosystem services by attracting and sustaining insect, bird, and mammal communities that may help regulate pests. Trees with fruits that can be consumed or sold are commonly included in these systems as well.

Although simple agroforestry systems are widely promoted by government agencies and NGOs, monoculture systems ("sun coffee") are common in some regions. In North Sumatra, for example, monocultures are promoted and employed to maximize coffee yields, and many farmers may be unaware of shade tree benefits.

Choosing the right shade tree

Agroforestry systems generate significant environmental benefits though there are a number of tradeoffs that should be considered when providing guidance to farmers as they consider these options. Shaded coffee typically has lower productivity than full sun coffee and increase the cost of weeding, while pest pressure may be lower and natural predators more abundant in shade systems and therefore require less costly pest management products[5]. Economic trade-offs should be considered to find the right combination of shade trees that provide environmental benefits while generating economic returns. In addition to levels of revenue, the timelines are also important to consider, as timber species take longer to generate returns than fruit trees or other revenue generating shade variety options. Different management regimens and the timing of labor requirements should also be considered, as shade management can be labor intensive on mature shade trees and may also require special knowledge and training. These tradeoffs should be examined to ensure strong alignment with farmer needs and opportunities to help catalyze changes in farm management to advance broader environmental goals.

A living document

This catalog contains information about tree species currently found within Indonesian coffee farming systems. Some tree species facilitate coffee yields and improve soil nutrition, while other trees may be selected by farmers due to their farm, income, or biodiversity benefits. While many of these species are propagated by farmers, some simply occur on coffee farms through natural regeneration. Tree species accounts were created from interviews with farmer groups and agroforestry experts and data compiled from scientific publications and technical reports in both English and Bahasa. The catalog focuses on tree species but also includes commonly planted palms and shrubs. While this catalog compiles all current knowledge, future research is needed to establish propagation guides and establish how each species interacts with coffee plants. Nomenclature follows www.plantsoftheworldonline.org/. This catalog is intended to be a living document that will be refined and updated as more information or research becomes available about these species.

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SHADE BENEFITS

So why all the fuss over trees? Trees clean our air and make it more breathable, clean our water, keep soil healthy, buffer floods, and provide habitat for wildlife and enhance biodiversity, all of which contributes to keeping us healthy.

Incorporating trees in and around coffee production, particularly native species, can also provide benefits to coffee and people. Here are just a few reasons why:

- **Coffee quality:** Evidence shows that coffee under shade produces higher weights of fresh fruits, larger beans and better visual appearance[5].
- **Climate regulation**: As climate change continues, coffee communities are heating up. Given that arabica requires cool temperatures between 18 and 21 degrees Celsius, shifts in on-farm temperatures put production at risk. Trees help reduce temperature volatility, cooling air during the day and keeping it warmer during the night, reducing stress on coffee plants. [6]
- **Soil health**: Fallen leaves and roots help maintain healthy soils by offering natural aeration, nutrients and moisture, providing food for healthy soil fauna that convert the dead plant materials into nutrients available for plant growth. [7]
- **Erosion prevention**: The presence of tree systems helps prevent erosion, particularly on steep slopes and under heavy rainfall, by reducing rainfall impact and holding soil together underground[8]. Leaf litter from the trees also helps diminish rain-induced erosion[9].
- **Water capture / regulation**: Rainwater is retained on tree leaves, to be released back into the air as evaporation. Leaves on the ground act as sponges, soaking up moisture and gradually releasing it. Shaded soils retain moisture far longer than soils exposed to sun. This is very important as climate-change-induced droughts increase in frequency and intensity. Finally, tree roots usually run deeper than coffee and other crops, so they don't compete with them for water or soil nutrients[10].
- **Pest control:** Trees provide safe refuge and habitat for pest predators such as birds, bats, ladybugs, spiders, and lizards. These natural predators eat insect pests that might otherwise harm coffee production, and pest outbreaks spread more slowly when trees are mixed into the farm. This natural pest control can decrease pesticide costs[11].
- **Pollination**: Trees provide safe refuges for natural pest predators such as ladybugs, spiders, and lizards, and pollinators such as bees and butterflies, giving them rapid access to the coffee. More tree species support more pollinators, which is important for coffee as the diversity and abundance of bees impacts coffee fruit sets, fruit weights, and yields[12].
- **Biodiversity**: Trees also provide habitat for native birds, reptiles, mammals, and other plant species such as orchids and bromeliads. Each layer of leaves above the coffee has unique microclimatic attributes, providing unique habitats for unique species[13].
- **Carbon capture**: Agroforestry systems in Indonesia can accumulate and store a significant amount of carbon, with values as high as 69.5 tons/ha[14]. Tree density is one of the most important metrics that influences carbon sequestration, as denser spacing leads to higher carbon stored per area[15]. Tree age/size is also important, with mature trees holding much more carbon than young trees.
- **Income security**: Shade trees provide fruits, lumber, and other fibers that can be sold in addition to the coffee, increasing the overall income security of the farmers. Because of their deep roots and energy stores, trees are more resilient to climate change, and are therefore better equipped than coffee to produce fruit in drought years, providing a reliable secondary source of income. Trees can also directly provide fruits, seeds, oils, fuelwood, and construction materials for household use, increasing the economic resilience of the farmers.[16]

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