



BENEFITS OF AGROFORESTRY

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According to Naturland standards, organic coffee and cocoa must be cultivated under agroforestry systems appropriate to local conditions, under shade trees. Several benefits can be seen physically or experienced passively by practicing a well-managed agroforestry system. Growing coffee under agroforestry systems have several direct economic benefits. There are also agroecological benefits at farm level, social and cultural at community level.

Benefits of agroforestry on an economic level

Growing other products for personal consumption

Under agroforestry systems, other crops are grown together with the cash crop. These other crops can be used by the farmer and their families for personal consumption, providing them with healthy and diverse nutrient-rich food. Agroforestry systems can also be a reliable source of animal feed for livestock. Firewood and construction material can also be produced on the farm, with multiple species of trees providing wood at various stages of the year.

Reducing expenses and dependency

By acquiring food, fodder, firewood and construction materials from their farm, farmer reduce their expenses as they don't have to purchase those goods on local markets. This makes them independent from market price fluctuation. Thanks to the agroecological benefits of agroforestry, farmers are able to reduce their dependency and save money on external inputs (fertilizers, pesticides).

Diversification of income and risk

Besides own consumption, the additional goods produced in the agroforestry system can be sold on local markets and create alternative sources of income. These edible products produced together with coffee can earn a premium as they are produced organically. Some goods can even be processed by the farmers and their families to be sold as value-added products such as essential oils, fibres, processed fruits, and handicrafts from wood. It reduces economic risks for the farmer as they do not have to depend on one cash crop and its price fluctuation.





- 1 Timber (construction, firewood, ...)
- 2 Animal fodder
- 3 Food (banana, palm tree, ...)
- 4 Monetary revenues (coffee, ...)
- 5 Fibre (clothes, textiles,...)
- 6 Medicine (herbs, bark,...)
- 7 Mulching material

Figure 1: Example of products that can be used for own consumption or to sell on local markets.

Getting higher prices for high quality coffee

Growing coffee in agroforestry systems has several beneficial impacts on the coffee quality. A better quality enables better prices on export markets, bringing more income to the farmer – one of the crucial reasons to convert to an agroforestry system on the individual farmer’s level.

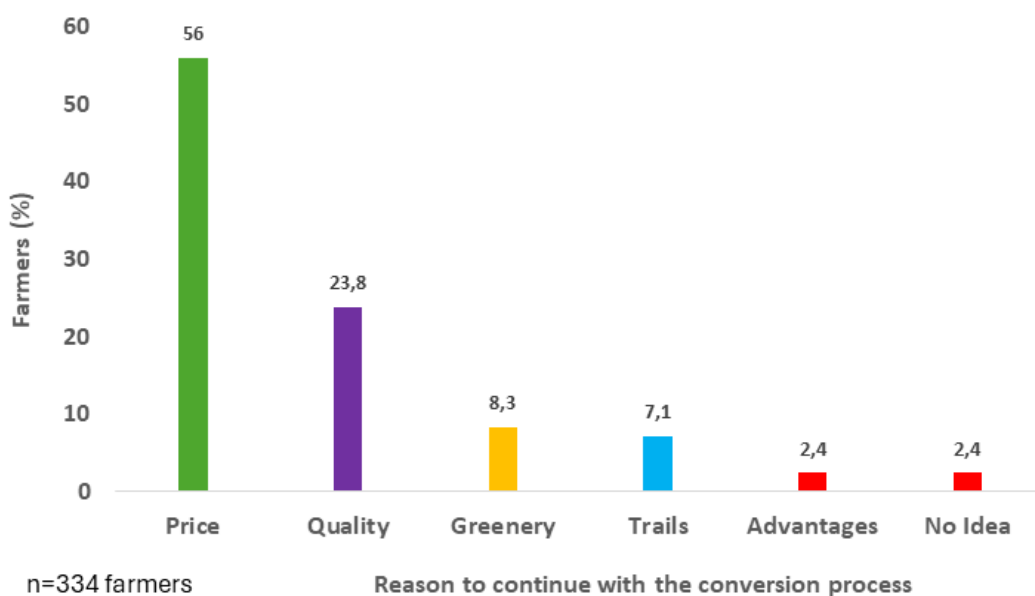


Table 1: Reasons to continue the conversion process to agroforestry started 7 years ago (Burundi). own illustration according to Ndiokubwayo et al. (2021)

Influence of shade on coffee plants

Shade trees create a cooler and optimum environment for the coffee plant. It lowers the stress experienced by the coffee plant, which results in slower fruit ripening and better filling of beans. A slower development of the bean leads to:

- denser and heavier beans, which leads to more complex flavors and aromas and retaining of their fresh flavors for an extended period of time.
- increased acidity due to higher levels of beneficial organic acids. These acids result in a brighter and more complete flavor profile in the brewed coffee.
- slightly lower concentration of caffeine.

Shade in an agroforestry system regulates temperature and direct sunlight exposure. Direct sunlight exposure for longer durations can increase the levels of chlorogenic acid in coffee beans, leading to bitterness. Shade mitigates the risk of “sunburn” on coffee cherries, which results in undesirable flavors and aromas in the coffee.

Influence of the presence of shade trees

Trees in an agroforestry system promote a richer and more diverse soil microbiome, including beneficial bacteria and fungi. This microbiome improves the nutrient uptake of coffee plants and leads to a more robust and flavorful coffee bean.

Furthermore, the shade tree varieties can have an impact on the final flavor profile, since the trees influence the microclimate and nutrient availability for the coffee plants in specific ways. The flavor notes variations based on the shade tree species can be subtle yet distinctive from each other. For instance, *Grevillea robusta* can impart hints of citrus notes in the beans.

Less resource competition

Coffee intercropped with trees in an agroforestry system limits the number of flowers and fruits on a single plant. It reduces the competition for resources among the developing beans, improving cup quality.

Reducing the risk of losses

Cash crops experience less environmental stress by being shielded from the elements, like wind and heavy rain. Less loss occurred during these extreme weather events.



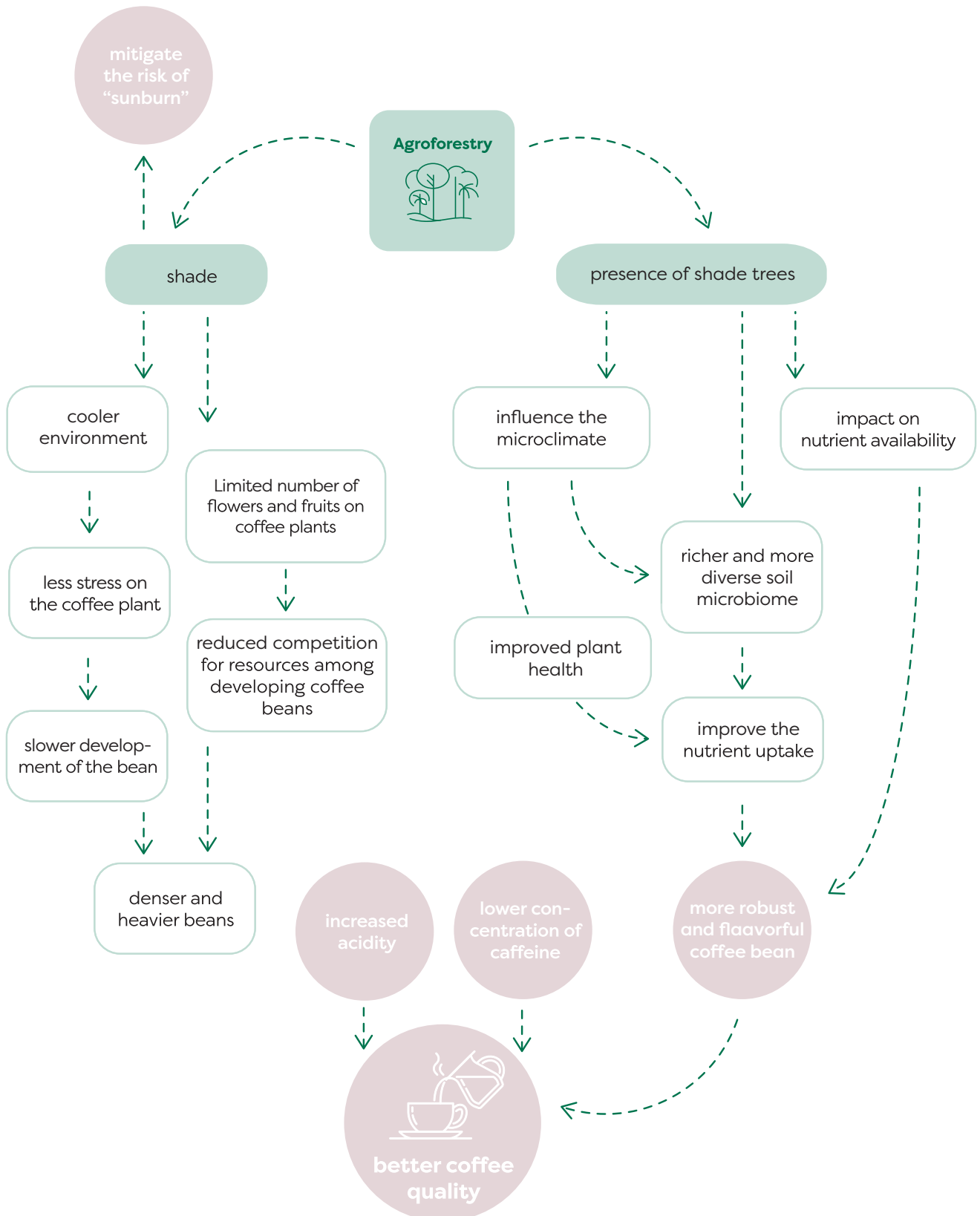


Figure 2: Sum-up of the causal effect of agroforestry on coffee quality

Agroecological benefits of agroforestry on the farm

Soil conservation

Trees improve the structure and stability of the soil. Extensive root systems of the trees hold the soil particles together, preventing soil erosion, providing higher amounts of biomass for mulching and nutrient recycling. Trees act as wind-breakers and regulate wind speed, reducing soil erosion. The canopy of trees can intercept rainfall, reducing its impact on the soil surface, and slowing down water runoff. Their root systems bind the soil particles, stabilising the soil structure and preventing erosion.



Figure 3: A root system stabilising the soil
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Nutrient cycling

Trees capture nutrients deep in the soil through their extensive root systems and bring them to the surface. These nutrients become available to the crops. Leaf litter, root exudates, and other falling organic matter from the trees further supplement the soil with nutrients. In this way, a closed nutrient cycle is established.

Certain tree species in agroforestry, particularly leguminous trees, have the ability to fix atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteria in their root nodules. This process enriches the soil with nitrogen, an essential nutrient for plant growth. The crops benefit from each other, increasing productivity as the diversity of crops leads to higher yields.

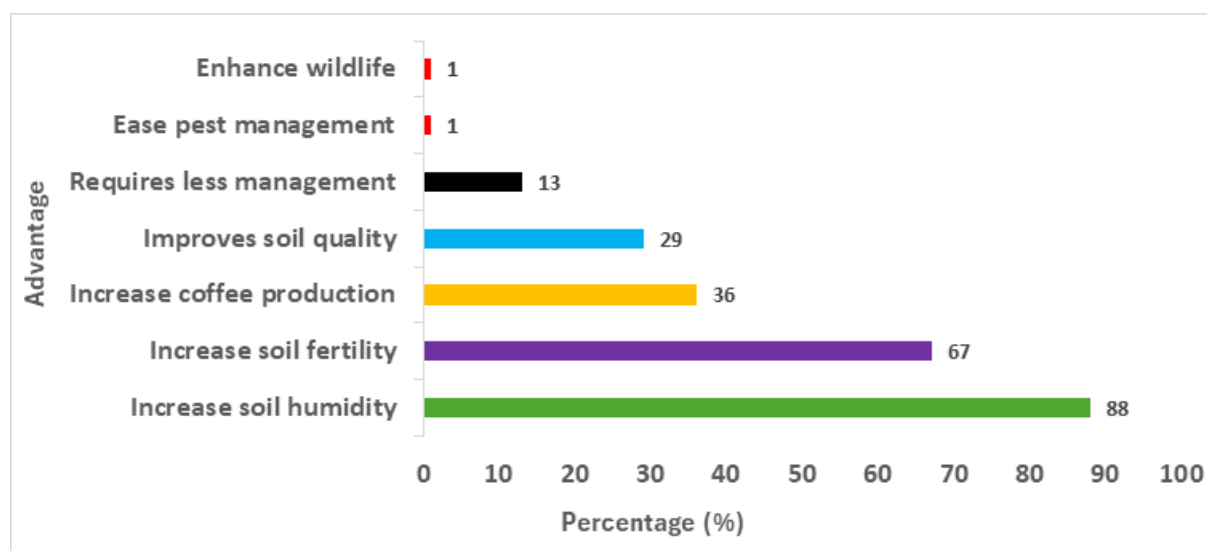


Table 2: Advantages of shade trees on coffee plots as seen by 334 farmers during their conversion process to agroforestry in Burundi. own illustration according to Ndiwokubwayo et al. (2021)

Organic matter input

Fallen leaves, twigs, and other tree biomass decompose, adding organic material and nutrients to the soil. This organic matter improves soil structure, water-holding capacity, moisture retention and nutrient retention, leading to enhanced soil fertility.

Microbial activity

The presence of trees and the litter layer of organic matter create a favorable environment for beneficial soil microorganisms and (mycorrhizal) fungi. These are essential to decompose organic matter into nutrients that can be absorbed by plants.

Shade and organic matter reduce soil temperature and protects soil from direct sunlight. This is beneficial for soil microbes, as high temperatures endanger their vitality and life.

Water use efficiency

The tree roots create channels and pores in the soil, allowing water to penetrate more easily. In line with good soil structure, this increases the soil's ability to absorb and store water, reducing surface runoff and promoting groundwater recharge. Trees also bring water up from deeper layers in case there is a lack of rain or not enough water coming from above. Their canopies provide shade, reducing evaporation from the soil surface and minimising moisture loss. This can reduce water requirements for crops, as they experience lower evapotranspiration rates.

Regeneration of the soil

Agroforestry systems can reclaim polluted or degraded soils with particular species of trees. Agroforestry can also reduce existing soil toxicities like salinization and acidification and keeping them in check.

Improving pests & diseases monitoring and management

As farmers spend more time on their field to harvest the intercrops and because the shaded field is a more comfortable place, they can observe the occurrence of pests and diseases and can implement pest and disease management measures before they can spread and cause damage to the plants.

A higher density of desired plants limits weed growth. Multiple tree species in an agroforestry system provide shelter for small mammals, reptiles, and birds, which can feed on disease-causing pests. The improvement of biodiversity reduces the occurrence of pests and diseases.





2014

There is no intercropping and no shade trees. There are big problems with Antestia bug. Farmers don't spend much time in their fields.



2018

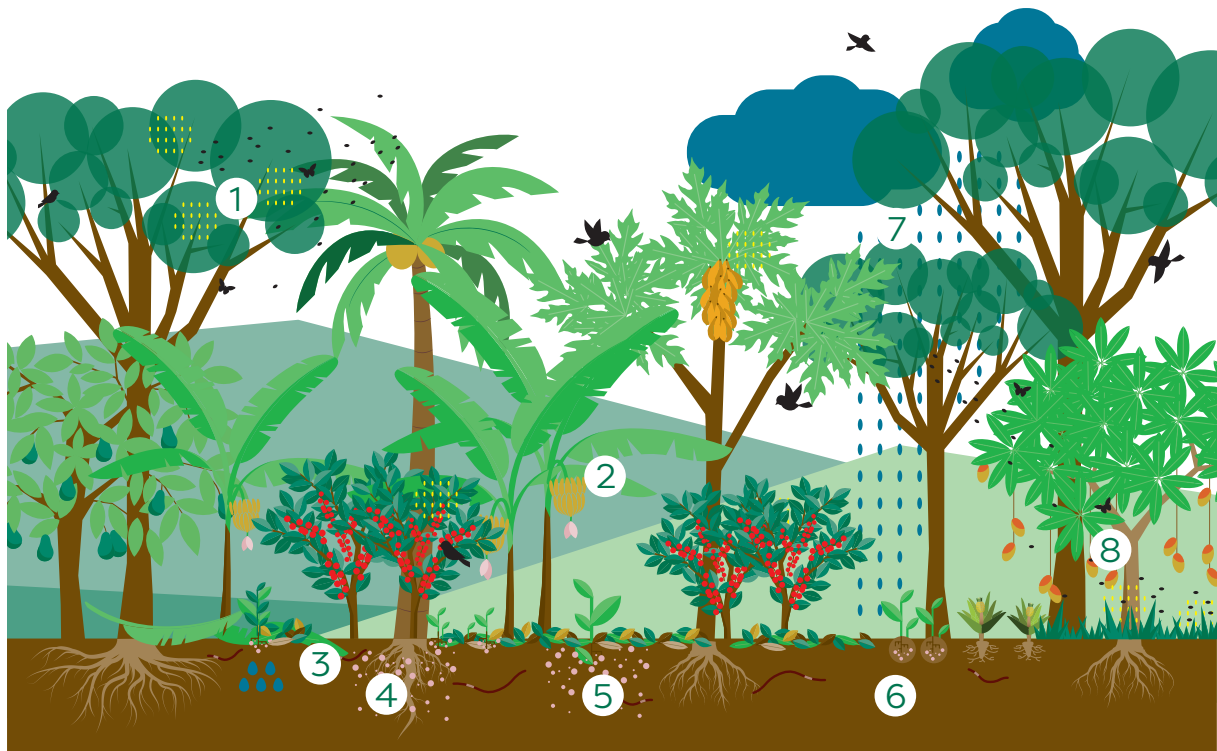
Farmers start spending more time in their fields improved farm management and pest observation



2022

Farmers do spend more time in their fields as they can harvest other crops. Monitoring of the Antestia bug is much better. If discovered, they use a biopesticide produced of Neem.

Figures 4, 5 and 6: Evolution of a coffee farm from 2014 (start of the conversion to agroforestry) to 2022 at COCOCA, Burundi © Naturland e. V.



1 Enhancing biodiversity and the presence of various species, as well as attracting pollinators such as bees and butterflies.

2 Providing shade that reduces water and heat stress on crops, animals, and farmers.

3 Good soil structure and organic soil cover reduce rainwater runoff, allowing water to infiltrate the soil.

4 Increasing nutrient inputs available for plants due to deep roots system and nitrogen-fixing trees, stabilising soil with root system.

5 Enhancement of biological activity through

reduced soil temperature, providing organic matter as habitat and food for various insects and organisms.

6 Creating a good soil structure, improving moisture retention and nutrient-holding capacity.

7 Protection from wind, sun and heavy rain. Reduced water runoff, soil erosion and water losses through evaporation due to heat and direct sunlight.

8 Providing habitat for natural predators that feed on pests and prevent the spread of diseases.

Figure 7: Sum-up of the agroecological benefits of an agroforestry system

Benefits on social and cultural level

Preserving communities

Agroforestry enhances traditional food systems with a diverse supply of fruits, vegetables, nuts, animal products, safeguarding access to culturally significant foods. It assists in preserving local traditional knowledge and practices in farm management and food production, empowering local communities by including their needs and wishes into the planning and development of the agroforestry system, giving them the decision making power over their land and resources.

Bringing job opportunities

Agroforestry provides job opportunities to the local community in various cultivation stages, such as planting, harvesting, and processing agroforestry products other than the cash crop.

Preserving the future

Agroforestry systems preserves natural and national resources like biodiversity from being depleted for future generations by increasing biodiversity. In an agroforestry system, 2.5 times as many birds as in a conventional coffee farm can be observed in average.

Attractivity of the territory

Improving the aesthetics of the landscape and ecosystem full of biodiversity increases the appeal of the area for working, promotes tourism and recreational activities by creating a beautiful landscape and ecosystem full of biodiversity.



Figures 8 & 9: two coffee plantations
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Benefits of agroforestry on ecological and environmental level

Carbon sequestration

Trees planted in agroforestry systems can help absorb the carbon from the atmosphere and inject it into the deeper horizons of the soil contributing to carbon sequestration thus helping in tackling climate change.

Mitigation of the impacts of climate change

The increasing negative impacts of climate change such as irregular rainfall, increasing droughts, landslides, strong winds etc., can have severe impacts on farms, humans, and animals. Agroforestry

can help reduce the impacts in various forms, i.e. windbreaker trees can protect the cash crop from severe winds, trees planted on a hill side can hold the soil with their roots and can prevent landslides.

Improving air and water quality

Trees can absorb dangerous pollutants from the atmosphere and reduce air pollution thus increasing air quality.

The risk of chemicals leaching into groundwater and other water sources is avoided, because no synthetic fertilizers and pesticides are needed. Humans and animals that might use this contaminated water, are protected.

Summary

Agroforestry improves the livelihoods of farmers and their families by providing economic benefits that can be invested in housing, livestock, and education for children. It also significantly impacts the environment by improving soil fertility and biodiversity and creating healthier farms for future generations. As a holistic approach to agriculture, agroforestry offers a guarantee for sustainable communities and an agricultural future.

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Picture & Table sources

- Table 1 & 2: own illustrations modified according to Ndiokubwayo, Soter & Havyarimana, Tharcisse & Windbuehler, Sarah & Niragira, Sanctus & Habonimana, Bernadette & Kaboneka, Salvator & Megerle, Heidi. (2021). Farmers' Perception of Coffee Agroforestry Systems in an Area Targeted for Organic Certification in Burundi. *East African Journal of Forestry and Agroforestry*. 3. 40-53. 10.37284/eajfa.3.1.352
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