AGROFORESTRY PLANTATIONS: IMPROVING RETURNS WHILE DECREASING COSTS
Case: Cacao

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Fg.4 Chimelb project. Brachiaria ruziziensis used as ground cover in a cacao plantation to recycle nutrients and control erosion.

Introduction

Cacao is a plant native to the tropical rainforests of the Americas. However, technified plantations in South and Central America have shifted from the traditional agroforestry systems, in which cacao naturally grows, to monoclonal, dry zone plantations. These changes, together with aggressive nutrition programs have achieved higher yields in shorter periods of time. This has led to large monoculture cacao plantations in countries that where originally know for the diversity of their cacao varieties production.
Monocultures decrease the resilience of the plantations – both economically and environmentally – and increase the amount of resources needed to maintain the expected production, especially the water demand.
Large scale plantations can be developed in a resilient, technified, profitable, sustainable way. The principles followed by this type of projects can be also applied to smallholders.

Objectives

- List resource efficiencies achieved in agroforestry plantations, using as examples existing 12Tree plantations
- Determine the environmental services of an agroforestry plantation in terms of biodiversity and overall ecosystem health
- Show the economic advantages of using agroforestry systems

Fg.1 Conversion of previous cattle farm into an agroforestry cacao plantation with primary pigeon peas shade. 12Tree Plantation – Cuango (Panama)

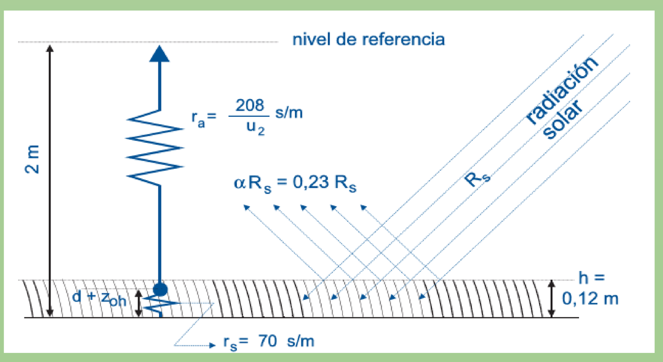
Fg.2 Water resource conservation in an agroforestry cacao plantation. 12Tree Plantation – Chimelb (Lanquín, Guatemala)

REFERENCES

1. *SISTEMAS AGROFORESTALES.*
   Susana Benedelti R. Ingeniero Forestal, División Silvicultura, Instituto Forestal. Santiago. Nicolás Espinoza R., Ingeniero Forestal (El
2. *http://www.worldcocoafoundation.org/wp-content/uploads/files_mf/adjaloo2013genomicsphysiologypollinator429kb54.pdf*
3. *https://www.smithsonianmag.com/science-nature/you-wouldnt-have-chocolate-without-invisible-flies-and-extreme-yeast-180954172/*
4. *Evapotranspiración del cultivo - Guías para la determinación de los requerimientos de agua de los cultivos.*
   FAO

Decrease of water usage

When estimating the water lamina needed to sustain a cacao plantation, the region's evapotranspiration ratio is a reference number. Agroforestry systems result in a reduced evapotranspiration ratio[1]. This reduction has a direct impact on the amount of water used. When the evaporating surface is the soil surface, the soil coverage percentage impacts the evaporation factor[4]. During the establishment period, almost 100% of the evapotranspiration occurs in form of evaporation, after establishment, over 90% occurs as transpiration (vaporization of water in the plant through the stomas)[4]. This is one of the main reasons why maintaining soil coverage in a new plantation makes the project more profitable – the amount of water needed has a direct correlation with the size of water pumps (energy consumption), dimension of pipes, valves, etc. (infrastructure costs).
In the project Chimelb (figure4), *Brachiaria ruziziensis* is used to prevent erosion and as a ground cover to decrease evaporation in the early stages of the plantation. Ground covers also help recycle nutrients added in the nutrition programs.



Calculation method for the evapotranspiration ratio in a reference crop (pastures)[4].

When a shade crop breaks the direct incidence of solar radiation over the crop, in the later years the transpiration can be reduced.
Wind speed is also a variable considered when calculating the evapotranspiration ratio in a given area. When introducing wind barriers in an agroforestry system, the speed decreases and thus reducing evapotranspiration. (Figure 3 shows natural wind barriers provided by a bamboo forest next to the cacao plantation in Cuango farm, Panama)

Improve pollination and create short – and long – term revenues

Potential permanent Crops

- Coconut – the shade provided by coconut palms is ideal for cacao in a pattern where the production is still profitable. In a combined irrigation system for both crops, a palm can produce up to 250 nuts per tree per year
- Rubber – in the right scheme and market, can provide permanent revenues to the plantation

Increase Biodiversity and overall ecosystem health

Agroforestry systems create interconnectivity between forest areas adjacent to a plantation. An agroforestry system can create an adequate habitat for the repopulation of fauna in a location[1]. When shade trees are included, a farm with neighboring natural forests can act as a biological corridor for local fauna and flora. While increasing the connectivity of the existing natural forests, the biodiversity of forest patches separated from the main forests tend to increase.
As these biological corridors inside the plantations are created, seed disseminators like birds, agoutis and monkeys, among others, spread seeds increasing the flora biodiversity as well.

Fg.5 Howler Monkey (Alouatta palliata) in the Cuango project. This is a florivorous species, but the diet can include up to 50% of fruits when available

Fg.3 Plantain primary shade in cacao agroforestry Plantation. 12Tree Plantation – Cuango (Panama)

Increase the resilience of a plantation

Agroforestry systems create effective wind barriers[1] and decrease the attacks of pests. A natural forest surrounding a plantation can create a natural barrier against diseases and pests.
Patches of natural forests can also divide the farms and isolate potential outbreaks of fungal diseases that otherwise would easily spread (i.e. Monilia in the case of cacao).
Figure 2 shows a cacao plantation with plantain growing as a primary temporary shade. The natural bamboo forest that acts as buffer between the plantation and the river, decreased the speed of the river in flood events in 2018, where cacao trees had been planted less than two months earlier. No plantlets were lost in the event.

Potential profitable temporary Crops

- Plantain – Musaceae increase the presence of forcipomya, thus increasing pollination[2, 3]
- Pigeon peas – leguminous plants fix nitrogen in the soil

Example of establishment cost mitigation in Cuango project in Panama

Average Establishment Costs **USD2,500/ha** → Average earnings from plantain: **USD850/ha** → Average Establishment Cost after Plantain: **USD1,650/ha**