The land user, Mr. Rafael Medina, drying cacao beens by spreading them manually under the sun in a greenhouse. (Hanspeter Liniger)

Agroforestry system of cacao and gallery forest (Colombia)

cacao

DESCRIPTION

Agroforestry system of cacao crop under gallery forest shadow as family agriculture. It is located at the foothill ecosystem of the Andes, in the Cusiana River, Orinoco Watershed, Colombia.

The agroforestry system of cacao crop planted under gallery forest is a private farmer initiative for family agriculture. The Crop is located in the gallery forest of Pozetas Stream, in the Cusiana River Basin. It is in the Foothill Ecosystem (300m a.s.l.), between the Andean Mountains and the Orinoco Floodable Savanas. Municipality of Tauramena (Casanare), Colombia.

The cacao growths in an area of 4 hectares, being considered small farming, according to the Orinoco Region scales. The cacao density is 1080 plants/hectare and the distance between plants is 3m. In this area, after tree thinning, the forest occupies 30% approximately. Some of the common tree species are Cedrus spp., Ficus spp. and Anadenanthera peregrina, among others.

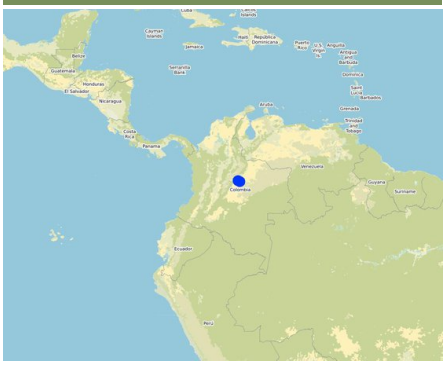
The purpose of the technology is to use the gallery forest land in a productive way to generate income for the family, while keeping part of the forest and integrate it in the agroforestry as cacao needs some shadow, specially in early growth stage.

Seed germination and seedling preparation, forest thinning and soil improvement with lime and organic fertilizer (rice husk), and finally planting, are the main establishment activities. Then the maintenance activities include cutting weeds, trimming cacao trees and fertilization every 2-3 months.

The cacao crop has produced fruits since the sixth year of being planted (2016) and is harvested every two weeks. It presents two yield peaks, the first one is in May-June and the second one in October-November. However it produces fruits along the year.

This technology provides additional income to the family, while conserving part of the original gallery forest. The more complex and diverse production system might favored pollination and crop health. The technology compared with other land uses around it such as oil palm tree and rice is more sustainable and it is something land users prefer. They also like the value added to the cacao beens by processing their self the cacao beens to produce hand made 100% cacao bars for drinking chocolate.

LOCATION



Location: Municipality of Tauramena, Rural District of Iquia, Casanare, Colombia

No. of Technology sites analysed: single site

Geo-reference of selected sites

- -72.79953, 5.0246
- -72.60177, 4.92761

Spread of the Technology: evenly spread over an area (0.04 km²)

In a permanently protected area?: No

Date of implementation: 2010

Type of introduction

- [x] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

Cacao fruits collection (Ana Silvia Martinez)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Tree and shrub cropping: cacao

Is intercropping practiced? No
Is crop rotation practiced? No

Forest/ woodlands

- (Semi-)natural forests/ woodlands. Management: Selective felling

Tree types (evergreen): Cedrus species, Anadenanthera peregrina, Ficus spp.,
Products and services: Fuelwood, Protection against natural hazards, shadow

Water supply

- rainfed
- ✓ mixed rainfed-irrigated
- full irrigation

Purpose related to land degradation

- ✓ prevent land degradation
- reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed

biological degradation - Bh: loss of habitats, Bq: quantity/ biomass decline

SLM group

- agroforestry

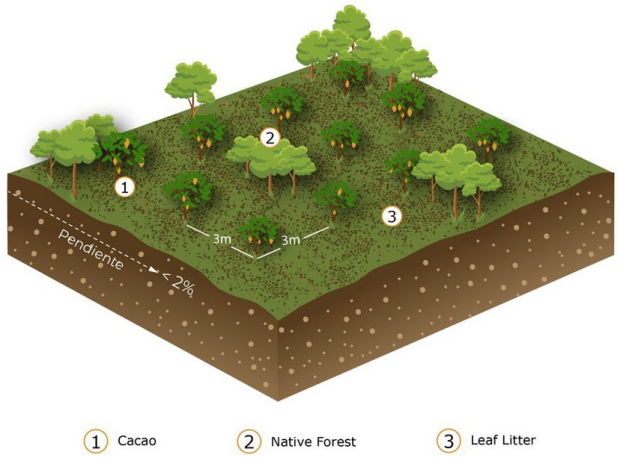
SLM measures

management measures - M1: Change of land use type, M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

In the agroforestry system of cacao and gallery forest, the cacao trees are planted, having 3 m distance between them. The native forest occupies 30% of the system and provides shadow to the cacao trees. Shadow is important for the good development of cacao, especially in early stages. Additionally the forest increases system complexity, diversity and balance, it increases crop pollination and health. The leaf litter from the cacao and the forest are also an important source of organic matter for soil.



Author: Diego Orduz and Luisa F. Vega

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **4 hectares**)
- Currency used for cost calculation: **Colombian Pesos**
- Exchange rate (to USD): 1 USD = 3750.0 Colombian Pesos
- Average wage cost of hired labour per day: 45000

Most important factors affecting the costs

The plant material from seeds to seedlings are the highest cos for the technology establishment. Then the fertilization is an important maintenance cost.

Establishment activities

1. Seed germination (Timing/ frequency: Enero)
2. Plant nursery establishment (Timing/ frequency: Febrero)
3. Clear felling of 70% of native forest in the area (Timing/ frequency: Febrero)
4. Sow hole digging (Timing/ frequency: April-May (beginning of rainy season))
5. Addition of lime and rice husk to the sow hole (Timing/ frequency: April-May (beginning of rainy season))
6. Cacao seedling planting in field (Timing/ frequency: April-May (beginning of rainy season))

Establishment inputs and costs (per 4 hectares)

Specify input	Unit	Quantity	Costs per Unit (Colombian Pesos)	Total costs per input (Colombian Pesos)	% of costs borne by land users
Labour					
Forest thinning to open cropland	ha	4.0	150000.0	600000.0	100.0
Sow hole preparation and seedling planting	ha	4.0	575000.0	2300000.0	100.0
Plant material					
Cacao seeds	seed	5400.0	25.0	135000.0	100.0
cacao seedlings	seedling	5000.0	500.0	2500000.0	100.0
Fertilizers and biocides					
Lime sack	50 kg	10.0	12000.0	120000.0	100.0
Rice husk	container	1.0	400000.0	400000.0	100.0
Total costs for establishment of the Technology				**6'055'000.0**	
Total costs for establishment of the Technology in USD				*1'614.67*	

Maintenance activities

1. Cutting of weeds, specially around each cacao tree (Timing/ frequency: Every 2 months)
2. Cacao tree trimming (Timing/ frequency: Every 2 months)
3. Fertilization (Timing/ frequency: Every 2-3 months)
4. Harvesting (Timing/ frequency: Every 2 weeks)

Maintenance inputs and costs (per 4 hectares)

Specify input	Unit	Quantity	Costs per Unit (Colombian Pesos)	Total costs per input (Colombian Pesos)	% of costs borne by land users
Labour					
Cutting of weeds, specially around each cacao tree	day	18.0	45000.0	810000.0	100.0
Cacao tree trimming	day	12.0	45000.0	540000.0	100.0
Fertilization and soil amendment with lime	day	13.0	45000.0	585000.0	100.0
Harvesting	day	24.0	45000.0	1080000.0	100.0
Equipment					
Manual tools (e.g. machete, trimmer, shovel)	kit	1.0	150.0	150.0	100.0
Fertilizers and biocides					
Lime sack	50 Kg	10.0	12000.0	120000.0	100.0
Fertilizer sack	50 Kg	40.0	96000.0	3840000.0	100.0
Total costs for maintenance of the Technology				**6'975'150.0**	
Total costs for maintenance of the Technology in USD				*1'860.04*	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☑ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☑ humid
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
The technology is located between 2000-2200 mm isohyets. The rain season occurs from April to November and dry season from December to March.
Name of the meteorological station: Precipitation map of the Municipality of Tauramena (2015)

Slope
- ☑ flat (0-2%)
- ☐ gentle (3-5%)
- ☐ moderate (6-10%)
- ☐ rolling (11-15%)
- ☐ hilly (16-30%)
- ☐ steep (31-60%)
- ☐ very steep (>60%)

Landforms
- ☐ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude
- ☐ 0-100 m a.s.l.
- ☐ 101-500 m a.s.l.
- ☐ 501-1,000 m a.s.l.
- ☐ 1,001-1,500 m a.s.l.
- ☐ 1,501-2,000 m a.s.l.
- ☐ 2,001-2,500 m a.s.l.
- ☐ 2,501-3,000 m a.s.l.
- ☐ 3,001-4,000 m a.s.l.
- ☐ > 4,000 m a.s.l.

Technology is applied in
- ☐ convex situations
- ☐ concave situations
- ☑ not relevant

Soil depth
- ☐ very shallow (0-20 cm)
- ☐ shallow (21-50 cm)
- ☐ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☑ very deep (> 120 cm)

Soil texture (topsoil)
- ☐ coarse/ light (sandy)
- ☐ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ☐ coarse/ light (sandy)
- ☐ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Topsoil organic matter content
- ☐ high (>3%)
- ☐ medium (1-3%)
- ☐ low (<1%)

Groundwater table
- ☐ on surface
- ☑ < 5 m
- ☐ 5-50 m
- ☐ > 50 m

Availability of surface water
- ☐ excess
- ☑ good
- ☐ medium
- ☐ poor/ none

Water quality (untreated)
- ☐ good drinking water
- ☑ poor drinking water (treatment required)
- ☐ for agricultural use only (irrigation)
- ☐ unusable

Water quality refers to: surface water

Is salinity a problem?
- ☐ Yes
- ☑ No

Occurrence of flooding
- ☑ Yes
- ☐ No

Species diversity
- ☐ high
- ☑ medium
- ☐ low

Habitat diversity
- ☐ high
- ☑ medium
- ☐ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- ☐ subsistence (self-supply)
- ☐ mixed (subsistence/ commercial)
- ☑ commercial/ market

Off-farm income
- ☐ less than 10% of all income
- ☑ 10-50% of all income
- ☐ > 50% of all income

Relative level of wealth
- ☐ very poor
- ☐ poor
- ☑ average
- ☐ rich
- ☐ very rich

Level of mechanization
- ☐ manual work
- ☐ animal traction
- ☑ mechanized/ motorized

Sedentary or nomadic
- ☑ Sedentary
- ☐ Semi-nomadic
- ☐ Nomadic

Individuals or groups
- ☑ individual/ household
- ☐ groups/ community
- ☐ cooperative
- ☐ employee (company,

Gender
- ☑ women
- ☑ men

Age
- ☐ children
- ☐ youth
- ☐ middle-aged
- ☑ elderly

government)

Area used per household
- ✓ < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale
- ✓ small-scale
- medium-scale
- large-scale

Land ownership
- state
- company
- communal/ village
- group
- individual, not titled
- ✓ individual, titled

Land use rights
- open access (unorganized)
- communal (organized)
- leased
- ✓ individual

Water use rights
- open access (unorganized)
- communal (organized)
- ✓ leased
- individual

Access to services and infrastructure

health	poor	good
education	poor	good
technical assistance	poor	good
employment (e.g. off-farm)	poor	good
markets	poor	good
energy	poor	good
roads and transport	poor	good
drinking water and sanitation	poor	good
financial services	poor	good

IMPACTS

Socio-economic impacts

Crop production	decreased	increased
production area (new land under cultivation/ use)	decreased	increased
farm income	decreased	increased
diversity of income sources	decreased	increased

There was not crop production before the SLM

There was not a production area before SLM

The main income sources are expensive livestock and cacao bars

Socio-cultural impacts

SLM/ land degradation knowledge	reduced	improved

Ecological impacts

soil organic matter/ below ground C	decreased	increased

It has not been tested, however it is assumed a soil organic matter increase you to the increased leaf litter added by the caco trees.

Off-site impacts

downstream flooding (undesired)	increased	reduced

The different levels of the agroforestry system and the cacao tree density might increase water retention and infiltration. It contributes to reduce down stream flooding during rainy season.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

CLIMATE CHANGE

Gradual climate change

seasonal temperature increase	not well at all	very well	Season: dry season

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology
- ✓ single cases/ experimental
- 1-10%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?
- ✓ 0-10%
- 11-50%

- [ ] 11-50%
- [ ] > 50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The technology generates Income along the year and keep us busy.
- It is a way of having a crop and the gallery forest together.

Strengths: compiler's or other key resource person's view

- The more complex and diverse production system might favored pollination and crop health.
- The technology compared with other land uses around it such as oil palm tree and rice is more sustainable.

Weaknesses/ disadvantages/ risks: land user's view → how to overcome

- It takes 6 years to begin to produce, but during the first years it is still requirement all maintenance activities → Planting cacao varieties, which produce fruits in less than 6 years.
- There is little support for small farmers an entrepreneur initiatives, from public and private institutions, when then do not belong to any project. → By planning the potential occurrence of technologies/ initiatives,FF that is worth to give support, especially from public institutions and plan some resources for it.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome

- Gallery forest thinning to open cropland is about 70%, which is a high portion of forest. The more gallery forest is protected, the better buffering for extreme climatic events → Using cacao tree varieties with more shadow tolerance, which let leave more forest percent in the agroforestry system

REFERENCES

Compiler
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Reviewer
Hanspeter Liniger

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Resource persons
Ana Silvia Martinez - land user
Rafael Medina - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5763/

Linked SLM data
n.a.

Documentation was faciliated by
Institution
- n.a.

Project
- n.a.