





CIRAD long-term adaptive research programme to the Partnership for Sustainable Agroforestry (PSAF) - Ai Ba Futuru project

Mission report for January 6-27, 2022

Diagnosis of agroforestry and farming systems in Manatuto, Viqueque and Lautem districts, and comparison with the Baucau district



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Implemented by



Summary

Objective of the study

The ecological and socio-economic performances of customary agroforestry systems have been assessed in Baucau by CIRAD, but their replication or adaptation to other Eastern municipalities of Timor-Leste remained to be demonstrated, especially in the other three districts where PSAF is working (Lautem, Manatuto, Viqueque). To this end, a global diagnosis of the agroforestry systems was carried out in each of these districts in order to highlight the commonalities and differences with the situations analysed in Baucau. The final objective is, for each of these districts, to highlight recommendations for action inspired by the work carried out in Baucau in terms of local livelihoods, vulnerabilities, and resilience-building.

Framework of analysis and methods

Our analysis was broken down into three stages to clarify the interactions between agroforestry systems (AFS), on the one hand, their mobilisation in farmers' production strategies, on the other, and their influence on the current and future coverage of people's needs, as illustrated in the figure below.



The first part of our analysis is the ecological description of the types of agroforestry systems found in Timor-Leste and how these may vary according to the characteristics of the four selected districts. The second part describes the farming systems and agrarian dynamics. It presents how these farming systems are based on specific combinations of agroforestry systems. The third part of the survey shows how these farming systems do (or do not) cover the basic necessities of rural households and to what extent agroforestry systems are present in the investment strategies of different types of farmers.

This three-tier framework of analysis is used for each of the four sampled districts. The precise data collected and analysed in each of the four districts are not put in this summary. However, we present the aggregated and synthesised results to understand, on the one hand, how the detailed analyses carried out in Baucau can be replicated in the other districts and, on the other hand, to provide elements of response on the resilience of agroforestry systems as well as on the potential of transformability of the rural economies that depend on them.

The study was conducted in seven villages, with two villages per district, except for the Viqueque district where, due to time constraints, only one village was sampled. The study combined various survey methods: focus group discussions, individual interviews in the village (for socio-economic data) and in the fields (for farming data), biomass and soil quality assessment.

Result 1 - Similar agroforestry systems

The five AFS that were depicted in the Baucau district are found in the other three districts, but their occurrence varies according to the ecological and socio-economic specificities of each district, as shown in the table below.

District	Baucau	Manatuto	Lautem	Viqueque
		HOME GARDEN		
Occurrence	+++	+++	+	+
Location		Next to th	ne house	1
Main crops and trees	Corn, lemon, beans, tubers, Fruit trees	Corn, vegetables, Fruit trees	Corn, vegetables, Fruit trees	Banana, ginger, Fruit trees
Use	Fruits, staple crop, animal food	Fruits, staple crop, animal food	Fruits, staple crop, animal food	Cash crop, fruits
Main constrains	Sun competition bet	ween staple crops and tre ow trees, dense settlemer	ees, landownership to g nt, renewing of the old t	et the authorization to rees
Opportunities	Cooling of tempera	ature (trees), secured land self-reliance, capital asse	tenure, diversification ets (trees, land, animals	of nutritious food and
	CR	OP AND FALLOW	·	
Occurrence	+++	+++	+++	+++
Location	Valley and plains	Valley	Plain	Plain
Main crops and trees	Corn, peanut, cassava, pumpkin	Corn, rice, cassava	Corn, rice, cassava, coconut, teak	Corn, rice
Use	Staple crop, animal food, cash crop	Staple crop, animal food, cash crop	Staple crop/Cash crop, animal food	Staple crop
Main constrains	Renewal of soil ferti	lity limited by land access	bility (fallow rotation), r	narket prices changes
Opportunities	Cash provision, t	food base for self-consum provi	ption, feed and fodder sion	provision, firewood
	YOL	JNG AGROFOREST		
Occurence	+++	+++	++	++
Location	Hills, plains, former Crop & Fallow	Hills Former Crop & Fallow	Lowland Living Hedge & Crops	Lowland Living Hedge & Crops
Main crops and trees	Cassava, corn, pumpkin, papaya, banana, citrus trees, coconut	Betelnut, candlenut	Coconut, teak	Banana, ginger, Gmelina, teak
Use	C	ash crop and secured pro	ductive land for the fut	ure
Main constrains	Land property	access/recognition, livesto	ock degradation, marke	t prices changes
Opportunities	Diversification	of farming system, cash	provision, securing land	tenure for heirs
	OL	DAGROFOREST	· 0	
Occurence	++	+++	+++	+
Location	Hills. aully	Hills. aullv	Hills. aully	Hills, upland
Main crops and trees	Coconut, palm wine, fruit trees, teak, gmelina, bamboo	Betelnut, candlenut	Coconut	Teak
Use	Fruits and cash crop	Cash crop	Cash crop	Fruits
Main constrains	Renewal of old trees	s, accessibility (far from he land between	ousing and/or steep slo descendants	pes), segmentation of
Opportunities	Carbon stock, secur crop), resilience	ring land tenure within the to climate and market chap provi	family and <i>knua</i> , capita anges, firewood, stapp sion	al assets (timber, cash le crop and fodder
	SIL	VOPASTORALISM		
Occurence	+++	+++	+++	+++
Location	Lowland and plains, rocky hills	Valley	Lowland	Lowland
Main vegetation	Grass, savannah, secondary forests	Secondary forest, grass	Grass	Grass
Use	Pasture/Land ava	ailable to possible expand	crop fields /Firewood/T	raditional medicine
Main constrains	Competition betwee that c	een livestock (free grazing can lead to conflicts betwe	, fire rotation to renew en villages and/or inha	the grass) and fields bitants.
Opportunities	Carbon stock, firew and far	ood and fodder provision, ming regulation (empowe	access to resources for rment for community re	or all, non-formal land

Result 2 – Four household profiles but six farming systems

Four production factors strongly influence the capacities of rural households and their choice of livelihoods strategy: access to land, the (direct and indirect) availability of cash, the availability of (family) labour, and social capital. The varying access to these capitals results in four types of rural household and in six farming systems, which are respectively described in the left-hand and right-hand sides of the following diagram.



These six production systems value different agricultural and agroforestry produce, and therefore they rely in different ways on the five AFS, as shown in the table below.

FARMING STRATEGY	Mains crops in BAUCAU	Mains crops in MANATUTO	Mains crops in LAUTEM	Mains crops in VIQUEQUE	Main AFS used
Specialization in intensive cropping	Flooded rice/Horticulture			Banana and ginger	Crop field and fallow, home garden, young agroforest
Specialization in agroforests' harvesting		Betelnut, candlenut	Coconut		Old agroforest, young agroforest
Specialization in livestock breeding	Small ruminants	Cows	Cows or water buffaloes	Water buffaloes	Sylvo-pastural lands
Abandonment of farming	Corn, banana	Cassava, taro	Cassava, coconuts		Home garden, crop field and fallow
Diversification of agriculture and of income	Corn, pumpkin	Betelnut	Coconut, corn, cassava	Banana, cassava, corn	Home garden, crop field and fallow, sylvopastoral lands
Survival agriculture	Corn, cassava	Betelnut	Coconut		Home garden, young agroforest

Result 3 - Investment options depend on farming strategies

Farming strategies also have a marked influence on the possible sources of finance to support investments in these rural economies. As indicated in the following table, the sale of forest and agroforestry products is seen as a possible source of finance mainly for households specialised in agroforest harvesting or those using survival farming, and not much so - if at all - for other farming systems.

FARMING			Main sources	s of funds for	future invest	tments		
STRATEGY	Viqueque	Lautem		Manatuto		Ba	Baucau	
Specialisation in livestock breeding	livestock breeding	livestock breeding, jobs	livestock breeding	livestock breeding, sale of crops	livestock breeding	sale of crops, livestock breeding	sale of tree products, livestock breeding	
Specialisation in intensive cropping	sale of crops					sale of crops		
Specialisation in agroforests' harvesting				sale of crops, sale of tree products	sale of tree products			
Abandonment of farming		sale of crops, sale of tree products	livestock breeding	jobs	jobs, sale of tree products	livestock breeding, sale of tree products		
Diversification of agriculture and of income	sale of crops	livestock breeding, jobs	Sale of crops, livestock breeding				sale of tree products, livestock breeding	
Survival agriculture		jobs, livestock breeding	sale of tree products	sale of crops, sale of tree products	sale of tree products	sale of tree products, sale of crops	livestock breeding, sale of tree products	

Contributions of agroforestry systems to ecological and economic resilience

Different datasets must be mobilised to analyse the interactions between AFS and their environmental resilience or the economic resilience of rural households. On the one hand, ecological resilience is studied using three types of data characterising the state of AFS. On the other hand, the economic resilience of households using AFS is estimated from data associated with their farming systems.

Three variables were used to study the ecological resilience of three types of AFS (home garden, young agroforest, forest garden): tree density, tree biodiversity and soil depth (as a proxy for fertility and carbon storage). Almost all AFS have a medium to high scores of tree biodiversity (at least 5 different tree species per farm field) in each district. Tree density presents similar traits in the four districts: forest gardens are the most dense systems, followed by home gardens and young agroforests. The results are more variable for soil characteristics, especially with different textures and different soil depths.

Three variables were chosen to indicate the economic resilience of the six farming systems: annual income, savings and revenue diversification. The combination of these three indicators shows the relative weakness of the socio-economic resilience of production systems that depend on agroforestry today. Firstly, the farming systems most dependent on AFS do not have a high level of income, within a range of US\$ 400-4.500 per year and per household. Second, the same is true for the criterion of savings, except for households that have specialised in intensive use of old agroforests and have invested in these plantations. Finally, the AFS-dependent farming systems show diversified sources of income – like the sale of tree products, of crops, jobs or local trade – and demonstrate their flexibility and adaptability.

Based on the results presented above, several actions to promote agroforestry are proposed to increase the ecological resilience of AFS and the economic resilience of farming systems. They are described and ranked in the following table according to their specific utility within the six farming systems. Their geographical scope is also indicated as the relative importance of the AFS vary among the four sampled districts. Specific actions to develop agroforestry are described, either to address current and future constraints to their expansion, or to seize opportunities not yet fully exploited in these rural contexts.

Farming	Main AFS used	Constraints	AFS's contribution to face	Opportunities	AFS's contribution to take	Districts
strategies	by the farmers	constraints	the constraint	opportunities	the opportunity	concerned
Specialization in intensive cropping	Crop field and fallow, home garden, young agroforest	Farmers have small/medium access to land	Interested in planting a few fruit trees to enrich their home gardens (for self- consumption purpose)	Agroforestry offers complementary revenues, that are not sufficient to meet the family needs or to increase livelihoods, but that remains too significant to put it away	Interested in a few high-value trees in or around their crop fields to complement their revenue	Baucau, Viqueque
Specialization in agroforests' harvesting	Old agroforest, young agroforest	This farming system is suitable with a low pressure on land at the aldea level		Easy access to land allows to produce important volumes of agroforestry products (coconut, betelnut, candlenut, teak) that is sufficient to make a living and to support investment	Tree plantations over large surface in old and young agroforests are the main way to accumulate capital to pass on to children	Manatuto, Lautem
Specialization in livestock breeding	Sylvo- pastural lands	Because of their breeding activity, they do not invest in tree plantation and rely more on collective pasture land		Interested in trees species that provide fodder for animals	Enrich sylvo-pastoral lands in fodder- specialised tree species	all
Abandonment of farming	Home garden, crop field and fallow	No reliance on trees for food or revenues		Potential interest to plant a few trees to mark land in crop fields and forest gardens Interested in enriching home gardens with a few	Slow-growing tree species in fallows and in old little-used agroforests Fruit trees in home gardens	Baucau, Manatuto, Lautem
Diversification of agriculture and of income	Home garden, crop field and fallow, sylvopastoral lands	Access to land and/or water and/or techniques is a pre- condition to invest in agroforestry	Develop agroforestry support schemes that are built on a comprehensive understanding of the household economy: tree plantations are to be combined with some form of crop farming or silvo- pastoralism	fruit-trees Combination of various AFSs to reduce the risk of pest attacks or to mitigate environmental and economical shocks	Payment for environmental services may constitue an attractive option for this type of household as their farming system is flexible and adaptable to new activity	all
Survival agriculture	Home garden, young agroforest	Limited access to land for shifting cultivation and to natural resources to feed animals, etc. Low revenue make them be very exposed to prices decrease	Invest in tree products with a secure market	Tree products are their main sources of income More intensive use of agricultural land	Intensify tree plantations in the small surfaces of their home garden and yound agroforest Plant trees that facilitate or maintain these intensive agricultural uses	Baucau, Lautem Baucau, Manatuto, Lautem
	J. The second seco	In the absence of savings, there is a requirement to ensure a regular minimum income flow	Investing in income- generating agroforestry at short term			Manatuto

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Glossary

Local words
Abat laran
Aldea
Bibi atan
Fetosan
Humane
Karau atan
Knua/Clan
Mane foun
Pastagem
Quintal/Toos permanenti
Rai fujik
Suco
Toos
Toos abandonado
Toos foun
Toos na'in
Toos posan/Toos posalaki
Tua
Tua sabu
Uma lisan

English words Forest Garden Village Herdsman for small ruminants "women's donors" "women takers" Herdsman for big ruminants Lineage Men who could not pay the dowry Grassland (and Silvopastoralism) Home Garden "Virgin" Land Collectivity Field Fallow Crop and Fallow Farmer Young Agroforest Palm Wine Palm Whisky Sacred House

List of abbreviations

AFS BMZ CF	AgroForestry System German Federal Ministry for Economic Cooperation and Development Annual crop field with fallow
CIRAD	French Agricultural Research Centre for International Development
EU	European Union
FAO	Food and Alimentation Organization
FG	Forest garden (or old agroforest)
HG	Home garden
HH	Household
LHC	Living hedge and crops
MAF	Ministry of Agriculture and Fisheries
PSAF	Partnership for Sustainable AgroForestry
SP	Silvopastoral area
UN	United Nations
YA	Young agroforest

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1 Introduction

1.1 Context of the study

1.1.1 The national objective to reach food security

Agriculture is the main source of food, employment, and income for two thirds of the population of Timor-Leste, who mainly live in rural areas. It generates around 90% of exports (without oil). However, the country remains strongly dependent on food imports (especially for cereals) and a large part of its population lives under the poverty line.

At the national scale, principal productions are rice, maize, coffee, cassava, sweet potato, taro, bananas, squash, kidney beans, soybeans, mung beans, peanut, white potato, vanilla, and coconut (FAO, 2011). In irrigated areas, rice is the main production. When irrigation is hardly doable, farmers usually mix a diversity of crops (FAO, 2011).

Since the independence, one of the government priorities is to reach food security at the national scale. By 2030, according to the National Food and Nutrition Security Policy (Republica Democratica de Timor-Leste, 2017), the target is to "be free from hunger and malnutrition and Timorese people will enjoy healthy and productive lives. People in Timor-Leste will be well-fed principally from increased variety of locally produced safe and nutritious food for healthy and productive lives while witnessing carefully managed agroecosystems".

To make this vision happen, the Government wishes the development of agroforestry systems (AFS) and the plantation of one million trees. Timor-Leste's strategic Development Plan 2011 to 2030 identifies increasing agrobiodiversity with a focus on nutritious and high-yield crops including coffee, coconut, and other potential cash crops such as cocoa, cashews, hazelnuts, and spices. The Ministry of Agriculture and Fisheries (MAF) new Strategic Plan has outlined several agricultural goals: (i) increase rural incomes and reduce poverty, (ii) promote environmental sustainability and conservation of natural resources, (iii) sustainably increase food production through improved crop varieties, forestry, livestock species, and fisheries (Paudel *et al.*, 2022).

1.1.2 The Ai ba Futuru project

Ai ba Futuru (Partnership for Sustainable AgroForestry – PSAF; 2017-22) is a project co-financed by the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ), in collaboration with the Ministry of Agriculture and Fisheries (MAF).

The objective of PSAF is to improve access to environmental, economic, and social benefits for vulnerable population through the development of agroforestry, and to promote employment and income generation for marginalised groups. It aims to support more than 4,000 households from four municipalities (Manatuto, Baucau, Viqueque, and Lautem) to adopt agroforestry and afforestation practice, and especially to provide marginalized people (in particular young men and women) with socio-economic opportunities. Specifically, this project aims to increase the productivity of AFS, strengthen the capacity of actors along selected agroforestry value chains, improve the market access for selected agroforestry products (e.g., fruits and

vegetables, raw and processed wood products), and improve the institutional and organizational framework for the promotion of agroforestry.

1.1.3 Involvement of CIRAD

While farmers in Timor-Leste have applied traditional AF practices for centuries, the official promotion of AFS in Timor-Leste through public policies is recent. It is thus important that an adequate knowledge basis is established to ensure sound production, processing, and marketing practices. This report addresses three research topics that are related to ecological benefits gained from AFSs, socio-economic impacts, and the implications of both for building resilience against climate change.

AFS are at the heart of village farming systems and rural economies, although they are still poorly studied in Timor-Leste. They are very diverse because they are adapted to the specificities of the environmental and socio-cultural contexts. They are also complex systems because of the diversity of the natural resources involved, the wealth of local knowledge associated with them and their evolution over decades or even centuries. Due to the heterogeneity and complexity of Timorese AFS, CIRAD decided to focus on the technical, ecological, and socio-economic diagnosis of AFS in one of the four districts involved in the PSAF project. After a visit to all these four districts, the Baucau district was selected especially because of its central localization and its diversity of socio-ecological systems, which place it at the interface of the three other districts (Cogné et al., 2020). Although this district is the most economically developed after Dili, many areas at the border of the district are far from the main roads and are isolated, thus allowing to describe contrasted situations that could also occur in the other Eastern municipalities of Timor-Leste. Moreover, in terms of agronomic and forestry production, the Baucau district reassembles the main systems that were identified in the other districts, in terms of forests (eucalyptus, tamarind, teak, makassar oil tree, mahogany...) as well as in term of agrarian structure.

In the Baucau district, CIRAD focused on a small sample of customary AFS in order to precisely describe their main characteristics, assess their socio-economic and ecological benefits, and identify current or future constraints to their improvement and expansion. This in-depth knowledge of a small number of AFS is necessary to understand their underlying dynamics and to establish realistic conditions for their improvement and extension. However, the PSAF project is active in four districts, and one may wonder to what extent the lessons and results drawn from analyses in Baucau are replicable or successfully expandable to other districts and agroforestry schemes. This is the purpose of this study.

To achieve this objective, this mission conducted research over a three-week period in several eastern municipalities of Timor-Leste, according to the following schedule:

- Jan 6-8, Dili: quarantine period for Sixtine and Guillaume;
- Jan 8-14: surveys in the Manatuto district;
- Jan 15-21: surveys in the Lautem district;
- Jan 22-24: surveys in the Vigueque district;
- Jan 25-27, Dili: debrief and restitution of preliminary results to GIZ;
- Jan 31 Feb 8: Complementary socio-economic surveys in the Baucau district.

1.2 Objectives and framework of analysis

The ecological and socio-economic performances of customary AFS have been assessed in Baucau, but their replication or adaptation to other Eastern municipalities of Timor-Leste remained to be demonstrated, especially in the other three districts where PSAF is working (Lautem, Manatuto, Viqueque). To this end, a global diagnosis of the AFS was carried out in each of these districts in order to highlight the commonalities and differences with the situations analysed in Baucau. The final objective is, for each of these districts, to highlight recommendations for action inspired by the work carried out in Baucau in terms of local livelihoods, vulnerabilities, and resilience-building in response to climate change. It should also indicate the knowledge gaps related to the specificity of certain AFS whose natural or socio-economic conditions differ from those found in Baucau.

The final output is an assessment report of the contribution of the CIRAD researchsupport program to the development of sustainable, resilient, and profitable livelihoods through agroforestry – in a narrow sense, in the form of increased income and employment, and in the wider sense as defined by long-term resilience-building towards the impacts of climate change – for the 4 districts of Baucau, Lautem, Manatuto, and Viqueque.

To achieve this result, our analysis is broken down into three stages to clarify the interactions between AFS, on the one hand, their mobilisation in farmers' production strategies, on the other hand, and their influence on the current and future coverage of people's needs, finally (Figure 1).



Figure 1: A three-tier framework of analysis

The first part of our analysis is the ecological description of the types of AFS found in the eastern municipalities of Timor-Leste and how these may vary according to the characteristics of the four selected districts. It is also an opportunity to introduce the land tenure rules and user rights associated with AFS.

The second part describes the farming systems and agrarian dynamics. It presents

how these farming systems are based on specific combinations of AFS.

The third part of the survey shows how these farming systems do (or do not) cover the basic necessities of rural households and to what extent AFS are present in the investment strategies of different types of farmers. This three-tier framework of analysis is used for each of the four sampled districts. These results are then aggregated and synthesized to understand, on the one hand, how the detailed analyses carried out in Baucau can be replicated in the other districts selected by the PSAF and, on the other hand, to provide elements of response on the resilience of AFS as well as on the potential of transformability of the rural economies that depend on them.

1.3 Presentation of study areas

The study was carried out in one *Suco* (one or two villages) supported by the Ai Ba Futuru project in each targeted district (Figure 2 and Figure 3).

The choice of the *Sucos* relies on:

- Landscape differentiation: highlands (Manatuto), plateau (Lospalos), lowlands (Viqueque); in comparison to the main agroecological zones identified in Baucau district's landscape (Table 1).
- Climate disparities: northern (Lospalos) and southern coastal parts (Manatuto and Viqueque);
- Market access: road, proximity or distance at the local (municipality) and national level (Baucau, Dili);
- Communication facilities: the research was facilitated because the villages were already aware and involved in the Ai ba Futuru project.

	Altitude (m)	Annual Rain Fall (mm)	Bedrock	Example of Suco
Highlands	700-1000	>1200	Barique Formation, Lolotoi complex, Cablac Limestone	Atelari
Plateau	500-700	1200-1500	Baucau Limestone	Gariuai
Valleys	150-500	1200-1500	Bobonaro Scaly Clay	Gariuai, Samalari
Lowlands	<150	900-1200	Recent fluvial sediment	Samalari

Table 1: Characteristics	of the main	agroecological	zones ir	Baucau	district

The villages were chosen to cover a diversity of physical and economic situations according to these criteria:

Suco DISTRICT	Number of <i>Suco</i> 's villages	Chosen villages	Topography & Height	Climatology Annual Rainfall	Distance to the district main town - Access to market	Agro- ecological zones	N° of household or inhabitants										
Manehat		Nu-Ahuk	Highlands 700-800 m	South Coast Rain +++ 2100 mm	50 km	Steep Reliefs	455 inhabitants										
Manehat MANATUTO	3	Dambuahun	Medium Iands 350-500 m	South Coast Rain +++ 1900-2000 mm	Remote	Forest in Slopes	318 inhabitants										
Souru	7	Caivaca	Plateau 450-500 m	North Coast Rain ++ 1700 mm	6-7 km	Forest in	160 families (about 100 households)										
LAUTEW		Nairete	Plateau 480-520 m	North Coast Rain ++ 1700 mm	Close	grass plains	142 families (about 90 households										
Umatolu VIQUEQUE	5	Krarek- Maruk	Coastal area 70-100 m	South Coast Rain + 1500-1600 mm	30 km Medium	Lowland (riverbed) and grass plains	140 families (about 90 households)										
Gariuai Samalari BAUCAU		Cairiri	580-630m	1300-1600	14 km Close	Plateau,	895 inhabitants										
										-	-	Ossolı	Ossoluga	130-330m	1300-1600	27 km Remote due to seasonal river crossing	lowland (riverbed) and valley

Table 2: Main characteristics of studied areas

Suco targeted - CIRAD mission January 2022



Figure 2: Administrative localization of studied Sucos (Adapted from)





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LOCATION OF THE AFS PLOTS INVENTORIED IN THE SUKU SORU LAUTEM DISTRICT









¹ Suco can also be written « suku » (see maps)

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A low climate variation can be observed between the three chosen *Suco* (Figure 4). A year can be split into two cultural seasons: Dry season from July-August to October (<150 mm) and a Rainy season from November to June, (>150 mm). The main rainy season is from November to April, and the period from April to June is considered as a "small second rainy season" with less rainfall. September tends to be the driest month of the year with around 30 mm of rainfall.



Figure 4 : Rainfall maps of the three studied *Sucos* (Adapted from https://data.humdata.org/dataset and https://download.geofabrik.de, DEM from http://seedsoflifetimor.org/climatechange/maps-of-timor-leste/gis-resources/)

Climatic diagram of Soibada, the closest city to Manehat *Suco*, shows the distribution of the rainfall and temperature over the year (Figure 5). Climatic diagrams of Lospalos (next to Souru *Suco*) and Dilor (next to Umatolu *Suco*) are presented in Appendix 1.



Figure 5 : Climatic diagram of Soibada, next to Manehat Suco, Manatuto

2 Methods

2.1 Outline of the methodological approach

In relation with the general objective of the diagnosis (providing social, geographic and landscape information as well as technical and economic information in a short time), the methodological approach relied on several tools that are detailed in Table 3 and illustrated in Figure 6. All these surveys were preceded by a reminder of the connections of our research team with the Ai Ba Futuru project.

Steps of the study	Information sought	Methodological tools associated	Number of Surveys	
1 Focus Group Discussion	History and infrastructures of the village, Pre-diagnosis of cropping systems and their location, Basic necessities	<i>Focus group</i> (semi- structured survey)	5	
2.1 Agro-ecological	Landcover, agroforestry systems localization,	Landscape transects analysis	5	
information	soil and the biodiversity in different AFS	Soil, biomass, and biodiversity surveys	27	
2.2 Socio-technical information	2 Socio-technical information 2 Socio-technical 2 Socio-tech		42	
2.3 Socio- economic information	Households' economics and investment strategies; Basic necessities; Most important economic activities, resilience of agroforestry systems,	Household interview	136	
Restitution of preliminary results	Presentation of the work carried out in the village: farming systems typology, and discussion on the first results	Restitution workshop	5	

Table 3:	Synthesis	of the	methodological	approach
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Figure 6 : Pictures of the survey steps (from left to right, top to bottom: Focus group discussion, landscape transect, soil analysis, restitution meeting, interview with a farmer) (Pictures: Mazin and Lescuyer)

2.2 Collection of socio-geographical information

The collection of the main socio-geographical elements was carried out using two methods:

- The reading and analysis of the participatory maps produced in the framework of the Ai Ba Futuru project.
- A landscape analysis as recommended in the first step of the agrarian diagnosis process, and as described by Barral *et al.* (2012). This analysis confirmed and completed the results obtained from the maps. Visits across the village's territories with the help of local guides made it possible to describe the biophysical environment of the farms (topography, land use patterns, etc.). In addition, the AFS encountered were specifically localized.

2.3 Collection of technical-economic information

The objective of this phase was (i) to describe the current diversity of farming systems (or activity systems) and their technical systems, (ii) to determine the key events in the agricultural evolution of the area and the current dynamics as well as more specifically (iii) the AFS and their place in the farming systems. For this, an approach adapted from agrarian diagnosis (Barral *et al.*, 2012) was applied.

Semi-structured interviews were conducted in the field with farmers (Appendix 2). The aim was to learn about technical, economic, and social transformations and to

understand their determinants, whether local, regional, national or even international (Cochet and Devienne, 2006). This made it possible to identify the agrarian dynamics.

Information was also collected on technical systems, particularly in order to establish a work schedule. In addition, data about non-agricultural activities (hunting, fishing, collection of non-timber forest products, etc.) were collected to have a vision at the scale of the activity system (Gasselin *et al.*, 2014).

The surveys were structured into 5 parts:

- 1. The identification of the household structure and its social capital (age, family composition, education, kinship connections).
- 2. The historical path of the household and its family (displacements, first access to land, animals).
- 3. The distribution of production factors as land, work force and equipment.
- 4. The characterization of the different cropping systems, their location and functioning, their production and repartition between self-consumption and sale.
- 5. The characterization of the different livestock breeding systems (small husbandry and cattle), their products and management.

Finally, particular attention was paid to AFS and their place in farming systems. These elements were completed by a specific data collection to compare local AFS to those of Baucau.

About eight to ten households were interviewed in each village with a specific attention to cover a diversity of situations (near/far from the village center, young and old people).

2.4 Collection of agro-ecological information

In order to link the results found in Baucau (Cogné *et al.*, 2022), an adaptation of the plot inventories' protocol was made to characterize the main species biodiversity and the main soil morphology compared with geological map (Thompson, 2011). This adaptation is a simplified version of what was measured in Baucau (Cogné *et al.*, 2022) considering the short amount of time and logistic budget available for this mission (e.g. no possibility to take new laboratory samples). The following steps are described below:

1 - Soil observation:

- Dig a hole of 50cm (operation stopped if the bed rock is already found).
- Observation of the layers (0-10cm, 10-30cm, >30cm): texture and organic matter (dark color), local name and local color given to the soil, rock presence (0=none, 1= a few, 2=medium 3 = a lot), other observations relative to the specificity of the plot.
- Observation of the plot: slope and other observation relative to its specificity (presence of water, mechanical tools, specificity about the rocks found, mulch...).
- 2 Biomass and biodiversity inventories (Figure 7):
 - Measure the size of the field and point with GPS.

- Choose a representative location inside the field (not necessarily centre if it is surrounded by a living hedge).
- Draw a circle of 7m ray, plot A, and note all the trees and palms inside (species and circumference).
- Draw a circle of 15m ray, plot B, and note all the trees and palms larger than 100cm circumference.



Figure 7 : illustration of the inventory protocol and selection of trees in the field

The forms filled in the field can be consulted in the Appendix 3. The field sample inventoried was also reduced (5 to 6 inventories per village) compared to Baucau district to characterize the main AFS that could interest the project, that is to say, where people use to plant seedlings. Thus, the **main systems inventoried were Home Gardens and Young Agroforests**. However, other systems considered representative of the area for the household income were also inventoried such as **Forest Gardens** (specialized on betelnut, coconut and teak) in Manatuto and Lospalos. Variants of young agroforest (**« Living Hedge and crops »**) as well as homegarden variant (**« Home field »**) were also inventoried in Lospalos and Viqueque.

2.5 Basic necessities survey

The Basic Necessities Survey (BNS) approach is based on the United Nations (UN) definition of poverty as the "lack of basic necessities." Through a participatory approach local people define the goods (assets) and services they believe are basic necessities, that is "Something that all household should have, and none should do without". This approach has been used for almost twenty years under the framework of rural development (Davies and Smith, 1998) or conservation-oriented projects (Detoeuf *et al.*, 2018) in tropical countries.

The usual four steps for conducting a BNS are:

1. Conduct focus groups to create a list of basic goods and services and related indicators.

2. Create a data entry form with the final list of goods and services. For each item of the list, three questions are asked:

- a. Do you have it? Yes or No.
- b. If the item is a good, then ask how many do you have?
- c. Do you want to increase its number? If yes, which ways and means will you use to do this?
- 3. Conduct BNS interviews with either the male or female head of household.
- 4. Analyze, visualize and share the results.

For our study, we combined a collective approach of identifying basic necessities during the focus group discussion held in each village with a verification of the presence of these basic necessities during individual interviews with rural households. The first step is described in Appendix 4 and allowed us to draw up a list of basic necessities and indicators adapted to the situation of the population in each village. This list of basic necessities was then inserted into the individual questionnaires (see Appendix 5) in order to find out (1) whether the household met these basic necessities, (2) whether the household wished to increase the number of or access to these necessities, and (3) what means it would mobilise to achieve this objective. This last question provides information on the investment options available to the household and, indirectly, on whether its investment potential is linked to one or more AFS.

2.6 Individual interviews of households

The objective of the individual interviews with households was to estimate the present and future assets available to them to improve their living conditions, in a rural environment where agriculture is expected to be the main economic activity.

The first part of the interview consisted of collecting standard household information that can partially explain the status of household assets: age of the household head, household size, level of education, membership of formal or informal groups, length of residence in the village.

The second part of the interview aimed to quantify assets by assessing agricultural production (for self-consumption or trade), financial capital (farm income and other income), livestock savings (number of large animals), and social capital (relationship with the *Knua* head). The assessment of agricultural production was localised and related to the five agroforestry spaces described for Baucau, namely: home garden, crop field and fallow, pasture, young agroforest, old agroforest.

These first two parts of the questionnaire made it possible to establish a typology of farmers in each of the villages in order to understand and characterise the diversity of production strategies, while at the same time corroborating the parallel qualitative analysis of farming systems.

The typology of farmers was essentially based on the two criteria of annual income level and main sources of income. The sources of income could be associated with the types of primary production of the households and/or off-farm activities. Other variables were used to describe the socio-economic characteristics of each type of farmer, such as the age or sex of the head of the household and his/her social capital (i.e. link with the *Knua* head), but these variables proved not to be discriminating.

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The third part of the survey assesses the coverage of basic necessities by households and explains their investment strategies to improve their living conditions in the medium term. This last part helps identify investment strategies that are based on the development of AFS.

These individual interviews were run with 136 rural households, the distribution of which is presented in Table 4.

District	Manatuto		Los P	alos	Viqueque	Bau	Icau
Aldea	Nu-Ahuk	Dambuahun	Tchaivatcha	Nairete	Kraremaruk	Cairiri	Ossoluga
Sample	15 households (112 inhabitants)	19 households (124 inhabitants)	16 households (114 inhabitants)	18 households (129 inhabitants)	17 households (120 inhabitants)	26 households (182 inhabitants)	25 households (121 inhabitants)
Total population	455 inhabitants	318 inhabitants	100 households	90 households	90 households	895 inhabitants	940 inhabitants
% of sampling	25%	39%	16%	20%	19%	20%	13%

Table 4: Number of individual interviews conducted in the sampled districts

The sampling rate varies between 13% and 39%, which suggests that the responses can be considered representative (UNSD, 2005). The households interviewed were selected randomly. In the first instance, the questionnaire was filled in with several participants after the focus group that introduced the study. In the second stage, respondents were selected by travelling through the different neighbourhoods of the village in order to interview people from the different *Knua*. The interviews were conducted in *Tetun* or in the vernacular language.

2.7 Restitution of preliminary results

In each village, a restitution of our surveys and of preliminary results was organized. It was a short informal meeting with people of the aldea, in presence of the chief (about 10 attendees per restitution). It introduced the typology of farming systems and their development strategies identified in the aldea. This presentation was followed by a discussion about the typology and the main difficulties and stakes at the aldea level.

3 Situation of the agroforestry systems in the Baucau district

3.1 Agroforestry systems of Baucau district

Thanks to previous work, five main AFS were identified in Baucau district. A reminder is presented in Table 5.

Typology reference adapted from "An Introduction to Agroforestry", P.K.R Nair (1993)	CROP SYSTEM INCLUDING A FALLOW PHASE	SYLVOPASTORAL	YOUNG AGROFOREST	HOME GARDEN	FOREST GARDEN
Baucau location reference	Flat and slope lands	Rocky and superficial soils, slope lands, fallow lands (i.e. former rice, CF)	Closed to a stream and/or closed to village centre	Village centre (attached to houses)	Closed to a stream (can be dry during the dry season)
Density of trees inside the plot (low, medium, high)	Low	Medium	Medium-Low	Medium-High	High
Main crops and animal husbandry	Corn, peanut, sweet potatoes, cucurbitaceae, beans, horses, buffalo, goats and sheep	Horses, cows, buffalo, goats and sheep	Chili, papaya, condiment, vegetable, banana	Corn, cassava, taro, yam, vegetable, condiment, banana, bamboo, papaya cucurbitaceae, beans, chili, pigs and chicken.	Yam, condiment
Main trees planted	Candlenut, Coconut, Teak, Gmelina	Teak	Teak, Swietenia mahagoni , Gmelina , Coconut, Citrus, Gliricidia	Citrus, Coconut, Breadfruit, Mango, Candlenut, Teak, <i>Gmelina</i> , Goyava	Palm (betel, coconut), Mango, Breadfruit, <i>Gmelina</i> , Teak, Candlenut
Main trees not planted	Eucalyptus alba , Timonius , Rosewood, Tamarind, Kussum tree, Ziziphus mauritiana , Albizia julibrissim , Corypha	Eucalyptus alba and Timonius , Rosewood, Tamarind, Kussum tree, Ziziphus mauritiana, Delonix regia, Sesbania grandiflora, Leucaena leucocephala, Albizia julibrissim , Sandalwood, Palm (Borassus , Corypha)	<i>Timonius</i> , Kussum tree, Rosewood (Samalari), Palm (<i>Borassus , Corypha</i>), <i>Sesbania grandiflora , Leucaena leucocephala</i>	Palm (<i>Borassus</i> , <i>Corypha</i>), Kussum tree, Custard apple, <i>Leucaena leucocephala</i> , <i>Sesbania grandiflora</i> , Tamarind, Wild candlenut, Cotton tree	Arenga , Corypha , Borassus

Landscape and species characteristics:

Social characteristics:

Typology reference adapted from "An Introduction to Agroforestry", P.K.R Nair (1993)	CROP SYSTEM INCLUDING A FALLOW PHASE	SYLVOPASTORAL	YOUNG AGROFOREST	HOME GARDEN	FOREST GARDEN
Social land use regulation					
Land ownership	Household	Кпиа	Household	Household	Knua or household
Labour	Household or Exchange of services (neighbours, relatives)	No specific labour	Household	Household	No specific labour
Resources ownership	Household or exchange services (neighbours, relatives)	Common and <i>knua</i> (tree trunk)	Household	Household	<i>Knua</i> or household
Main use	Food for self-consumption, animal food, economic income	Animal food, construction, firewood, traditional medicine	Economic income, firewood, land securization	Food for self-consumption, economic income, animal food	Construction, firewood, traditional medicine, food for self-consumption, economic income, land securization

Others:

Infrastructure					
Water availability			All year or only raining		All year or only raining
	Raining season	Raining season	season	All year	season
Fence/Hedgerow	Depend	No	Depend Depend		No
History track					
Date of installation (crop and/or					
livestock system)	0 to 3 years	> 50 years	2 to 10 years	> 5 years	> 50 years
			Crop system including a		
	Sylvopastoral land (pasture,		fallow phase, Sylvopastoral	Crop system including a	Llomo gardan voung
Precedent crop system	savana or secondary forest),	Savana, forest	land (pasture, savana or	fallow phase, Young	Home garden, young
	Forest garden		secondary forest), Forest	agroforest	agrotorest
			garden		
Mean size of the plot (ha)	0,3 to 1,25	200 to 500 (village scale)	0,2	0,3	0,5
Number of fire/year	0 to 2	1 to 3	0 to 1	1	0 to 2
Total plot inventoried in Gariuai	8	6	6	8	5
Total plot inventoried in Samalari	6	6	9	10	4

Table 5: Baucau AFS's main characteristics (Reference: Cogné et al., 2022)

3.2 Farming systems of Baucau district

3.2.1 Presentation of the studied area

Two sucos were selected for the research study (see Technical reports): Gariuai, composed of 8 villages and Samalari composed of 4 villages. One *aldea* per *suco* was chosen for the purpose of this mission to give insights about the diversity of farming systems in the region of Baucau: Cairiri *aldea* (895 inhabitants) located in Gariuai *Suco* and Osso Luga *aldea* (940 inhabitants) located in Samalari *suco*. Cairiri is located on the Baucau plateau while Osso Luga is located in the hills.

The history of these villages is closely embedded with the main trends happening in the country between colonial time and independence. They differ especially by their geo-morphologic conditions and, the population displacement that occurred during the Indonesian occupation and their access to services and infrastructure (Table 6).

BAUCAU D	ISTRICT	PORTUGUESE ERA	INDON	INDONESIAN OCCUPATION Transition pha		1	NDEPENDENCE	
Main event	Village	<1975	1975-78	1978-1999	1999-2002	2002-2010	>2011	
	Cairiri		Escape and surviving in the mountain and	Relocation of housing close to main roads	Civil war, people flee again to the mountain	Most of the people stay closed to the road, emigration to Dili and to other countries.		
Location & Displacements	Osso Luga	villages on the top of hills, so actual forest garden were the fo homegarden	forests; indonesian army burn villages, sacred houses, forests	Relocation of housing on the other side of the river, in Samalari aldea	before progressively coming back, people also flee to West Timor (Kupang)	Rehabilitation of Osso Luga village		
Crops & Animals	Cairiri	Teak, coconut, animals (goa buffalo), kapoke trees (cotton) rice to pay the colonial tax (m from Chinese trade) Suco co organize community to produ coconut and teak on "commu	Abandonment o plantations, fields, livestock. ief ce nal	Candlenut intensive planting, new coconut variety, fruit and spice trees (e.g. clove, jackfruit), tractors to till and new technics to plant rice, corn and peanut field. Chemical fertilizer distributed to farmer. Stop using buffalo in the rice field.	Crisis: Re-allocation of fields, sale of land (cash flow need), illegal sale of sandalwood. Militia and army kill livestock. The other	Illegal sale of sandalwood (crisis), cutting of big trees (<i>Casuarina</i> , rosewood in Osso Luga, Rubber tree in Cairri) to rebuild sacred house and open new fields	Improved variety of ri mahogany, gmelina, ban plantation	ice, mboo
	Osso Luga	land".	Second	Secondary forest regrowth		(corn). Cutting of palms (coconut on communal land) to rebuild houses.	Improved variety of ri mahagony, sandalwoo plantation	ice, ood
Infrastructure & Services	Cairiri	Road from Baucau Vila to Venilale, Catholic professional school (Fatumaka)	ed lage dren ntre ch.), Invasion crisis	Opening of new schools (until secondary sch.) to a wider public, agriculture extension workers/ Crisis in the end of 1990's where part of the village was burnt again and infrastructure destroyed	Indonesian army and militia burn and break infrastructure services. UN soldiar and other NGO first aids to support	Water infrastructure (tank), electricity a		Road rehabilitation project (ILO), access to school and professional
	Osso Luga	No road, no school (suco, ald	es eia)	First road creation	village.	Building of primary school and chapel	Water Baucau infrastructure (tank), electricity	u Vila

Table 6: History of Cairiri (Gariuai suco) and Osso Luga (Samalari suco)

3.2.2 Land tenure rules

The traditional rules of land tenure, the *Aldeas* history of displacement and the national agricultural policies led to differentiated access to land and capital between farmers households. In Baucau, the farming systems are distinguished according to:

(i) The social organization at the level of the extended family (from grandparents to grandchildren), which is responsible for the allocation of production factors,

- (ii) The social organization at the level of the *Knua*, which participates in the distribution of specific tasks (particularly for livestock), and
- (iii) The distribution of the members of the *Knua* in the landscape (i.e. highlands, valleys, and humid lowlands). There are many exchanges between the different farming systems, particularly for livestock feed. Indeed, animals play a key role in social relationships between *Knua*.

In the extended family, land is transmitted from fathers/uncles to sons/nephews. Elders generally have greater access to land than younger adults, who are more likely to leave the villages.

In villages that were displaced during the Indonesian occupation, families have resettled on their ancestral lands by *Knua*. Land appears to be pre-divided by extended families within the *Knua*. Nevertheless, land conflicts may exist. The presence of non-natives in these *Aldea* is relatively low. In the *Aldea* that were densified by the displacement of the population under the Indonesian occupation, the presence of allochthones is more important. In addition, there are many land conflicts, particularly regarding State land that are claimed by customary institutions.

In both cases, the installation of AFS is a way of marking land.

3.2.3 Farming systems

Various productive strategies and allocations of production factors (land, work and capital) are observed in this district. According to its access to resources, by choice or by need, a household may develop a specific investment strategy along its life to increase its capital and to prepare the future and transmission to its heirs. These dynamics result in four main types of farming systems that can be identified to cover the diversity of socio-economic situations in Baucau district.

• Type 1: Household with restricted access to land / Small landowners

These households can be:

- Allochthones. The *Mane Foun* are men who could not pay the dowry, the couple have to settle on his parents in law land and must share the products with them.
- Late arriving inhabitants in the *Aldea*. Some households also came back later than the others in the village because they did other jobs in town during occupation or at the beginning of Independence. So, they had to settled once the land had already been occupied and "distributed" and have not the priority for opening the land.
- Some families whose parents died early, are ill or widowed women face difficulties to access or manage land, because of a lack of labor force. They are not able to open new land or to maintain a solid fence.

These small landowners borrow land from the families of the landowning *Knua*. They may also illegally occupy state land. In both cases, their access to land is not secured. These households develop diversified technical systems close to their homes (home gardens combined with pigs or few goats) with, depending on possibilities, market gardening plots and/or maize and/or rice crops in sharecropping.

Some may stay in their parents or parents in law house until they are able to build their own house. Generally, 3 generations live together and share all their revenues. These households are characterized by a poor social and financial capital.

They can be considered as Poor Households. With a restricted access to land, if the household's labor force is weak (disease, few children or widowed), it may stay poor and survive from very few incomes from agroforestry sale and just manage to feed themselves with a CF land or HG.

• Type 2: Household with balanced assets / Specialized farmers

This type refers to a medium household without any specific social or financial capital, but with balanced access to each different production factor: land, labor force, animals.

When they get married, households are provided with lowland to produce primarily flooded rice (mostly for self-consumption) in the rainy season and market gardening (for sale and self-consumption) in the dry season. These households generally have small slash-and-burn maize fields in valleys and small livestock near their homes. Profits from the lowland parcels are shared with parents, extended family, and all those mobilized for production. Indeed, rice cultivation requires a large workforce.

These household rely on horticulture and flooded rice but they can also find non-farming jobs (construction, public services, managing a *kiosk*).

• Type 3: Agroforestry producers' households / Big landowners

These households maintain and enrich AFS in valleys and humid lowlands. Their objective is to produce cereals and tubers for the extended family, and to extend their tree plantations with a view to strengthen the household's land holdings to provide as much capital as possible to their children. These households have a few heads of livestock and sometimes use their plots for grazing and a significant portion of their production for the Knua's herd, as well as possibly for a pig breeding belonging to the household.

• Type 4: The cattle breeding households / Big husbandry owners

This type of households is associated with richer people and represents a minority in the village. They belong to chosen families who were given a couple of cows or goats, sheep during Indonesian Occupation. This assistance from the former government gave them the advantage over other households to develop their cattle capital by free reproduction in the collective pasture area.

- Big ruminants breeding households breed these animals for the *Umane* ("women's donors") of the *Knua.* These households are often those whose younger generation is predominantly male, but also produce cattle (oxen, Balinese cows, sometimes horses) for other families of the *Knua.*
- Small ruminants' households produce cattle for the *Fetosan* ("women takers") of the *Knua*. These households are often those whose younger generation are mostly constituted of young women, but also produce livestock (sheep, goats) for other families of the *Knua*
- However, the animals are usually managed by a herdsman (called *Bibi Atan* for small ruminants and *Karau Atan* for big ruminants)

These households also use agroforestry parcels that provide extended families and animals with food. Herders may also have agreements with agroforestry producers to allow their animals to graze on their parcels in the dry season.

Farming systems	Investment strategy	Age of head of household	Type of land exploited	Average area managed (in ha)	Cropping systems	Cattle	Small ruminants	Pigs	Poultry
Small Iandowners	Diversification	18-80	Variable depending on available loans/rentals	0.5 to 1 ha	HG, CF (sharecropping), Swamp rice and market gardening (sharecropping)	0	0	0 to 4	5 to 100
Diversified farmers	Horticulture and flooded rice production	18-80	Humid lowlands, valleys	0.5 to 1.5 ha	Swamp rice & market gardening CF, HG, (+YA)	0 to 2	0 to 5	0 to 1	5 to 60
Agroforestry producers	Intensification	> 40 years old	Valleys and humid lowlands (river= old agroforests)	2 to 4 ha	CF, YA, FG, HG	0 to 5	0 to 5	2 to 4	5 to 60
Cattle	Big ruminants breeding households	> 40 years old	Valleys, highlands, and humid lowlands (rice fields)	0,5 to 2 ha (Cult.) 200 to 500 ha (Pastures at village scale)	HG, CF; Rice Sharecropping/Help, timber? (Planted In SP et CF)	9 to 25	0-5	0 to 2	5 to 20
households	Small ruminants' households	> 40 years old	Valleys, highlands, and humid lowlands (rice fields)	0,5 to 2 ha (Cult.) 200- 500ha (Pastures at village scale)	HG, CF; Rice Sharecropping/Help, timber (planted In SP et CF)	0 to 2	20 to 100	0 to 2	5 to 20

Table 7	presents the main	characteristics	of the different	farming sy	/stems id	dentified.
	Table 7 : Main c	characteristics of	farming systems	of Baucau	region	

3.3 Households' economic dependence on AFS

3.3.1 Farming systems

Interviews conducted with 51 households in the villages of Cairiri and Ossoluga describe five farming patterns in this district (Table 8 and Table 9).

Pastures and old agroforests appear to be two AFS that are little used by these rural households, as already observed by Martin (2021). On the one hand, there are few livestock owners in Cairiri and none in Ossoluga, but most households keep small ruminants (goats, sheep) and pigs. On the other hand, old agroforests are almost never a source of income and are only marginally a source of food for self-consumption. The difficult access to commercial networks for candlenuts or coconuts probably limits a wider use of these agroforests. Moreover, as Martin (2021) showed, they perform several functions that are probably not well captured in our questionnaire, such as the provision of traditional medicines, fuelwood or timber. In a nutshell, two of the farming

systems mentioned in Table 7 (i.e. agroforestry producers and breeders of small ruminants) are therefore not very widespread, at least in the two sampled villages, and are not included in the following analysis.

The vast majority of households depend for their food and income on the crops they grow in their home garden/fields/young agroforests. However, this type of low-intensity polyculture does not allow a large proportion of households to escape poverty. In Ossoluga, for example, 44% of the households interviewed have a yearly income below \$800. Intensification of production through horticulture increases the average income level for some households. Similarly, off-farm revenue allows 56% of households to increase their annual income.

	POOR	DIVERSIFIED	HORTICULTURE	
Yearly range of income	\$ 800 <	\$ 1.100 - 2.800	\$ 1.500 - 6.000	
Source of income 1 (most important)	home garden	home garden	off-farm income	
Source of income 2	young agroforest	off-farm income	home garden	
Source of income 3	field	young agroforest	field	
Source of income 4 (least important)	off-farm income	old agroforest		
Source of production 1 (most important)	home garden	home garden	home garden	
Source of production 2	young agroforest	field	field	
Source of production 3	field	young agroforest		
Source of production 4 (least important)	old agroforest	old agroforest		
Cattle capital (big animals)	2-4	1-8	1-6	
Social capital	low	medium	medium	
Range of age (yr)	40-59	37-67	45-65	
Main sources of funds for investment	livestock breeding, sale of tree products, sale of crops	sale of tree products, livestock breeding	sale of tree products, livestock breeding	
% of households (in the sample) 44%		32%	24%	

Table 8	3:	Farming	archetypes	in	Ossoluga
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Table 9: Farming archetypes in Cairiri

	POOR	OFF FARM	HORTICULTURE	CATTLE
Yearly range of income	\$ 400 - 2.500	\$ 2.100 - 10.800	\$ 1.060 - 2.580	\$ 6.000 - 8.300
Source of income 1	off-farm income	off-farm income	fields	pasture
Source of income 2	home garden	young agroforest	off-farm income	off-farm income
Source of income 3	young agroforest	home garden	home garden	home garden
Source of income 4		field	young agroforest	fields
Source of production 1	young agroforest	young agroforest	fields	pasture
Source of production 2	home garden	home garden	home garden	home garden
Source of production 3		field	young agroforest	fields
Source of production 4				young agroforest
Cattle capital (big animals)	1-3	1-5	1-5	8-15
Social capital	low	medium	low	high
---	--	---	---	--------------------------
Range of age (yr)	45-72	45-72	41-58	59-65
Main sources of funds for investment	sale of tree products, sale of crop products	livestock breeding, sale of tree products	sale of crop products, livestock breeding	sale of crop products
% of households (in the sample)	27%	35%	23%	15%

Although in the same district, the types of farmers in these two villages have different profiles. On the one hand, poor households have broadly similar characteristics in the two villages. At the other end of the spectrum, there are no cattle owners in Ossoluga, whereas they represent 15% of our sample in Cairiri. Between these two types of farmers, those who practice horticulture are present in both villages, but those in Ossoluga have a higher range of annual income. This difference may be explained by the place of off-farm income in the economy of these households, or by the possession of social capital that allows access to economic opportunities.

3.3.2 Basic necessities

As shown in red colour in Table 10 and Table 11, there are only a few basic necessities that are not covered by the sampled households in Ossouga. Access to water appears to be the major problem for many households who need to irrigate their horticultural plots, especially in dry seasons.

						FAI	RMI	NG	TYF	PES	OF 1	ГНЕ	но	USE	НО	LDS					
Types of basic necessity			F	200	R						HOF	RTIC	ULT	URI	E		DI	VER	SIF	IED	
Land: 1 rice field + 1 corn field																					
Land: 1 Plantation (banana, papaya, lemon)																					
Animals: 1 big animal																					
Money: 100\$/month																					l
Minimum eqpmt: 1 machette, 1 dig stick, 1 ensada																					
Cloths: 1 pant & 1 tee shirt every 2-5 months																					
3 meals a day																					
Access to water < 50m																					
Access to hospital																					1
Access to electricity																					
Access to road																					

Table 10: Level of coverage of basic necessities in Ossoluga (by the interviewed households)

						FAR	MI	NG	ΤY	PES	S OF	ΞН	IE H	IOU	SEH	IOL	.DS					
Types of basic necessity	ho	rtic	cult	ure			р	001	r				cat	tle				of	f fa	rm		
1 big animal																						
2 fields																						
25\$/week																						
Minimum agric. eqpmt																						
Food: 2 meals/day																						
new clothes every 6 months																						
Access to water < 300m																						
Distance to school < 1km																						
Distance to hospital < 4km																						

Table 11: Level of coverage of basic necessities in Cairiri (by the interviewed households)

3.3.3 Investment options

The low standard of living of many rural households leads them to consider several ways to cover basic necessities and to finance future investments. Table 12 and Table 13 show the activities that the households (grouped according to the farmer typology) would rely on either to better cover their basic necessities or to fund investment. Three colors are associated to specific activities in order to facilitate the reading of these tables: brown stands for livestock breeding, blue for the sale of crop products, green for the sale of tree products.



Table 12: Investment options for the interviewed households in Ossoluga

Table 13: Investment options for the interviewed households in Cairiri

	93	98	101	102	104	107	108	87	88	90	92	103	109	99	100	91	97	105	106	86	110	111	89	94	95	96
Basic necessity				poor						hortio	culture							off farm						ca	ttle	
													sale of					sale of								
1 big animal		local	palm			livestock							crop	livestock		livestock	remittanc	crop		livestock						
		trade	wine			breeding							products	breeding		breeding	es	products		breeding	job					subsidies
1 homo gardon i 2	sale of	sale of	sale of				sale of	sale of	sale of						sale of											
fields	crop	tree	tree				tree	crop	tree						tree											
lielus	products	products	products				products	products	products						products											
			sale of			sale of																			sale of	sale of
			tree			tree																	sale of		crop	crop
25\$/week	sale of		products,		sale of	products,	sale of	sale of	sale of			sale of					sale of				sale of		crop		products,	products,
	crop	local	palm	re mitta nc	crop	livestock	tree	crop	crop	livestock		crop	livestock	livestock		livestock	tree	local	livestock	livestock	tree	remittanc	products,		livestock	livestock
	products	trade	wine	es	products	breeding	products	products	products	breeding		products	breeding	breeding		breeding	products	trade	breeding	breeding	products	es	subsidies	job	breeding	breeding
new clothes every 6															remittanc											
months															es											
Minimum eqpmt: 1																							sale of			
machette + 1 dig														livestock						livestock			crop			
stick + 1 pickaxe								subsidies						breeding						breeding			products			

There is no homogeneous trend in the two villages. Investing in livestock is a strategy frequently cited by poor and diversified households in Ossoluga and by households with off-farm income in Caririri, but surprisingly not by current livestock owners. This is clearly a strategy for intensifying livestock in or around cultivated areas, not in silvopastoral areas that seems difficult to access for many households.

Selling tree products (especially fruit) is also an option widely cited by households with diversified economies or those with low incomes.

The sale of agricultural produce is also a source of finance, especially in Cairiri, for households that depend on income from agriculture.

4 Manatuto district: Study of Manehat Suco

4.1 Presentation of the studied area

Manehat *Suco* is composed of 3 villages: Nu-Ahuk (60 Households), Dambuahun (67 Households) and Issadan (66 Households). Nu-Ahuk is in the hills, next to the road built by Indonesian government whereas Dambuahun is closely embedded with Issadan village, in the valley. They are close to each other (approximately 5 kms by the road). Both villages' landscapes are characterized by an important forest cover and some grass plains in the valley of Dambuahun.

The current population and land distribution in the *Suco* territory is mainly explained by successive population displacements during Indonesian occupation. The history of these villages is strongly intertwined, they are provided with different but complementary public services and infrastructures (Table 14).

MANEHA	IT SUCO	PORTUGUESE ERA		INDONESIA	OCCUPATION		IND	EPENDENCE	
Main Events	Village	<1975	1975-1983	1983-1990	1991-1993	1994-2002	2002-2010	2011-202	22
	Nuu-Ahuk			Displacement to		Displacement to the hills		Still in the l	hills
Location &		Neighbour villages in the	Escape to Makfahik	Natarbora	Displacement to	road	Creation of		
Displacements		hills	mountain	Displacement to	original village	Displacement	Issadan village		
	Dambua-hun			Soibada		to the valley	Some returned to the hills	Still in the v	alley
	Nuu-Ahuk	Specialization			2 cows/ 5HH		Come back to	Distribution Teak, coffee	Chicken
Crops & animals	Dambua-hun	and beteinut to pay Portuguese tax	Abandoned	crops and animals	2 cows/ 5HH	50 cashew seedlings, 30kg of rice/HH	Candlenut forests in the hills	Distribution Teak, coffee Bambu Nursery (GIZ)	diseas & Pigs disease
	Nuu-Ahuk							Electricit	iy.
Infrastructures & services	Dambua-hun	Old road			Road & houses Construction 1250m2/HH		IDT : Microcredit for creation of a new activity/ 15 people groups	Electricit Church, Clini School	c and

Table 1/ ·	History	of Nu-Abuk	and Dambuahun	Manohat Suco
Table 14.	пізіогу	OI NU-AIIUK	anu Dambuanun,	Manenal Suco

4.2 Type of AFS in Manehat Suco

4.2.1 Characterization and distribution of the AFS

The five main AFS already identified in Baucau district (Cogné *et al.*, 2022) are present in Manehat *Suco*: Crop and fallow, Forest Garden, Home Garden, Young Agroforest, Silvopastoralism. Other cropping systems as flooded rice and market gardening were not observed in this highland area. In Manehat villages, the main staple crops are grown in Crop and Fallow fields and the main cash crops, betelnut and candlenut are grown in Forest Gardens.

Table 15 below resumes the local toponymy, the characteristics, products and using rights of each type of AFS in this *Suco*. Farmers do not use any inputs (pesticides or fertilizer) and work with manual equipment such as pickaxe, machete, hoe and digging

stick. The distribution of these AFS among the landscape can be represented in a transect (Figure 8).



Figure 8 : Transect of Manehat Suco landscape and distribution of AFS

In English	In Tetun terik	Characteristics	Activities	Products (Main products, secondary products)	Management scale	Location
Home garden HG	Quintal/Toos uma hun	Located next to the house dedicated to grow some staple crop and vegetables, keeping some trees of interest for medicinal, firewood purpose. Individualized by fences and obtained by slash and burn process on a fallow or forest. Small animals as chicken and pigs can access it.	Agriculture, Small livestock rearing, Firewood, Medicine	Corn, cassava, pumpkin, banana, papaya, beans, spinach, tomato, spices, Fruits, Firewood, Small husbandry	Household	Village, next to the houses
Crop and Fallow CF	Toos foun	Space dedicated to grow staple crop (cassava mixed with sort-cycle crops) for self-consumption and animals, keeping some old trees. Individualized by fences and obtained by slash and burn process on a fallow or forest.	Agriculture, Big livestock fodder, Firewood	Corn, Rainfed rice, cassava, Taro, pumpkin, beans, banana, papaya, Firewood	Household	In the slopes close to the villages
Forest Garden FG	Abat laran	Space dedicated to grow one or two main cash crops species mixed with other fruit or construction-wood trees.	Fruits, Firewood, Construction	Betelnut Candlenut Teak, Avocado, Coffee, Mahogany, Firewood, Bamboo	Extended family	Next to the river in the former villages location's
Young Agroforest YA	Toos posan/Toos posalaki	Former crop and fallow field with tubers lefts and planted with young trees, dedicated to grow as a forest garden or a home garden. Still individualized by fences	Fruits, Firewood	Cassava, Some fruits, Firewood	Household	In the slopes, in the place of a former field
Silvopastorali sm SP	Pastagem	Free space of pasture made of forest and grass plains.	/	Big husbandry (cows)	<i>Knua</i> (opening of new field), <i>Suco</i> (animal fodder)	Around the village

Table 15 : Local toponymy of AFS, management scale, activities and products in Manehat Suco

4.2.2 Specificities of Manatuto's AFS

4.2.2.1 Succession from Crop and fallow to Forest Garden

The succession from Crop and Fallow system to Forest Garden described for Baucau is similar in Manehat *Suco* (Figure 9) but presents variations of toponymy and main planted species.

Farmers use to open land by slash and burn to cultivate staple crops for four years, letting some old trees in the field. Corn in association with beans and pumpkins and/or rice are cultivated the two first years, and cassava, banana and sweet potatoes from the 1st or the 2nd year. Fields usually have an opened area from 0.2 to 0.5 ha, individualized by a bamboo fence. Corn, rice and vegetables are grown during rainy season and rice can be grown at the end of rainy season to prevent it from the damages of violent rain episodes. Cropping calendar is presented in Table 16.

Table	16	· Cropping	calendar	of	Cron	and	fallow	system	in	Manatuto	district
Table	10	. cropping	calendar		Grop	anu	lanow	System		Manatuto	uistiict

						Yea	ar 1											Yea	ar 2					
Work operations	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D
Slash & fix the fence																								
Burn																								
Seedling corn & others																								
Weeding(1/month)																								
Seedling rice 2																								
Harvest corn & rice 1																								
Harvest Others																								
Harvest (cassava)																			Lit	tle b	oy li	ttle		
Harvest rice 2																								

For tree plantation or pursuit of the program, it is important to consider that the maximum workload is the slash and burn operation from August to November.

After staple cropping, there can be two different technical dynamics for this field.

- Fallow: It can be abandoned in fallow for about 1 to 10 years depending on the household land ownership. The household then opens a field in wild or abandoned land within its *knua* area.
- It can become a Young Agroforest when some trees are planted inside the field from the 2nd year of cultivation. It is called *Toos Posa* when 1-2 years old trees are planted and cassava is still cultivated, and *Toos Posalaki* after 5 years when the trees are big enough for the fence to be removed and animals to be allowed to access the grass and tree fodder inside.
 - Home garden: If the trees planted are fruit trees, wood for construction, and medicinal trees, this field will become a home garden after six years.
 - Old Agroforest: If the field is planted with specific tree species such as candlenut and betelnut or more rarely teak, coffee, avocado trees, this young agroforest will turn into old agroforest for fruits cash crops after twenty years.

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Figure 9: Pictures of crop and fallow evolution in Manehat Suco (Left: *toos foun* 1st year, right up: young coffee and betelnut agroforest, right bottom: Young home garden agroforest), (Pictures: Mazin)

This cropping succession is presented in the figure below (Figure 10). The study showed that trees given by NGOs are usually planted in YA: *Toos Posa or Toos Posalaki (Rambutan, Mahogany, Coffee, Avocado...)*. This process aims at creating "an agroforestry capital" to mark land and prepare its transmission for children and/or to extend the surface of FG where cash crop is cultivated.



Figure 10 : Succession of cropping system to create betelnut and candlenut agroforests, Manehat Suco

4.2.2.2 Biodiversity and soil inventories in Manehat Suco

A total of 11 inventories were done in the two villages of Nuu Ahuk and Dambua Hun:

- 4 young agroforests (YA)
- 4 homegardens (HG)
- 2 forest gardens specialized in betelnut (FG Betel)
- 1 forest garden specialized in betelnut and candlenut (FG betel and candlenut)

The densest system is forest gardens (Table 17). However, if we compare the diversity level, we notice that home gardens are much more diverse than forest gardens specialized in betel and candlenut. They also have the most diverse species composition of medium to big trees (>10cm diameter) measured in the 153 and 706m² plots (plot A and B). The sizes of the fields were restricted to less than 2000m² in general. This can be due to the landscape feature (steep slopes) and the practices (regular opening of land every 1 to 2 years) which limit the farmers to cultivate bigger field permanently.

The total species inventories observed in the two villages are reported in Appendix 6.

AGROFORESTRY TYPE	Density small trees (number/ha)	Density big trees (number/ha)	Number of species observed in the field	Number of tree species observed in plot A&B (>10cm diameter)	Surface (ha)
YA	243	15	14	3,5	0,2
HG	422	67	20,25	8,25	0,1
FG BETEL	780	71	8,5	4,5	0,07
CANDLENUT	1300	113	12	5	0,4

Table 17: Palm and trees density & biodiversity inventoried in AFS of Manehat Suco

Soils observed in both villages were all deeper than 50cm. They are all clayish soils, although silt and sands could be found in the lower layers (around 20-30cm) of young agroforest and home gardens. All types of plots observed had a superficial layer of 10cm containing organic matter (black colour). Young agroforests and home garden present lighter soil colour below 10cm which means that there is a loss of organic matter. On the contrary, the two types of forest gardens still contain a lot of organic matter until 30cm deep and even deeper for the forest garden specialized in betel.

AGROFORESTRY TYPE	SOIL DEPTH		0-10CM	-		10-30CM	-		>30CM	
		LOCAL COLOUR	TEXTURE	ROCKS	LOCAL COLOUR	TEXTURE	ROCKS	LOCAL COLOUR	TEXTURE	ROCKS
YA	>50CM	Black	MO+C(S)	1	Black-chocolate	(MO) + C(S)	1	White-yellow	SC	2
HG	>50CM	Black	MO+C	0,5	Yellow-chocolat	(MO)+C	1	Yellow	C (L)	1
FG BETEL	>50CM	Black	MO+CS	0	Black	MO+C	0	Chocolate-yellow	(MO)+C	0,5
FG BETEL AND CANDLENUT	>50CM	Black	MO+C	1	Black	MO+C	2	Yellow	LC	2

Table 18: Soil observations in AFS of Manehat Suco

(Notes : Legend explanation of table 18)

	Local		
Agroforestry type	colour	Texture	Rocks
YA=Young		MO = Organic	Score given to the quantity of rocks found in the soil:
Agroforest;		matter;	0=no rocks; 1= a few essentially composed of small rocks
HG=Homegarden;	Colour	C=Clay; L=Silt;	les than 5cm wide; 2=medium quantity of rocks with
FG betel = Forest	perceived	S=Sand;	different sizes including some with more than 5cm wide;
Garden specialized	by	(X)=a few;	3=a lot of rocks with different sizes including rocks more
in betelnut	farmers	+=and	than 5cm wide

4.2.2.3 Forest Garden specialized with cash crops: Betelnut and candlenut

FG (*Abat-laran*) in both visited villages are in the slopes, in the former *aldea* place, next to the river and some forests were planted closer to the village since Indonesian

occupation in the 1990's. They are mainly planted with betelnut (*bua*) and candlenut (*kamii*), the two main cash crops in this *Suco*. More recently, some teak, coffee, avocado trees, given by NGOs, were planted in these forests. Every household has at least one forest garden planted with cash trees. All these forests are maintained thanks to 'assisted natural regeneration'.

The main work operation is the collection of fruits during dry season (June to September). The betelnut and candlenut are then sold until November, in bags of 25kg to trucks of retailers or in the traditional market. The sale of such dried products of long conservation is adapted to the restricted access to market of this remote area (Figure 11).



Figure 11: Betelnut forest garden and bags of betelnut in Manehat Suco, (Pictures: Mazin)

4.2.2.4 Big ruminants rearing in silvopastoralism systems

Two main livestock rearing systems have been identified in Manatuto:

- The cattle breeding system is a local variation to the prominent rearing of small ruminants (goats and sheep) in Baucau district. People leave their animals in collective pasture within their *Suco* area (Silvopastoralism area). These pastures can be the grass land in flat areas but mostly the tree fallows where some species serve as fodder. Some cows are tied next to the house and are fed with cassava and banana leaves from CF fields (Figure 12).
- And small husbandry (pigs, poultry, dogs) fed with corn and cassava grown in home gardens and crop and fallow.



Figure 12: Silvopastoralism in Manehat Suco (grass plains in NuuAhuk) (Pictures: Mazin)

4.3 Farming systems

4.3.1 Land access rules and production factors organization

As in Baucau district, Manatuto land is pre-divided between the *Knua* and divided again by extended family within the *Knua* level. The specificity of this district is that both men and women can inherit land. Thus, land is shared between brothers and sisters.

No case of paid work has been noticed. Mutual support is linked to the extended family or the *Knua* level, mainly during preparation of the land (slash and burn, ploughing, and planting the seedlings):

- More intensive work such as slash and burn, fixing the fence, growing staple crops, and collecting fruits in FG may be managed by young household members (children) and the benefits are shared with the elders (grandparents).
- Elders seem to have bigger responsibilities in managing the farm than youngers. Youngers are more likely to find non-farming jobs or complementary jobs outside the farm.

4.3.2 Farming systems in Manehat Suco, Manatuto

In Manehat *Suco*, we can distinguish 4 types of allocation of capital and land resource types, like in Baucau:

- Household with restricted access to land / Small landowners. As in the Baucau district, these households can be:
 - Allochthones. If a man and a woman do not come from the same *aldea*, the household inherits two lands far away from each other and will probably exploit only the land in the village where they settle.
 - Late arriving inhabitants in the *aldea*.
 - o Some families whose parents died early, are ill or widowed women.

They generally inherit a small empty land to build a house and grow a HG or a CF or small lands to do both. They work in the *Abat laran* (FG) of their extended family and share agroforestry products benefits. They will inherit it at their parents' death. The household can borrow land from other *knua* to grow more staple crops in CF but

generally is not allowed to plant trees because they mark the territory. They have no big animals or only one but will rely on the sales of chicken (10 to 30).

• Household with balanced assets

This 'medium' household is given one empty land from the husband and one from the wife part within their *Knua* area when they get married. These lands are intended to build a house, plant a HG and grow food (CF) for the nuclear family. The household contributes to the collection of betelnut and candlenut in the FG of the extended family and inherits them properly when the grandparents or parents die or cannot manage these anymore. The benefits from the sales of agroforestry products are shared between the extended family.

It is also given few animals as chicken, pigs, and one or two cows. Cows are sold for big investments as building a house or paying children's school whereas chickens or pigs are sold for more regular expenses, as a complementary income to cash crops. Some may take care of their parents' cattle but really inherit it when their parents or parents-in-law die. Some men may have worked in other non-farming jobs before getting married, so they can buy one or two cows.

• Household specialized with agroforestry / Big landowners

A household inherits empty land, a place to build the house, an already tree-planted HG or do not need any HG and already productive *Betelnut FG*, sometimes two to five FG. It is also given both big and small animals, sometimes until five cows. And it relies mainly on bigger animals because it has no need of small husbandry for sales. These households benefit from a privileged access to agroforestry capital and so to investments as house, school.

• Household specialized with cattle / Big husbandry owners.

These households are provided with more than twenty or thirty cows and can mainly rely on it. Still, they have one CF field to feed their family and the animals (cassava) and one or two productive betelnut FG for complementary revenue and marking their land for the future.

As in Baucau, a household may develop a specific investment strategy, and these dynamics result in 4 main types of farming systems. They are presented in the scheme below (Figure 13). Some precisions about each type of farming system that can be found in the village are given below.

Type 1: POOR Households: These households survive from few incomes from betelnut and candlenut sales.

Type 2: PLURIACTIVITIES. These household may have different activities for a living and for developing their capital.

• **DIVERSIFICATION OF SOURCES OF INCOME:** Some households, even if they have access to FG, may not be able to extend their surface of cash crops for lack of labor force or available land in their *knua*. They try to multiply their source of incomes to complement their capital with non-farming jobs (construction, public services, managing a *kiosk*) and/or by specializing with high-value farming products as growing vegetables in their HG if they have access to water or make traditional palm-tree whisky and sell chickens.

If the family has a restricted access to land, generally, the young members work outside so they can capitalize to pay school for their children while grandparents still cultivate food for the extended family.

 ABANDON FARMING: Others but few households find a non-farming job to buy their food and only sell FG products. It is necessary for families with few lands and no option of diversification inside the village. Generally, they do not have animals but keep a small HG or CF for security and try to maintain their FG capital to have land to transmit to their children.

Type 3: AGROFORESTRY PRODUCERS. For household whose FG production is a sufficient source of income and who can access sufficient land to increase this capital, they may rely mainly on agroforestry products' sales. They have a process of intensification of their agroforestry capital.

- Households who have balanced assets may open new or unused fields within the *Knua* area. This process allows to create a CF rotation for staple food but also to extend the FG area by planting Betelnut and Candlenut (according to the succession presented previously). This strategy aims at increasing their agroforestry products source of incomes in the long term but also to be able to give already productive FG to their children. They also let their animals reproduce to be able to give some to their children.
- Big landowners possess land and work force to open new land regularly and plant YA of Betelnut and Candlenut. They may end their career with five to ten productive *Abat laran* so can rely exclusively on agroforestry products benefits. Moreover, they have an easier access to agroforestry-support programs (especially with trees distribution) as they have enough space to plant them. In the long term, they can develop niche markets with specific planted trees, notably teak and rambutan, cashew, avocado or coffee in this *Suco*. They also can pay private school for their children but also ensure them a good capital transmission of already productive and diverse AFS.

Type 4: CATTLE SPECIALIZATION

Finally, those who have more cattle can specialize with big animals (20 to 50 or 100 cows at the end of their career). They can sell them for a good price and have a reserve for traditional events in their family and can also sell some FG products but as a complementary income. The dynamic of planting some new FG is also present, to share their capital of animals and agroforestry between their children.

The farming systems' characteristics of each type is resumed in Table 19.



Figure 13: Manehat Suco's farming systems typology

Tabla	10.	Monohot	Sucolo	Earmina	avatama	main	abarastaristica
Idule	19.	Wanenal	SUCUS	ганни	SVSLEIIIS	IIIdIII	Characteristics

Farming systems	Investment strategy	Age of the HH	Type of land exploited	Average area managed (in ha)	Cropping systems	Cattle	Small ruminants	Pigs	Poultry
Poor	Surviving	30 to 70	Variable depending on available land	0,5 to 1 ha	FG, CF (Sharecropping, Help) or HG	0	0 to 2	0 to 2	5 to 20
Diversity	Diversification	20 to 60	Variable depending on available land	0,5 to 1 ha	CF (Sharecropping, Help) HG, FG	0 to 5	0 to 3	0 to 2	5 to 60
Fiunactivity	Abandon farming	20 to 60	Variable depending on available land	0,2 to 1 ha	HG or CF, FG	0	0	0	0
Agroforestr	Intensification	>40	Valleys, highlands	0,5 to 2 ha	FG, YA, CF	0 to 10	0	0 to 2	5 to 20
specialized	Capitalization	>40	Valleys, highlands	1 to 5 ha	FG, CF, YA	0 to 10	0	0 to 2	5 to 20
Cattle specialized	Capitalization >40 highla		Valley, highlands	0,5 to 2 ha (Cult.) 200- 500ha (Pastures at village scale)	SP, CF, FG	20 to 50	0 to 5	0	0 to 40

4.4 Households' economic dependence on agroforestry systems

4.4.1 Farming archetypes

The household interviews were conducted in the two neighbouring villages of Nu-Ahuk and Dambua-hun, which share four identical farming archetypes (Table 20 and Table 21).

	POOR	ABAT LARAN DEPENDENT	OFF-FARM	CATTLE
Yearly range of income	\$ 1.500 <	\$ 1.500 - 4.000	\$ 1.500	> \$ 4.200
Source of income 1	old agroforest	old agroforest	off-farm income	pasture
Source of income 2	home garden	home garden	home garden	home garden
Source of income 3	field		old agroforest	old agroforest
Source of income 4				
Source of production 1	home garden	home garden	home garden	pasture
Source of production 2	field	old agroforest	old agroforest	home garden
Source of production 3	old agroforest	field	field	field
Source of production 4				old agroforest
Cattle capital	<8	5-10	<5	>10

Table 20: Farming archetypes in Nuu-Ahuk

Social capital	Low	Medium	Low	Low
Range of age (yr)	28-60	28-65	34-36	38-84
Main sources of funds for investment	sale of crops, sale of tree products	sale of crops, sale of tree products, livestock breeding	Non-farming jobs	livestock breeding, sale of crops
% of households (in the sample)	33%	33%	13%	20%

Table 21: Farming archetypes in Dambua Hun

	POOR	ABAT LARAN DEPENDENT	OFF-FARM	CATTLE
Yearly range of income	< \$ 1.700	\$ 1.000 - 4.500	\$ 2.500 - 7.600	\$ 2.500 - 7.600
Source of income 1	old agroforest	old agroforest	off-farm income	pasture
Source of income 2	off-farm income	home garden	home garden	old agroforest
Source of income 3	young agroforest		old agroforest	
Source of income 4			young agroforest	
Source of production 1	young agroforest	old agroforest	home garden	pasture
Source of production 2	old agroforest	home garden	young agroforest	old agroforest
Source of production 3	field	young agroforest	field	field
Source of production 4	home garden	field	old agroforest	
Cattle capital	0-1	6-8	2-8	12-40
Social capital	Low	Medium	Low	Low
Range of age (yr)	35-65	40-70	40-50	35-55
Main sources of funds for investment	sale of tree products	sale of tree products	Non-farming jobs, sale of tree products	
% of households (in the sample)	26%	26%	37%	11%

The first two categories of farmers - poors and *abat laran* dependent - rely heavily on access to old agroforests for their income, mainly by selling betel and candle nuts. They supplement their agricultural production with home gardens and young agroforests.

Several of these households tend to intensify their betelnut and candlenut production through secure access to these AFS.

Some farmers have also specialised in animal husbandry and have adopted a strategy of accumulating cows and horses, which provides them with a comfortable income.

Finally, a minority of households (mostly young) no longer derive their main income from farming activities while at the same time not benefitting from the public pensions paid to veterans or from family remittances. Their income comes more from permanent or temporary jobs, often practised outside the village, which are supplemented by subsistence farming, generally practised in their home gardens.

4.4.2 Basic necessities

Almost similar lists of basic necessities were drawn up in both villages. Only a minority of which depend on a national or local collective institution (written in orange in Table 22 and Table 23). The non-coverage of basic necessities (in row) by the interviewed households (in column) are indicated by a red cell in the tables.

	FARMING TYPES OF THE HOUSEHOLDS													
Types of basic necessity		POO	R			AB	AT LAF	RAN		O FA	FF RM		CATTLI	E
Distance to agroforests < 1km														
Opening 1 new crop field every year														
2 big animals + 6 chickens														
Money: more than 10\$ a week														
Access to water < 1km														
Agric eqpmt (1 machette, 1 dig stick)														
1 house in cement/wood/bamboo														
Distance to road < 1km														
Distance to school < 1km														
Distance to hospital < 5km														

Table 22: Level of coverage of basic necessities in Nu-Ahuk (by the interviewed households)

Table 23: Level of coverage of basic necessities in Dambua hun (by the interviewed households)

	FARMING TYPES OF THE HOUSEHOLDS																	
Types of basic necessity		F	P00	R			ABA	T LA	RAN		OFF-FARM					CAT	TLE	
1 new rice & corn fields every year																		
1 cow																		
2 tree plantations (kamin & bua)																		
100\$ a month																		
1 house (after marriage)																		
Agric eqpmt (1 machette, 1 dig stick, 1 pickaxe)																		
Cloths: 1 pant & 1 tee shirt every 6 months																		
Traditional events (sau batar,)																		
Access to water < 1km																		
Distance to road < 1km (for market access)																		
Distance to hospital < 5km																		
Electricity: access to network																		

Not surprisingly, households belonging to the 'Poor' archetype have the most difficulty in meeting some of these necessities, such as owning cows or having a minimum amount of money every week. Some households that harvest betelnuts and candlenuts in the old agroforests face similar constraints, especially those that cannot adopt the strategy of intensifying this crop.

Households in the 'off-farm' and 'cattle' categories are not always able to have all these basic necessities, but these shortcomings are mainly indicative of their specialisation in livestock rearing or salaried work.

4.4.3 Investment options

Households were also asked about their willingness to increase their level of access to these basic necessities and the means they would use to do so. The purpose of these questions was to estimate their willingness and ability to invest, and the activities that would allow them to finance their investments. This information is collated in the Table 24 and Table 25 for the two villages, by assigning specific colours to the most frequently cited activities to finance these investments.

Basic necessities in Nu Ahuk	POOR	POOR	POOR	POOR	POOR	ABAT LARAN	ABAT LARAN	ABAT LARAN	ABAT LARAN	ABAT LARAN	OFF-FARM	OFF-FARM	CATTLE	CATTLE	CATTLE
Distance to	Sale of tree							Sale of tree							
agroforests < 1km	products							products							
Opening 1 new crop	Sale of crop	Sale of crop	Sale of crop	Sale of crop			Sale of crop				lobe		Sale of crop		
field every year	products	products	products	products			products				1002		products		
2 big animals + 6 chickens	cattle	Jobs	Sale of tree products		Sale of bushmeat		cattle	cattle			Jobs				
Money: more than 10\$	Sale of tree		Sale of tree	Sale of crop		Sale of tree		Local chanc	Sale of crop						a a ttl a
a week	products		products	products		products		Local shops	products						cattle
Access to water < 1km															
Agric eqpmt (1															
machette, 1 dig stick)															
1 house in															
cement/wood/bamboo															

Table 25: Investment options for the interviewed households in Dambua hun

Basic necessities in Dombua Hun	POOR	POOR	POOR	POOR	POOR	ABAT LARAN	ABAT LARAN	ABAT LARAN	ABAT LARAN	ABAT LARAN	OFF- FARM	CATTLE	CATTLE						
1 new rice & corn fields																			
every year																			
			Saleof								Sale of								
1 cow			tree		cattle			cattle			tree		Jobs			Jobs			
			products								products								
2 trop plantations (kamin							Sale of		Sale of	Sale of									
							tree		tree	tree									
a bua)							products		products	products		Loan							
										Sale of	Sale of	Local							
100\$ a month						Sale of				tree	tree	chonc					Sale of		
						whisky				products	products	shops					whisky		
1 house (after marriage)																			
Agric eqpmt (1 machette,																			
1 dig stick, 1 pickaxe)																			
Cloths: 1 pant & 1 tee																			
shirt every 6 months																			

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Three main observations emerge from these two tables. Firstly, it is the most disadvantaged households that express the greatest desire to increase the number of their basic necessities. Secondly, these households mainly demand three types of basic necessities: an increase in the number of large animals (especially cows), the regular and sufficient provision of cash, and an increase in the size of the agricultural/agroforestry land (more specifically the crop fields in Nu-Ahuk, and the abat laran in Dambuahun). Thirdly, the sale of agricultural products and tree products are the major sources of investment for the 'Poor' and 'Abat laran dependent' categories, in contrast to the 'Off-farm' and 'Cattle' categories.

Non-agricultural jobs are also a source of finance for households in the "Off-farm" category.

Breeding livestock is also a strategy sometimes cited for investment, but this option is unlikely to be available to households without a minimum herd of 6-8 cows.

5 Lautem district: Study of Soru Suco

5.1 Presentation of the studied area

Soru *Suco* counts seven villages. The two studied villages Caivaca (157 families) and Nairete (142 families) are characterized by a plateau area, a flat meadow surrounded by wooded hills, next to Los Palos Vila market.

These villages have been particularly densified during Indonesian occupation to the point that it is difficult to distinguish an *Aldea* from another, which has an impact on land distribution and access. The evolution of these villages and their agriculture is presented in Table 26.

SORU SU	ю	PORTUGUESE ERA		INDONESIA	N OCCUPATION			INDEPEND	ENCE	
Main Events	Village	<1975	1975-1978	1979-1980	1981-1990	1991-2001	2002-20	010	201	1-2022
Logation 8	Caivaca	Village in the	Escape to	Displacement	Los Palos Vila	Displacement to the valley near former village		Still in the	valley	
Displacements	Nairete	hills	Matebia mountains	to Los Palos vila	Displacement to the valley near former village. 3 villages mixed	CUPATION INDEPENDEN 181-1990 1991-2001 2002-2010 Palos Vila Displacement to the valley near former village Still in the val still in the valley placement the valley ar former dilage. 3 liges mixed Come back to coconut formation Still in the val still in the val still in the val stribution andlenut, Clove, Coconut NGOs distrib teak, caca avocado, val avocado, val avocado, val avocado, val stribution andlenut, Clove, Coconut NGOs distrib teak, caca avocado, val avocado, va	valley			
	Caivaca	Specialization with coconut	Abandana	d cross and		1 cow/ 10HH 1HH aquaculture formation	Come back to coconut forests in the	NGOs distr teak, ca marur rambu		
Crops & animals	Nairete	Portuguese tax + Paddy fields and animals	ani	mals	1 cow/ 10HH Distribution Candlenut, Clove, Coconut		hills and land mahogany coffee, extension. avocado, vanilla) Abandoned 2019 : Death of flooded field cattle because of drought			1 nursery GIZ
Information	Caivaca					Road & water tank	Church, Electricity	Korean	: Road, w	ater tank
Infrastructures & services	Nairete	Old road			School, Church	Electricity, water well	2008 : 1 3 coconut oil processin tractor for equipment, Coconut oil the Suco industry			ocessing conut oil y

Table 26: History of Caivaca and Nairete villages, Soru Suco

5.2 Type of AFS in Soru Suco

5.2.1 Characterization and distribution of the AFS

In Lautem, the same type of AFS as in Baucau district were encountered with a specific toponymy. The main difference is the Living Hedge and Crops which takes the form of a permanent field surrounded and protected by a living fence, as a mix between CF and YA (Figure 14).

Farmers do not use any inputs and work essentially with manual equipment such as pickaxe, machete, hoe and digging stick. Since 2008, one tractor is shared at the *Suco* level for ploughing flat field.

The Table 27 resumes the AFS characteristics of Soru Suco.

In English	In Fataluko	Characteristics	Activities	Products	Management scale	Location
Home garden HG	Quintal/Leku	Space next to the house dedicated to grow some staple crop and vegetables, keeping some trees of interest for medicinal, firewood purpose. Individualized by living fences and obtained by slash and burn process on a fallow. Small animals as chicken and pigs can access it.	Agriculture, Small livestock rearing, Firewood, Medicine	Corn, cassava, pumpkin, banana, papaya, Beans, spinach, tomato, spices, small husbandry, fruits	Household	In the village, next to the house. Few home gardens.
Living Hedge and Crops LHC	Pala	Space dedicated to grow staple crop corn mixed with other sort-cycle crops in spots, and cassava along the fence for self-consumption and animals, keeping some old trees. Permanent field individualized by living fences and obtained by slash and burn process on a fallow. Some trees can be planted are planted along the fence.	Agriculture, Big livestock fodder, Firewood Construction	Corn, Rainfed rice, cassava, taro, pumpkin, beans, banana, papaya. Coconut, fruit trees, teak, Mahogany, Cacao, Avocado, Coffee	Household	In the flat land or slopes close to the villages
Forest Garden FG	Осо	Space dedicated to grow one main cash crops species mixed with other fruit or construction-wood trees.	Fruits, Firewood, Construction	Coconut Teak, Betelnut, Bamboo, Firewood, Fruits	Extended family	In a valley, next to the river in the former villages location's
Silvopastoralism SP	Pastagem	Free space of pasture with grass plains.	/	Big husbandry (cows)	Suco but belongs to some mains <i>Clan</i> s	Around the village

Table 27 : Local toponymy of SAF, management scale, activities and products in Soru Suco, Lautem

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The distribution of these different AFS is represented in the transect below (Figure 14).

TRANSECT KEYS

Figure 14: Transect of Soru Suco landscape and distribution of AFS

5.2.2 Specificities of Lautem's AFS

5.2.2.1 Functioning of Living hedge and crops system

In this *Suco*, the flat grass lowlands and the availability of a tractor allows people to open bigger fields than in Manatuto (0,5-1 ha per family to more than 2 ha for big landowners). Usually, the first opening of the land is mechanized and completed with manual work in the slopes of the fields. Then, each year, farmers rely on the tractor for soil preparation (ploughing) of the land. A household must be able to pay the tractor driver and the fuel. Since it is in high demand and requires authorization from the head of *Aldea* to register, not all households have access to it, and few may access it every year.

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As preparing the land (or even one year before), farmers use to plant *Gliricidia (Ai-gamal)* and *Gmelina* trees as a living fence to protect crops from the cattle and to mark their territory. Because of the big amount of work spent in fixing this type of agroforest fences, these fields are permanent (Figure 15). Consequently, fertility restitution is a big stake in this cropping system.



Figure 15: Illustration of Living hedge and crops in Nairete (Left: Mixed cropping of corn, pumpkin and beans, with the Ai-gamal fence in the background, Right: recent fallow with former living tree fence) (Pictures: Mazin)

Usually, since the first season of cultivation, farmers may start to plant some trees such as teaks, coconuts, mahogany, or some fruit trees in one or two rows along the fence. Many of projects-given trees are planted inside these fields. This mix of CF and YA allow the farmers to constitute a cash crop agroforestry capital and to continue to cultivate the field (Figure 17). Some of these fields are planted progressively with trees from the fence to the center and will constitute in time:

- An old agroforest of coconut and/or teaks
- Or a home garden with mixed fruit and timber species

The cropping calendar is represented in Table 28. The succession of these LHC cropping system has a different temporal period compared to Baucau. It is represented in the Figure 16.

	Year 1																	Yea	ar 2					
Work operations	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D
Plant fence trees																								
Slash & fix the fence																								
Plough (tractor)/																								
Prepare the land																								
Seedling corn & others																								
Weeding(1/month)																								
Seedling rice 2																								
Harvest corn																								
Harvest Others																								
Harvest (cassava)																	Little by little							
Harvest rice 2																								
Plant tree seedlings																								

Table 28 : Cropping calendar of Crop and fallow system in Soru Suco



Figure 16: Succession of cropping systems in Soru Suco.



Figure 17: Examples of Young Agroforest along the fence in Nairete. Left: Cacao, Avocado in line, Right: Small Coconut (Pictures: Mazin)

5.2.2.2 Biodiversity and soil inventories in Soru Suco:

A total of ten inventories were conducted in the two villages (aldea) visited. A new type of young agroforest, called "Hedge and Crops", that was not present in Baucau was inventoried because it was widespread among the area. It is surrounded by a living hedge and the field is subdivided into several small plots where the fallow is in rotation with the crops from a year to another. In the valley, forest gardens were mostly specialized on coconut (the main cash crop in the *Suco*) and some people would also specialize on teak and mahogany, which is why we decided to sample these types of systems too.

As a result, the following inventories were carried out:

- 4 Young agroforest "Living Hedge and Crops" (LHC) type
- 3 Home gardens
- 2 Forest gardens specialized on coconut
- 1 Forest gardens specialized on teak and mahogany

The density of trees increases gradually from young agroforests (LHC), home gardens (HG), to forest gardens (FG COCONUT), as well as the tree species diversity. LHC young agroforests are generally spread on bigger surfaces (more than 1ha) than the other systems inventoried. This can be explained because this system integrates tractor tillage in flat lands that results in the opening of wider areas. We also observe that the forest garden specialized on teak and mahogany have the lowest biodiversity level in terms of total species observed in the field and in terms of tree species observed in the plots. It also has a lower plantation density compared to forest gardens specialized on coconut (Table 29).

AGROFORESTRY TYPE	Density small trees (number/ha)	Density big trees (number/ha)	Number of species observed in the field	Number of tree species measured in the plot A&B	Surface (ha)
LHC	211	35	17	4	1,3
HG	325	71	21	5	0,2
FG COCONUT	617	99	10	6	0,3
FG TEAK &					
MAHOGANY	520	28	3	3	0,1

Table 29: Palm and trees density & biodiversity inventoried in AFS of Soru Suco

In Soru, soils were varying greatly depending on the location of the field and the type of systems. In general, we found shallower soils in young agroforests (LHC) and homegardens (HG), while FG were deeper than 50cm. All systems were presenting a layer of 10cm with organic matter (darker colour). All systems were mainly composed of silt although it could vary in sand and clay contents.

Only home garden systems were showing presence of organic matter from 10 to 30cm deep (Table 30). This can be due to a higher input from small livestock manure and organic waste from the house. Homegardens also present the highest number of rocks compared to the other systems. Forest garden specialized on coconut were particularly low in organic matter content (less than 10cm) and showed Fe oxidation from the upper

layers. This can be related to the low amount of organic matter brought by coconut leaves that take long time to decompose.

AGROFORESTRY	SOIL DEPTH		0-10CM			10-30CM			>30CM	
1115	(ciii)	LOCAL			LOCAL			LOCAL		
		COLOUR	TEXTURE	ROCKS	COLOUR	TEXTURE	ROCKS	COLOUR	TEXTURE	ROCKS
LHC	40	Black	MO+ CL(S)	0,5	Chocolate	LC/ LS	0,75	Red	LC	1,25
HG	30	Black	MO+LC	2	Brown	MO+L	2	x	x	х
FG COCONUT	>50	Black-red	MO+LS	1	Chocolate-re	LC/LS	1,5	Red	LC	0
FG										
TEAK&MAHOGANY	>50	Chocolate	MO+LC	0	Chocolate-re	LC	0	Red	LC	0

Table 30: Soil observations in AFS of Souru Suco

Notes : see legend table 17

5.2.2.3 Forest gardens specialized with cash crops: Coconut

FG are very important as they are planted with the main cash crop: Coconut (Figure 18). The forest is maintained by assisted natural regeneration. Souru *Aldeas* were gathered in the middle of flat grassland, next to the road and remain far from the grandparents FG in the former aldea places (more than 2km). For this reason, informal groups are organized to share a transport to the FG to collect coconut and a dynamic of forest plantation in the plain closer to the village was observed.

Harvesting is spread out over the year with a larger workload during dry season. People sell fresh fruits but also co-products as copra and oil, and transformation represents a big amount of work. Some farmers are organized in groups to respond to large order of retailors who come with a truck destined the national market, mainly to Dili (e.g. 1000 L of coconut oil/month). Some also sell their products on the traditional market.

In Nairete village, a small virgin oil industry has settled. Also, a formal group of oil equipment sharing has been created. The *Aldea* chef is the leader of the group and about 40 families can access it if they pay. This collective structuration allows these families to reach a bigger market.



Figure 18: Coconut Forest Garden and firewood collection in Souru Suco (Pictures: Mazin)

5.2.2.4 Silvopastoralism

As in Manatuto, small animals are raised next to the house or in the HG and fed with the corn and tubers of the HG.

Big husbandry (mainly water buffaloes and cows) can move freely in collective pasture within the *Suco* (Figure 19). The plain grassland represents the main landform in this plateau area and allows a big animal load. Animals are also fed with coconut leaves, sometimes cassava.



Figure 19: Collective pasture in Tchaivatcha village (Picture: Mazin)

5.3 Farming systems

5.3.1 Land access rules and production factors organization

In Lautem district, the social and land organization is structured by *Clans* (the equivalent of the *Knua*). Land is pre-divided by main *Clans* within the village area.

Only men can inherit land. When a woman gets married, she must live in her husband's village. In traditional weddings, if the husband's family cannot pay the dowry, which is often high (sometimes about 50 cows), the man must stay on his clan's wife's land (*mane foun*). He lives with his parents in law and shares the land and products with them or borrows land to another clan.

This means that the access to land is conditioned by traditional marriage and the belonging to one of the main clans of the village. The ownership of animals (cattle and pigs) is also an issue to guarantee a fine wedding and transmission to the next generation.

The labor force is found at the extended family level, the use of external labor force is present but remains a minority.

5.3.2 Farming systems typology in Souru *Suco*, Lautem

In this *Suco*, the presence of a mechanized tractor, the proximity of the main district town and the densification of the villages seem to create a competition for production factors. The dynamic of abandoning farming is very present, especially in Tchaivatcha where it was difficult to meet farmers under 40 years old. At least, all the interviewees have already practiced non-farming jobs before settling or in complement to farming. Many rely also on extra sources of income as veterans' pension or children sending money from England or from Dili, whatever their social capital is. Again, we can distinguish 4 different farming system types (characterized by various productive strategies and allocation of production factors - land, work and capital).

- Households with restricted access to land/Small landowners.
- Allochthones. The *Mane Foun*.
- Late arriving inhabitants in the Aldea.
- Some families whose parents died early, are ill or widowed women face difficulties to open new land or to maintain a solid fence, because of a lack of labor force. In this district where cattle load is very important, having a solid living fence is paramount to secure cropping.

They work in the LHC and FG of their parents or parents in law and share the benefits with them. They can also borrow land to another *clan*. Some agreements exist between farmers, so they can stay on the land from generation to generation. Most of the time, they are provided with small lands or ones with a poor soil and cannot plant trees except those of the fence, for the owner to be able to get back its land at any time. They may plant more trees in their HG if they have one but there are few in these densified villages. Some have the right to plant trees by agreement of the landowner, but the latter can help himself with the agroforestry products as a sharecropping system.

These families usually do not have big animals but rely more on poultry for regular sales (from 30 to 100).

They may not have any process of fertility restitution or will put some ashes in plantation wholes and use small animal's manure. Moreover, they usually have restricted access to the tractor to open land because they cannot pay it or because of their small social capital. They have consequently a more restricted access to agroforestry resources and to technics.

• Household with balanced assets but facing technical constraints

When they get married, these households are given an empty land within the husband's *Clan* area to grow 1 *LHC field* of 1 ha or 2 *LHC* of semi-hectare in which they can do a rotation and/ or put manure collected in the plains. (One family in Nairete parks its cattle for night to facilitate manure collection). These fields allow the households to feed their family but also to sell some corn for animal breeders.

They access the tractor to open the land first, and then normally each year to prepare the land for their staple crop. People who could not get the tractor in time for the seedlings or could not get it at all would:

- Compensate with manual work on a smaller area to grow the minimal selfsufficiency food for the family.
- Rely temporarily on other sources of incomes (agricultural or non-agricultural) to buy their food for the year.

All these families have coconuts FG in their former aldea place. They work in it with extended family and inherit one or two when their grandparents or parents die. They do not need any HG.

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They get small and big animals at the wedding, generally have two to five cows or water buffaloes and one to five pigs but few chickens because they don't have private space around the house.

Most of them did a non-agricultural job or worked abroad to capitalize before they get married or settled at 30-40 years old when they are able to buy a big animal and to build a house.

• Household specialized with agroforestry / Big landowners

These households are granted with important area to grow crops in LHC (2ha fields) and access to water. Their field is big enough to operate a rotation inside the field itself (intra-field rotation) or they are part of a group to learn new technics of land conservation (mulch with leguminosis). They can create a diversified and rich YA by planting trees in LHC fields. Also, this type of households inherits already productive and big coconut FG and have a greater access to equipment, the same as the production group for coconut oil in Nairete.

They generally have some different animals inherited from their parents or bought from the revenue of coconuts as pigs (sometimes 30 before the drought of 2019), ten chickens, one to five buffaloes/horse, some fight roosters.

They benefit from a privileged access to production factors and so to agroforestry capital and investments as house and school.

• Household specialized with cattle / Big husbandry owners

This type of households belongs to chosen families who were given a couple of cows during the Indonesian Occupation or rich families who could buy some big animals and specialize early.

They are provided with more than twenty or thirty cows and can mainly rely on it. Still, they generally have one LHC field to feed their family and the animals (cassava) and one or two productive coconut FG for complementary income and marking their land for the future.

As in Baucau, a household may develop a specific investment strategy, and these dynamics result in 4 main types of farming systems. They are presented in the scheme below (Figure 20).

Some precisions about each type of farming systems that can be found in the village:

Type 1: POOR Households survive from very few incomes from coconuts sales and just manage to feed themselves with a LHC land or HG.

Type 2: ABANDON FARMING: In this district, an important proportion of households find a non-farming job or external source of income to buy their food. This type concerns poor households who need other incomes because of a too restricted access to farming resources but also households who could live from farming incomes but whose opportunities to earn money outside the village is more attractive. This second category may totally abandon their field and even sometimes release their animals in the wild.

Type 3: DIVERSIFIED FARMERS. In the studied area, whatever the access to land and capital, it seems that the households rely on diversified sources of income to complement revenues from coconut sales (maybe because of the low prices of coconut market and/or the damages of the 2019 drought on cattle). We can distinguish two investment strategies depending on the access to land and mechanization.

- **DIVERSIFICATION OF SOURCES OF INCOME:** Some households are not able to extend their surface of coconut because they do not have the ownership of the land and cannot plant trees. They try to multiply their source of incomes to complement their capital. They can find non-farming jobs (construction, public services, managing a *kiosk*) and/or specialize with high-value farming products as growing vegetables during dry season in their HG if they have access to water or making traditional palm-tree whisky and sell chickens.
- **INTENSIFICATION:** Households with balanced assets complement their Coconut revenues with sales of their excess of staple crop as corn, cassava, taro and occasionally with off-farm jobs as carpentry, construction when they cannot get the tractor. At the same time, they develop their coconut planted area in the long term by expanding LHC area and planting coconuts or some NGOs trees inside the hedge (teaks). This type relies on a combination of farming products and off-farm jobs to ensure the constitution of their capital and transmission.
- Big landowners may increase both LHC and FG areas during their lives. They
 open new land and intensify the plantation of different trees, including new
 projects-given trees (coffee, clove, mahogany, teak...). They sell coconut oil but
 also the excess of staple crop as corn, cassava for pig breeders. These
 households rely on all their different resources (space, groups, mechanization,
 various species of trees) and increase this capital for preparing the transmission
 of productive fields to their children. This current dynamic of projects-given trees
 to create plantation can turn into new markets as teak sales in some years.

Type 4: CATTLE SPECIALIZATION:

Finally, those who have more cattle can rely only on big animals (20 to 50 or up to 100 water buffaloes or cows at the end of their career). They also sell some coconut as a complementary income. They plant new FG in former CF to share their capital of animals and agroforestry between their children.

The farming systems' characteristics of each type is resumed in Table 31 below.



Figure 20: Souru *Suco*'s farming systems typology

In this district especially, because of the social rules on resources use, not everybody at the village level is able or allowed to constitute an agroforestry capital (Young Agroforest). Moreover, the process of land certification since 2016 is leading nuclear families to register and claim their land within their *clan's* land even if abandoned or lent to other clans to guarantee a minimal land ownership for their heirs. This may create more difficulties for small landowners to access land in the next years because they will have to give back their land for next generation and reinforce the exodus. Also, it can reinforce the important dynamic of relying on off-farms activities already existing with the 30-50 years old and 20-30 years old generations.

Farming systems	Investment strategy	Age of the HH	Type of land exploited	Average area managed (in ha)	Cropping systems	Cattle	Small ruminants	Pigs	Poultry
Poor	Surviving	30 to 70	Variable depending on available land	0,2 to 1 ha	FG, CF (Sharecropping) or HG,	0	0	0 to 2	5 to 20
Abandon Farming	Abandon farming	20 to 60	Variable depending on available land	0,2 to 1 ha	FG, (CF or HG)	0	0	0	0
Diversified	Diversification 20 to 60		Variable depending on available land	0,5 to 1,5 ha	CF (Sharecropping, Help) or HG, FG	0 to 2	0 to 5	2 to 4	5 to 60
farmers	Intensification (middle landowners)	>40	Lowland, hills	1 to 3 ha	LHC, YA, FG	2 to 10	0	02 to 20	5 to 20
	Intensification (big landowners)	>40	Lowland, hills	3 to 12 ha	LHC, YA, FG	2 to 10	0	2 to 40	5 to 20
Cattle specialized	Capitalization	>40	Lowland, hills	0,5 to 2 ha (Cult.) 200- 500ha (Pastures at village scale)	LHC, FG, SP	20 to 50	0 to 5	0	0 to 20

Table 31: Soru Suco's Farming systems main characteristics

5.4 Households' economic dependence on agroforestry systems

5.4.1 Farming archetypes

The household interviews were conducted in two villages located in the vicinity of the city of Los Palos. They share four farming archetypes (Table 32 and Table 33).

The proximity of the city of Los Palos, the sometimes-difficult access to land and the historically important presence of coconut trees strongly influences the farming archetypes observed in the two villages. More than 20% of the population do not obtain an annual income of more than \$900 and depend mainly on food crops grown in home gardens and open fields for their livelihood. Income is low and comes mainly from young and old agroforests, where coconut trees were planted.

A significant part of the population in these villages - around 30-40% - is detached from agriculture as a primary source of income. These are mostly elderly inhabitants who can rely on their veterans' pensions, a salaried job or remittances from their children. However, they continue to use home gardens or pastures to provide for their food needs. An (older) class of cow/buffalo/horse herd owners is also present. It is characterised by a logic of accumulation of livestock, which is very successful thanks

to the provision of common access pastures. Finally, a minority of middle-aged households opt for a diversification of their mode of production by combining all the AFS, both to cover self-consumption and to ensure a minimum level of sales.

	POOR	OFF-FARM	DIVERSIFIED	CATTLE
Yearly range of income	< \$ 600	\$ 2.000 - 7.000	\$ 4.000 - 5.000	> \$ 7.000
Source of main income (#1)	off-farm income	off-farm income	home garden	pasture
Source of second main income (#2)	young agroforest	pasture	pasture	off-farm income
Source of income #3	home garden	home garden	old agroforest	old agroforest
Source of income #4	old agroforest		young agroforest	young agroforest
Source of production 1	home garden	pasture	pasture	pasture
Source of production 2	field	home garden	young agroforest	old agroforest
Source of production 3	pasture	young agroforest	old agroforest	field
Source of production 4	young agroforest	field	home garden	home garden
Cattle capital (big animals)	0	2-15	12-20	15-100
Social capital	low	medium	Strong	strong
Range of age (yr)	36-60	50-60	40-60	40-70
Main sources of funds for investment	Sale of tree products	livestock breeding	Sale of crop products, livestock breeding	livestock breeding
% of households (in the sample)	22%	28%	17%	33%

Table 32: Farming are	chetypes in Nairete
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Table 33: Farming archetypes in Tchaivatcha

	POOR	OFF-FARM	DIVERSIFIED	CATTLE		
Yearly range of income	< \$ 900	\$2.200-9.000	\$ 1.500-3.600	\$ 4.400 - 14.000		
Source of income 1	old agroforest	off-farm income	Pasture	pasture		
Source of income 2	home garden	home garden	home garden	off-farm income		
Source of income 3			old agroforest	home garden		
Source of income 4			young agroforest			
Source of production 1	home garden	home garden	home garden	pasture		
Source of production 2	field	pasture	Pasture	crop & fallow		
Source of production 3	old agroforest	field	crop & fallow	home garden		
Source of production 4		old agroforest	old agroforest	old agroforest		
Cattle capital (big animals)	<10	<10	8-15	10-30		
Social capital	medium	medium	Low	medium		
Range of age (yr)	54-70	46-85	41-51	37-71		
Main sources of funds for investment	jobs, sale of crops, livestock breeding	sale of crops, sale of tree products, livestock breeding	livestock breeding, non- farming jobs	livestock breeding, jobs		
% of households (in the sample)	25%	38%	19%	19%		

5.4.2 Basic necessities

Almost similar lists of basic necessities were drawn up in both villages, with only a minority of which depend on a national or local collective institution (written in orange in Table 34 and Table 35).

The findings are similar to those in Manatuto district, both in terms of the "poor" households struggling to meet basic necessities and in terms of the types of basic necessities to be improved, which focus on livestock, agricultural/agroforestry land and cash.

	FARMING TYPES OF THE HOUSEHOLDS																	
Types of basic necessity	POOR			OFF-FARM						IVER	SIF	CATTLE						
1 big animal + 10 chicken																		
1 home garden + 1 field + 1 toos tuan																		
15\$/week																		
new clothes every year																		
Agric eqpmt (1 machette, 1 dig stick, 1																		
pickaxe)																		
Cooking equipment																		
Access to water < 150m																		
1 house																		
Birth certificates renewed every year																		
Social kultura																		
Distance to school < 6km																		
Distance to hospital < 5km																		
Electricity via public network																		
Distance to road < 100m																		

Table 34: Level of coverage of basic necessities in Nairete (by the interviewed households)

Table 35: Level of coverage of basic necessities in Tchaivatcha (by the interviewed households)

	FARMING TYPES OF THE HOUSEHOLDS														
Types of basic necessity	POOR			OFF-FARM					DIVERSIFIED			CATTLE			
2 big animals + 10 chicken															
1 home garden + 1 toos + 1 young agroforest															
15\$/week															
Agric eqpmt (1 machette, 1 dig stick, 1 pickaxe)															
Assistance from family															
New clothes every year															
Access to water < 50m															
1 house															
Distance to school < 2km															
Distance to hospital < 2km															
Electricity via public network															
5.4.3 Investment options

Households were also asked about their willingness to increase their level of access to these basic necessities and the means they would use to do so. Results are displayed in Table 36 and Table 37.

In these two villages, a single investment strategy emerges clearly, especially for non-"poor" households: that of letting livestock reproduce to increase its size.

A variety of activities or external resources are considered by these households mainly to increase their weekly income. The use of tree products or crops to achieve these objectives is mentioned only marginally and only by households that are not engaged in a livestock accumulation strategy.

		Poo	or			Off-farm				Diversification	n			Ca	ttle	
1 big animal + 10 chicken				cattle	cattle	cattle	cattle	Subsidies	cattle	cattle		cattle	cattle	cattle	cattle	cattle
1 home garden + 1 field + 1 tees tuen							Family		Family	Sale of crop				laha		
1 nome garden + 1 neid + 1 toos tuan							assistance		assistance	products				1002		
155 Jugok	Sale of tree	S	Sale of tree			lobs		Sale of crop	Sale of crop	local chore		cattle		Local chone	Local chore	
153/week	products	p	oroducts			1002		products	products	Local shops		cattie		Local shops	Local shops	
new clothes every year										Local shops						
Agric eqpmt (1 machette, 1 dig stick, 1 pickaxe)																
Cooking equipment																
Access to water < 150m																
1 house																
Birth certificates renewed every year																

Table 36: Investment options for the interviewed households in Nairete

Table 37: Investment options for the interviewed households in Tchaivatcha

		POOR					OFF-	FARM			D	IVERSIFICATIO	DN .	CATTLE			
2 big animals + 10 chicken			Jobs		Sale of fish	External income	cattle	cattle			Jobs	cattle	cattle			cattle	
1 home garden + 1 toos + 1 young agroforest				Family assistance							cattle				Family assistance		
15\$/week	cattle	Sale of crop products			Sale of fish	Sale of crop products		Sale of tree products	Jobs	Sale of crop products				Local shops	Jobs		
Agric eqpmt (1 machette, 1 dig stick, 1 pickaxe)								Sale of tree									
Assistance from family																	
New clothes every year																	
Access to water < 50m																	
1 house																	

6 Viqueque district: Study of Umatolu Suco

6.1 Presentation of the studied area

The time of this study allowed the team to visit only one village of the five Umatolu *Suco* villages. Krarek Maruk is located in a plain area and counts 140 families. The villages of this *Suco* were concentrated in the same land during occupation, which explains the current densification of villages in grassland.

The former *Aldea* location is one-day walking far from the center of the village, so these former lands are very little exploited. One part of the village's fields is across a river and is not accessible during a major part of rainy season.

Krarek Maruk *Aldea* started to specialize with banana production in 2006-2008 and ginger production two or three years ago.

The movements and evolution of the aldea and its agriculture and infrastructures is resumed in the Table 38.

UMATOLU	suco	PORTUGUESE ERA	IN	IDONESIAN OCCUP/	ATION	INDEP	ENDENCE
Main Events	Village	<1975	1975-1981	1982-1990	1991-2001	2002-2010	2011-2022
Location & Displacements	Krarek Maruk	Village in the hills	Escape to mountains	Displacement to the valley of former village. 5 villages mixed		Still in the valley, so h	ome went back to the ills.
Crops & animals	Krarek	Specialization with coconut and coffee to pay Portuguese	Abandoned crops and	Controlled access to coffee plantations by groups.	2-3 Buffaloes +ducks and chickens / groups	Specialization with Banana production for Viqueque and Dili market	Start to sell banana by groups with hired transports. Start specialization in ginger production for Viqueque and Dili market
	Maruk	tax + Paddy fields and animals	animals	Plantation of teaks	of 10 people	Abandoned flooded rice.	NGOs distribution teak, mahogany coffee. 2018: Chicken disease
Infrastructures and services	Krarek Maruk	Old road		School, Church	Road Indonesian burned houses before leaving	Government credit to invest in banana cropping 2005 : 1 tractor for the Suco	Electricity NGO ADRA : well, micro-credit invesment groups

Table 38: History	of Krarek	Maruk village,	Umatolu	Suco
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6.2 Type of AFS

6.2.1 Characterization and distribution of the AFS

In the Viqueque district, similar AFS to Lautem district were observed but with a smaller importance given to the FG because of their remoteness from the aldea. In particular, the CF have the form and characteristics of Living Hedge and Crops.

Farmers do not use any inputs and work essentially with manual equipment such as pickaxe, machete, hoe and digging stick. One tractor is shared at the *Suco* level for ploughing flat field since the 2000's but not very much used.

The Table 39 resumes the AFS characteristics of Umatolu *Suco*. In addition, the distribution of these different AFS is represented in the Figure 21.



TRANSECT KEYS

Figure 21: Transect of Umatolu Suco and AFS distribution

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In English	In Tetun terik	Characteristics	Activities	Products	Management scale	Location
Home Garden HG	Quintal	Space next to the house dedicated to grow some banana, ginger and some staple crop keeping some trees of interest for medicinal, firewood purpose. Individualized by living fences and obtained by slash and burn process on a fallow. Small animals as chicken and pigs can access it.	Agriculture, small livestock rearing, firewood, medicine	Banana, ginger, corn, cassava, pumpkin, papaya, beans, spinach, tomato, spices, small husbandry, firewood	Household	In the village, next to the house. Few Home Gardens.
Living Hedge and Crops LHC	Toos	Space dedicated to grow banana along the fence or mixed with staple crop as corn and cassava along the fence for self-consumption and animals, keeping some old trees. Permanent field individualized by living fences and obtained by slash and burn process on a fallow. Some timber or fruit trees are planted along the fence.	Agriculture, big livestock fodder, firewood	Banana, ginger, corn, rainfed rice, cassava, taro, beans, papaya, teak, betelnut, coconut, mahogany, cocoa, coffee, firewood	Household	In the flat land or slopes close to the village
Forest Garden FG	Abat laran	Space dedicated to grow fruit or timber trees, firewood trees or construction-wood trees. Or former banana field planted with teaks and/or coconuts.	Fruits, Firewood, Construction	Coconut teak, betelnut, bamboo, firewood	Extended family	Far from the village, few FG, few exploitation.
Silvopastora lism Pastagem SP	Pastagem	Free space of pasture with grass plains.	/	Big husbandry (water buffaloes)	Aldea	Around the village

Table 39 : Local toponymy of SAF, management scale, activities and products in Umatolu Suco, Viqueque

6.2.2 Specificities of Viqueque's AFS

6.2.2.1 Characterization and functioning of Banana Living Hedge and Crops system

This type of LHC is a field opened with the tractor in flat area or with manual work with living fences of *Gliricidia*.

The main specificity of these fields is that staple crops are grown with banana and some fields are even specialized with banana. Staple crops are grown in the middle of the field and banana along the fence (Figure 22). After one or two years of cultivation, banana area increases from the fence to the center, by transplantation of shoots. Few trees are planted to optimize the banana planted area. There also are few fallow periods by doing one or two years-rotations. After some years of cultivation, trees (mainly teaks) may be planted along the fence to create a Young Agroforest in the same process as in Lautem. In the village a dynamic of planting "new FG" fields closer to the village is observed. For the moment it has the form of YA (banana mixed with young teaks).

Banana can be collected each month for almost one year and represents an important workload. Labor force is found at the extended family level, except one case of paid work for banana harvesting the use of external labor force remains a minority. Working calendar is presented in Table 40.

Banana sales is destined to the national market. Organized trucks from Dili, Baucau or Viqueque come along the road to buy the products. One group in the aldea is organized to collect banana collectively and so to respond to large orders from Dili retailors.

A new tendency is observed since 2019, most of households plant ginger along the fence or in the HG, and this represents an important complement to banana income.



Figure 22: Staple crop with banana around the fence in Krarek Maruk (Picture: Mazin)

		Year 1													Yea	ar 2								
Work operations	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D	J	F	Μ	Α	Μ	J	J	Α	S	0	Ν	D
Fences planting																								
Banana																							[
(trans)planting																								
Slash and/or																								
ploughing																								
Seedling corn (+/-																								
rice) & others																								
Weeding																								
Seedling rice 2																								
and beans																								
Harvest corn																								
Harvest Banana																								
Harvest others																								
Harvest (cassava)																	Litt	le b	y lit	tle				
Harvest rice 2 and																								
beans																								

Table 40: Working calendar of Banana Field – Hudi Laran, in Krarek Maruk

The succession of crops in Krarek Maruk Living hedge and crops is presented in the Figure 23.



Figure 23: Succession of LHC system from banana to Fallow or teak agroforest

6.2.2.2 Biodiversity and soil inventories in Krarek Maruk aldea

Six inventories were carried out in the village of Krarek Maruk. The young agroforests LHC were mainly composed of banana and ginger as the main crop and there was no rotation observed inside the field as bananas are permanent crops. A variant of homegardens (HG) that we called "Home field" was observed. It has the same characteristics (interaction between crops, perennial, and small livestock system) although it is not located attached to the house and the field surface is wider. We chose

to better characterize this system as it was more present than the homegardens in this village.

As a result, the following inventories were carried out:

- 2 Living Hedge and Crops (LHC) specialized on banana and ginger
- 1 Homegarden
- 2 Home fields

Tree density measured was lower in this aldea compared to the inventories carried out in Manatuto and Lautem, especially for the LHC systems (Table 41). This can be explained by the fact that these systems specialize in banana which needs space to grow every year more via its offshoots. For the same reason, there is no possibility to combine a lot of tree species in these kinds of specialized systems.

Among these inventories, home field were the most diverse system. In the area were farmers grow perennials, their density reaches the highest value compared to the other systems. Their biodiversity level is similar to the biodiversity of home gardens observed in Baucau, although their density level is lower (Cogné *et al.*, 2022).

AGROFORESTRY TYPE	Density small trees (number/ha)	Density big trees (number/ha)	Number of species observed in the field	Number of tree species measured in the plot A&B (>10cm diameter)	Surface (ha)
LHC	97	28	6,5	2	0,3
HG	195	57	13	5	0,1
HOME FIELD	649	57	18	5	1,1

Table 41: Palm and trees density & biodiversity inventoried in AFS of Krarec Maruk aldea

The soils in this aldea were all black, although this was not necessarily attributed to the level of organic matter but rather influenced by the volcanic sand layer. Indeed, most of the fields inventoried were located in the riverbed, except for the homegarden plot. However, fresh organic materials were observed on all upper layer from 0 to 10cm and in deeper layers of homegarden and home field.

Almost no clay was censed in the systems observed, it is possible that these small particles wash away easily along the river (Table 42).

AGROFORESTRY TYPE	SOIL DEPTH (cm)		0-10CM			10-30CM			>30 CM		
		LOCAL COLOUR	TEXTURE	ROCKS	LOCAL COLOUR	TEXTURE	ROCKS	LOCAL COLOUR	TEXTURE	ROCKS	
LHC	>50	Black	MO+SL	0	Black	SL	0	Black	S	1,	5
HG	>50	Black	MO+LC	0	Black	MO+LC	0	Black	MO+LC		0
HOME FIELD	>50	Black	MO+SL	0	Black	MO+LS	0	Black	S		1

Table 42: Soil observations in AFS of Krarec Maruk aldea

Notes : see legend table 17

6.2.2.3 Few forest gardens and few home gardens

As FG are very far from the center of the village or across the river and not accessible during rainy season, they are abandoned or are used for collecting or fruits coconut, firewood, construction wood.

Due to the densification of the *Aldea* on other clan's land, few people have a HG, they may build a bamboo 'field home' inside the field to live during main periods of work.

6.3 Farming systems

6.3.1 Land access rules and work organization

In Viqueque district, the land is divided among the *Knua*. Within the *Knua*, the *Uma Lisan* (sacred house) belonging is important to qualify the social capital of a family. As in Lautem with *clans*, some main *Uma Lisan* have a specific status in the *Aldea*.

The inheritance system is a mix between previous studied districts. For a traditional wedding, both families find an agreement on the dowry (some big and small animals), but as in Lautem, a man whose family could not pay the dowry has to settle with his parents in law and share the land and animals with them (*mane foun*). He can inherit the land when they die.

6.3.2 Farming system typology in Umatolu *Suco*, Viqueque

In this village, people seem to get married later than in other studied villages, around 35-40 years old. Before 2006, they used to work outside the *Aldea* to capitalize to buy a house, before settling. Since the aldea is specialized with banana, people start earlier to cultivate this cash crop before they get married. This crop is an attractive source of income for these households, and it seems that few of them are abandoning their farming activity.

As the tractor is not very much used or accessible, the main differentiation criterium between theses farming systems seems to be the access to land. It will be easier for a household with important social capital to have big cropping area than for allochthones. Whatever their farming system, the main issue for all these households is to maximize their banana and ginger planted area. This means to access free empty land to open LHC system all along their lives.

As a result, 3 main farming systems were identified depending on the combination of production factors.

- Household with restricted access to land/Small landowners. As in other districts, these households can be:
 - Allochthones (mane foun),
 - Late arriving inhabitants in the *aldea*,
 - Some families whose parents died early, are ill or widowed women.

This type of households generally lives with the previous generation until they can afford their own house, many live in bamboo houses. They also work in the field of their parents (in law) and share the benefits with them. In the long term they can develop their banana and ginger planted area (0,5ha to 1ha of crop and fallow) only if

they find new empty land but far from home (across the main river or borrowed to someone) or develop new crops and animal rearing systems. They usually do not have any HG. They do not have big animal, or they can buy later one cow or water buffalo and just some small animals (1-5 chickens, 1-2 pigs).

This results in a difficult access to new empty land so a difficulty to develop their capital.

• Household with balanced assets

These households inherit one to four empty lands to grow staple crops and start banana and ginger production. If they are not in a densified part of the aldea (center and along the road to Viqueque town), they may start a small HG. They can access FG of their parents/grandparents for fruits fruits or construction wood if they want but most of them are abandoned. Sometimes coconuts selling can be a complementary source of income.

These households are given small animals as one pig and one chicken.

• Household specialized with farming / Big landowners

These households are provided with big LHC area (1-4 ha) with already accessible/reserved land in fallow to open new field. They usually have a HG where they may also plant banana, ginger and sometimes staple crops. They have greater access to facilities as the tractor to open a new field, projects-given trees they may plant in line along the fences, mainly teaks and mahogany, coffee, cocoa.

They are generally part of the group to share collectively the collect and sales of large orders of bananas. They have old agroforest in their parent's land, which is hard to access but can provide complementary source of income.

They have some big animals (1 to 5) but complement their revenues with many small animals (20 to 40 chickens and 2-5 pigs) they can feed with banana and corn.

• Household specialized with cattle / Big husbandry capital owners.

This type of households belongs to chosen families who were given a couple of water buffaloes during Indonesian Occupation or rich families who could buy some big animals and specialize early. They may have 20 to 30 water buffaloes let free in the aldea but still have important area of banana LHC.

The dynamics of investment for each of these types result in **3 main farming systems** presented in Figure 24.



Figure 24: Umatolu Suco's farming systems typology

Type 1: SPECIALIZED FARMERS

In this district, small landowners can invest mainly in banana and ginger production. They undergo a specialization that is sufficient for their living and investments, but they are dependent on the economics of these two crops.

They may try to intensify their production by opening new field but far from the village as they do not have the priority to access land.

Type 2: PLURIACTIVITIES

By choice, middle and big landowners can have diversified activities for a living and for developing their capital. They rely mainly on bananas and ginger, but also on a combination of farming products as pineapple, excess of staple crop (corn, cassava, taro) and sell chickens, fighting roosters. They can also find off-farm jobs (construction,

public services, managing a *kiosk*) occasionally as a complementary income.

They intensify their banana/ginger production and develop their tree planted area in the long term, by creating FG in their former LHC in the valley or by expanding their LHC area. The current tendency is to plant mainly teaks or some NGOs trees along the fence.

In this type, the cultivated area per household can vary from 1 to 3 ha (household with balanced assets) to 3-12 ha (big landowners).

Most of them did an off-farm job before settling. This current dynamic of NGOs trees plantation can turn into new markets as teak sales in some years.

Type 3: CATTLE SPECIALIZATION

Finally, those who have more cattle can rely only on big animals (20 to 50 water buffaloes or cows at the end of their career). They also sell banana products but as a complementary income. The dynamic of planting some new FG in former LHC field is also present, to share their capital of animals and agroforestry between their children.

Farming systems	Investment strategy	Age of the HH	Type of land exploited	Average area managed (in ha)	Cropping systems	Cattle	Small ruminant s	Pigs	Poultr y
Banana and Ginger Specialized	Specialization	>30 to 70	Variable dependin g on available land	0,5 to 1,5 ha	LHC (Sharecrop ping, Help) HG	0 to 2	0 to 5	2 to 4	5 to 60
Diversified farmers	Intensification of various farming production	>40	Lowland	1 to 12 ha	LHC, YA, HG, FG	2 to 10	0	02 to 40	5 to 20
Cattle specialized	Capitalization	>40	Lowland	0,5 to 2 ha (Cult.) 200-500ha (Pastures at village scale)	LHC, SP	20 to 50	0 to 5	0	0 to 20

6.4 Households' economic dependence on agroforestry systems

6.4.1 Farming archetypes

Due to time constraints, households from only one village were interviewed. Their farming profiles are presented in the Table 44.

As in the other districts, there is a minority of (elderly) households that are specialised in livestock rearing, and who use young agroforests and their home gardens as a source of food.

The specificity of this village is the strong specialisation of many households in the production of ginger and bananas, with more than 70% of their annual income that is derived from these two commodities. They are grown in young agroforests.

Finally, 29% of households opted for a more diversified production model. Although banana and ginger remain a substantial source of revenues for them, these households were able to invest in other commodities (like rice or cattle) or benefit from remittances. Their average income is a bit above the one of the specialised farmers while having adopted a more flexible farming system.

	GINGER & CATTLE	GINGER & RICE	CATTLE
Yearly range of income	\$ 2.000 - 5.000	\$ 1.300 - 4.600	>\$6.700
Source of income 1	young agroforest	young agroforest	pasture
Source of income 2	pasture	home garden	young agroforest
Source of income 3	home garden	non agricultural income	non agricultural income
Source of income 4	non agricultural income		home garden
Source of production 1	young agroforest	young agroforest	pasture
Source of production 2	pasture	field	young agroforest
Source of production 3	home garden	home garden	home garden
Source of production 4			
Cattle capital (big animals)	3-8	0-2	5-20
Social capital	low	medium	medium
Range of age (yr)	28-62	29-50	> 60
Main sources of funds for investment	Sale of crops	Sale of crops	livestock breeding
% of households (in the sample)	35%	41%	24%

Table 44: Farming archetypes in Krarek Maruk

6.4.2 Basic necessities

The list of basic necessities in Krarek Maruk differs little from those in the other districts in our study (Table 45).

Several cells in red indicate the lack of coverage of certain necessities, but these gaps are mainly explained by the farming system adopted by the households concerned. For example, livestock keepers do not need to own rice fields or agricultural equipment, while households that specialised in banana & ginger can live without owning cows or buffaloes.

In total, except for two diversification-oriented households that do not cover basic necessities that they really need in their production strategies, the high specialisation of these households in two agricultural commodities also allows them to cover basic needs.

	FARMING TYPES OF THE HOUSEHOLDS															
Types of basic necessity	DI	VERSI	BA	NAN	IA &	GING	SER S	SPECI	ALIS	ED		CAT	TLE			
2 cows, 2 chickens																
1 rice field + 1 field																
20\$/week																
new clothes every 6 months																
Food: 1 bag of rice /month																
Electricity: 1 lamp																
Agric eqpmt (2 machette, 2 dig stick, 2 pickaxe)																
Access to water < 100m																
Distance to school < 2km																
Distance to hospital < 2km																
Church < 1km																

households)

6.4.3 Investment options

Because of the specialisation of these households either in raising livestock or in the production and marketing of ginger and bananas, the sources of investment are reduced: sale of crop products or sale of livestock (Table 46) mainly to increase the average level of revenues.

 Table 46: Investment options by the interviewed households in Krarek Maruk

			DIVERSIFIED				BA	NANA & GIN	GER SPECIALIS	SED				CAT	TLE	
2 cows, 2 chickens							Sale of crop products						Sale of tree products		cattle	
1 rice field + 1 field				Sale of crop products	family assistance			Sale of crop products								
20\$/week	Sale of crop products	Sale of crop products	subsidies			Sale of crop products			Sale of crop products	Sale of crop products	Sale of crop products	Sale of crop products	cattle	subsidies		
new clothes every 6 months																
Food: 1 bag of rice /month																
Electricity: 1 lamp																
Agric eqpmt (2 machette, 2																
dig stick, 2 pickaxe)																

Except for one household in our sample, selling tree-related products is not considered to be a source of development for households in Kraremaruk. Because of the current importance of banana and ginger sales in this rural economy, most households see the sale of agricultural products as the main opportunity to raise funds for future investments.

7 Comparison with the Baucau district

7.1 Similar production factors in the four districts

7.1.1 Influence of migration and public policies on the distribution of production factors

Like in Baucau, the history of displacements during the Indonesian occupation led to the grouping and densification of villages in flat lands. These displacements contributed to current pressure over land distribution. In each *Suco*, we identified five historical trajectories (depicted in Figure 25) that contribute to explain today's differentiated access to land and capital:

- Most inhabitants were displaced and got a mitigated access to land tenure when they returned to their villages.
- Veterans stayed in the village or hid in the forest during occupation. They returned to the village earlier and got public pension after the war, which gave them an easier access to land, natural resources and financial capital.
- Some of the families who remained in the villages under the control of the Indonesian authorities during the 1980s and 1990s were given a couple of big animals as cows or water buffaloes, which they have been able to develop into a good-sized herd. They got an advantageous access to animal capital.
- Some adults were recruited by the Indonesian army. They came back to their villages after land repartition in already densified village. They may have no tenure rights, so a limited access to land.
- Allochthone households followed the same pattern than the local people who cooperated with the Indonesian army.



Figure 25: Drawing of population movements and of Aldea evolution from 1975 to 2022 in the study area

The national process of land certification has begun in 2016 and launched a new phase of land appropriation in the villages. Families claim the ownership of their land within their *Knua* land to secure the transmission of a capital to their children. For small landowners, this process can reinforce their difficulties to secure their access to land

because they do not have the tenure rights, and by the time it can strengthen the current rural exodus dynamics.

7.1.2 Land tenure rules

In all studied districts, land tenure results from the history of the village and from a combination of individual and collective rights of owning and using.

In a village, the land is divided among the several *Knua* and then shared between the members of the lineage (*Knua/Clan*).

Except in Manatuto where both male and female can inherit, the land is given to the males at the traditional wedding and/or when the parents die. The man of a household must pay the dowry to settle on his land. Otherwise, he must go to his wife's *Aldea* and settle with his parents in law, making him a small landowner.

Empty land within the *knua* area is common good for its members. To extend its cultivated area, a household of this lineage can open it by slash and burn and/or ploughing. Allochthone's people must borrow land to other *Knua/Clan* if they want to extend but are generally not allowed to plant trees. Thus, they are limited with the development of agroforestry.

All people with an important social position as *Knua*, *Aldea* or *Suco* chiefs are provided with larger lands. The social status linked to traditional rules is an explaining factor in access to land.

7.1.3 Work organization: the importance of the extended family

In the four districts, work organization is linked with the family or the lineage. Several tasks are distributed between the members of an extended family and the benefits of the cropping systems are generally shared:

- Grandparents and parents develop the land capital and grow staple crops for the family,
- Young households provide intensive work linked to cash crops like flooded rice and horticulture in Baucau, or to the collection of coconut (Lautem), betelnut (Manatuto) and banana and ginger (Viqueque).
- Generally, one uncle oversees livestock breeding for the extended family helped by youngers as shepherds.
- The land of a household head who leaves the village is maintained by its nuclear or extended family in exchange of some money sent to the family. The land is conserved and maintained even if a household abandons agriculture to keep a capital for inheritance.

There are very few formal associations or organizations, or paid work in the farms. But we notice the importance of informal groups and exchanges for producing, transporting, or selling farming products. This developed economy of gifts and counter-gifts can be collective (animals' gifts for traditional events) or individual (food, work). Mutual support for work is mainly linked to the extended family or the *Knua/Clan* level, mainly during preparation of the land period (slash and burn, ploughing and planting the seedlings).

Formal working groups have been working in some places and for a few years when either it was required by external buyers or to catch a trade opportunity especially with cash crops. However, these groups have usually been accessible to people with a high social capital.

7.2 Similar AFS but with varying contents

Cogné *et al.* (2022) described five main types of agroforestry system, which are present in the other three districts (Figure 26). However, the content and functions provided by each of these AFSs may vary in other districts, as shown in Table 47.

The combined flooded rice and horticulture system in the lowland is the only cropping system specific to the Baucau district.

 Table 47: Comparative description of agroforestry systems in the Baucau, Manatuto, Lautem and Viqueque districts

	Baucau	Manatuto	Lautem	Viqueque								
	НС	OME GARDEN										
Toponymy	Toos permanenti, toos uma hun	Toos uma hun, quintal	Leku	Toos uma hun, Quintal								
Occurrence	+++	+++	+	+								
Location		Next to the	ne house									
Main crops and trees	Corn, lemon, beans, tubers, fruit trees	Corn, vegetables, fruit trees	Corn, vegetables, fruit trees	Banana, ginger, fruit trees								
Use	Fruits, staple crop, animal food	Fruits, staple crop, animal food	Fruits, staple crop, animal food	Cash crop, fruits								
Main constrains	Sun competition between staple crops and trees, landownership to get the authorization to grow trees, dense settlement, renewing of the old trees											
Opportunities	Cooling of temperature (trees), secured land tenure, diversification of food nutrition and self-reliance, capital assets (trees, land, animals)											
	CRO	P AND FALLOW	•									
Toponymy	Toos udan	Toos foun	Pala	Toos								
Occurrence	+++	+++	+++	+++								
Location	Valley and plains	Valley	Plain	Plain								
Main crops and trees	Corn, peanut, cassava, pumpkin	Corn, rice, cassava	Corn, rice, cassava, coconut, teak	Corn, rice								
Use	Staple crop, animal food, cash crop	Staple crop, animal food, cash crop	Staple crop/Cash crop, animal food	Staple crop								
Main constrains	Renewal of so	il fertility limited by l market price	and accessibility es changes	(fallow rotation),								
Opportunities	Cash provisi	Cash provision, food base for self-consumption, feed and fodder provision, firewood provision										
	YOUN	IG AGROFOREST	YOUNG AGROFOREST									

Toponymy	Toos	Toos posalaki/Posan	Pala	Toos
Occurence	+++	+++	++	++
Location	Hills, plains, former CF	Hills Former CF	Lowland LHC	Lowland LHC
Main crops and trees	Cassava, corn, pumpkin, papaya, banana, citrus trees, coconut	Betelnut, candlenut	Coconut, teak	Banana, ginger, Gmelina, teak
Use	Cash c	rop and secured pro	ductive land for t	he future
Main constrains	Land propert	y access/recognitio prices c	n, livestock degra hanges	dation, market
Opportunities	Diversificatio	on of farming systen tenure f	n, cash provision, or heirs	securing land
	OLD	AGROFOREST		
Toponymy	Abat laran	Abat laran	Осо	Abat laran
Occurence	++	+++	+++	+
Location	Hills, gully	Hills, gully	Hills, gully	Hills, upland
Main crops and trees	Coconut, palm wine, fruit trees, teak, gmelina, bamboo	Betelnut, candlenut	Coconut	Teak
Use	Fruits and cash crop	Cash crop	Cash crop	Fruits
Main constrains	Renewal of o slopes	Id trees, accessibilit), segmentation of la	y (far from housin and between desc	ig and/or steep cendants
Opportunities	Carbon stoc capital assets change	k, securing land ter (timber, cash crop) s, firewood, stapple	ure within the fan , resilience to clim crop and fodder	nily and <i>knua</i> , nate and market provision
	SILV	OPASTORALISM		
Toponymy		Pasta	agem	
Occurence	+++	+++	+++	+++
Location	Lowland and plains, rocky hills	Valley	Lowland	Lowland
Main vegetation	Grass, savannah, secondary forests	Secondary forest, grass	Grass	Grass
Use	Pasture	e/Land available to p /Firewood/Tradi	oossible expand c tional medicine	rop fields
Main constrains	Competition b the grass) an	between livestock (fr nd fields (CF, YA.) th villages and/o	ee grazing, fire ro nat can lead to con r inhabitants.	otation to renew nflicts between
Opportunities	Carbon stock, f all, non-forr	irewood and fodder nal land and farming community	provision, access g regulation (emp regulation)	s to resources for owerment for



Figure 26: Examples of old agroforests: betelnut in Dambuahun, coconut in Nairete (Picture: Mazin)

7.3 Homogeneous farming systems but with district-related specificities

In each studied district, we have identified the same four types of farmers as those described in Baucau:

- Small landowners
- Households with balanced assets
- Big landowners (with a high endowment of social capital)
- Big cattle owners

These four types of farmer are explained by various combinations of traditional rules, social capital, history, and public agricultural policies. These variables influence the choice or the obligation of a household to opt for a specific farming strategy. These various allocations of production factors result in six different farming systems, which are reminded in the right part of the Figure 27.



Figure 27: Relationship between farmers' endowments in production factors and their farming systems

Only one farming system studied in the four municipalities is not present in the Baucau district: the archetype of specialization in agroforests' harvesting, which is found only in the districts of Manatuto and Lautem. The other five farming systems are present in at least one other of the three districts, but their main agricultural production may vary. Table 48 synthesizes the farming systems described in the four sampled districts. It details the main commodities produced by each of these systems.

Table 48: Comparison	of the farming	systems a	and of t	the main	agricultural	produce	between
	Bauca	au and the	other of	districts			

FARMING STRATEGY	BAUCAU	MANATUTO	LAUTEM	VIQUEQUE	Main AFS used
Specialization in intensive cropping	Flooded rice/Horticulture			Banana and ginger	Crop field and fallow, home garden, young agroforest
Specialization in agroforests' harvesting		Betelnut, candlenut	Coconut		Old agroforest, young agroforest
Specialization in livestock breeding	Small ruminants	Cows	Cows or water buffaloes	Water buffaloes	Sylvo-pastural lands
Abandonment of farming	Corn, banana	Cassava, taro	Cassava, coconuts		Home garden, crop field and fallow

Diversification of agriculture and of income	Corn, pumpkin	Betelnut	Coconut, corn, cassava	Banana, cassava, corn	Home garden, crop field and fallow, sylvopastoral lands
Survival agriculture	Corn, cassava	Betelnut	Coconut		Home garden, young agroforest

Several elements of the farming systems are common to the four districts studied:

- Trees are markers of land ownership and constitute a transferable capital for the next generation.
- Most households rely on one specific AFS to grow main cash crops.
- But they keep a diversity of cultivated AFS for food, complementary income and other uses as firewood, fence, construction, medicine, fodder.
- Rural households always keep a diversity of cultivated species (trees and crops) to comply with these multiple uses.
- The diversity of cropping systems and of cultivated species depend on the household's access to production factors, with a substantial diversity of situations from small to big landowners.
- A few rich households are specialized with cattle and have a smaller reliance on agroforestry products.

Conversely, there are also substantial differences in the application of these six farming systems in the four districts. Firstly, it is only in the Baucau district that the main source of income does not come from an agricultural product that is grown in an AFS.

Second, in the Viqueque district, the main cash crops are not agroforestry products but are grown in AFS. This little reliance on agroforestry products is observed now but can be reversed in the next years with the current dynamic of teak plantation.

Thirdly, in the Lautem and Manatuto districts, many households rely on agroforestry products as their main source of income and as their main strategy of investment for the future. In Lautem, however, the households tend to diversify their farming products sales to face the low price of coconuts. This tendency is also noted in Viqueque with banana. It illustrates the importance to keep a diversity of cultivated products to face market fluctuation. People plant trees to secure land ownership and to have a complementary income. This phenomenon is mainly observed for timber trees, like teaks and mahoganies, but also for some fruit trees like avocado or coffee.

7.4 A common set of basic necessities

The list of basic necessities is homogeneous in the seven villages studied, which is hardly surprising since households often have similar minimum needs to continue living in their villages. A set of 10 necessities was systematically identified in all villages. They are presented in the Table 49. There are no significant differences between Baucau and the other districts in this regard.

Basic necessities	Definition	Range
Access to agricultural land	Areas to grow crops or trees, for self-consumption or trade purpose. This land is considered to provide enough food for the family	1-3 lands
Ownership of large animal	At least one large animal (cow/buffalo/horse) must be owned by the household	1-2 animals
Agricultural equipment	At least one machete, one pickaxe, and one dig stick	
Cash money	Minimal amount to face unavoidable expenses every week or month	10-25\$ / week
Clothes	Set of clothes to be renewed at least every year (but often every quarter)	
House	House in cement/wood/bamboo large enough to shelter all family members	
Water	Maximal distance to reach a spring, a river, a well, a tank	50-1000 m
Electricity	Access to public network	
Hospital	Maximal distance to reach the hospital	2-5 km
School	Maximal distance to reach a primary school	1-6km

Table 49: Basic necessities quoted in all sampled villages

Some other necessities were identified in one or two villages: proximity of an asphalt road, cooking equipment, assistance from family, birth certificates, meals, traditional events, church.

However, the coverage of these basic necessities by households varies by district. Table 50 displays a dark red cell when the necessity is not covered by more than 50% of the households and a light red cell when it is not met by 10-50% of the households in each village.

	Baucau		Viqueque	Manatuto		Lautem	
	Ossoluga	Cairiri	Krarekmaruk	Nu-Ahuk	Dambuahun	Tchaivatcha	Nairete
Acces to agricultural land							
Ownership of a large animal							
Agricultural equipment							
Cash money							
Clothes							
House							
Water							
Electricity							
Hospital							
School							

Table 50: Coverage of the basic necessities in the 4 districts

The examination of Table 50 may be tricky because it partly relates to the dominant farming systems in each of these districts. For example, households specialising in intensive horticulture or livestock may not need access to new fields each year. However, this table highlights the most common constraints to the development of rural economies in these districts, which are access to land, ownership of a 'savings animal', renewal of farm equipment, and the availability of a minimum of cash for households in these villages. The coverage of these four basic necessities does not pose a

particular problem in Baucau, whose households by contrast face a major problem of access to water, which is less prevalent in the other districts.

7.5 Investment options depend on farming strategies

The basic necessities survey gave the opportunity to ask the households about their potential sources of funds to undertake a new productive investment. The summary of their main responses is presented in Table 51. The answers are presented according to the districts and to the farming archetypes. A few colors are used to stress the importance of the three main sources of funds, i.e. green for the sale of tree products (dark green for primary source, light green for secondary source), blue for the sale of crop products (dark blue for primary source, light blue for secondary source), and brown for livestock breeding.

The sources of investment are relatively consistent when associated with farming strategies, almost independently of the districts in which they are implemented. For example, households in the 'Poors', 'Abat laran dependent' and 'Off-farm' categories see tree products as a source of income for new investment. Livestock owners logically see the growth of their herd as the best way to acquire resources that can be easily mobilised through sales to finance an investment. Finally, households specialising in ginger production or horticulture see the sale of crops as the way to generate quick cash for investment. However, two of these farming systems are not well represented in Baucau: the one aimed at accumulating large animals and the one based on the harvest of old agroforests. The detailed diagnoses of the farming systems (and the specific AFS on which they are based) in Baucau are therefore only partly replicable in neighbouring districts. They should be supplemented by additional studies on these two farming systems.

	Viqueque	Lauten	n	Manatuto	,	Baucau		
Farming strategies	Krarek Maruk	Tchaivatcha	Nairete	Nu Ahuk	Dombua Hun	Cairiri	Ossoluga	
Specialisation in livestock breeding	livestock breeding	livestock breeding, jobs	livestock breeding	livestock breeding, sale of crops	livestock breeding	sale of crop products		
Specialisation in intensive cropping	sale of crops					sale of crops, livestock breeding	sale of tree products, livestock breeding	
Specialisation in agroforests' harvesting				sale of crops, sale of tree products, livestock breeding	sale of tree products			
Abandonment of farming		sale of crops, sale of tree products, livestock breeding	livestock breeding	jobs	jobs, sale of tree products	livestock breeding, sale of tree products		
Diversification of agriculture and of income	sale of crops	livestock breeding, jobs	Sale of crops, livestock breeding				sale of tree products, livestock breeding	
Survival agriculture		jobs, livestock breeding	sale of tree products	sale of crops, sale of tree products	sale of tree products	sale of tree products, sale of crops	livestock breeding, sale of tree products, sale of crops	

Table 51: Main activities to fund investment according to the households' interviews

8 Resilience of agroforestry systems

8.1 Environmental resilience

This mission allows us to compare three AFS (home garden, young agroforest, and forest garden) along three different criteria: palm tree and tree density per ha with a diameter superior to 30cm (related to carbon storage in the aerial biomass), palm and tree species diversity biodiversity in the field, soil depth (indicator for fertility and carbon storage). These results are resumed in Table 52.

	BAUCAU	MANATUTO	VIQUEQUE	LAUTEM
HOMEGARDEN				
TREE DENSITY (>30cm)	95	67	57	71
TREE BIODIVERSITY	High	High	Medium	High
SOIL DEPTH (cm)	20-50	>50	>50	30
YOUNG AGROFOREST				
TREE DENSITY (>30cm)	63	15	28	35
TREE BIODIVERSITY	Medium	High	Low	Medium
SOIL DEPTH (cm)	20-50	>50	>50	40
FOREST GARDEN				
TREE DENSITY (>30cm)	110	92		99
TREE BIODIVERSITY	High	Medium		Medium
SOIL DEPTH (cm)	>50	>50		>50

Table 52: Main ecological variables of three selected AFSs in the four districts

[Tree biodiversity qualification: High = more than 10 tree species / Medium = between 5 and 10 tree species / Low = less than 5 tree species]

Almost all AFS have a medium to high scores of tree biodiversity in each district, except the young agroforests in Krarek-Maruk (Viqueque). The most diverse are home gardens.

Tree density follows the same scheme as what was observed in Baucau: forest gardens are the most densed systems, followed by homegardens and then young agroforests. Tree density is generally higher in Baucau, except for the forest garden's palm and tree densities that are all equivalent between the districts. In Manatuto, although young agroforests are the less dense, they are also the most diverse compared to the other districts. Forest gardens were more diverse in Baucau, although this result can be related to the field sample studied (forest garden specialized on betel and coconut in the other districts whereas these conditions were not restricted in Baucau). The diversity of trees is important to bring natural auxiliaries (e.g. spiders, birds, bats...) to defend the crops from pests' attacks. During the inventories, some farmers explained their strategy to grow or preserve big trees to protect smaller trees and crops from strong winds and floods, which can be triggered by regular climatic hazards. The loss of tree diversity in Viqueque, along with crops and banana degradation due to insect bite illustrate the risks of more intensive production with reduced phytosanitary means in these regions.

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We observe different soil characteristics, especially different textures (silt and sandy soils that were less present in Baucau) and different soil depths. Lautem soils presented similar soils as in Baucau, especially because they had shallow depth (20 to 50 cm for homegarden and young agroforests observed) and because of their limestones content that was higher than in the other districts. This can be attributed to the fact that they share the same bedrock (Baucau Limestone).

Although we suppose that the differences of soils and their characteristics are mostly related to the nature of the bedrock, we also observed that forest gardens were all located on deeper soil. This can traduce either a significant input of organic matter by the system (thicker layer of organic content in general) but also the strategy of farmers to choose specific location and soil characteristics to grow a certain type of agroforestry system. Finally, topsoil layer was observed in all systems, which means that these AFS all participate to the creation of organic matter through the fall of leaves and the interactions with livestock. Moreover, the organic matter supports crop fertilization (especially when legumes are planted along or inside the field). It also allows to stock carbon in the soil, in addition to the living tree biomass.

Finally, these AFS systems are independent of the use of phytosanitary inputs and synthetic fertilisers. The fertility management relies on the forest in Manatuto. Farmers do rotation system over 20 years and let the forest regenerate before using it again. It is less true in Viqueque and Lospalos, where the villages use the flat land area (dominance of grass) to do "permanent field" systems (almost no fallow phase). The continuous cultivation of the same field among the years involves load of wood from the secondary forests and/or the forest gardens around to burn them inside the field. These "permanent" systems also need manure input to maintain soil fertility. However, fertility and pest management remain big issues for farmers to increase their yields that can vary greatly from a year to another, especially for annual crops.

The medium to high density and type of trees planted show that these systems also contribute to the preservation of tree biodiversity (except in the sampled village in Viqueque) and consequently to mitigate climate change by carbon storage.

The loss occurring in the annual crop yields could be compensated by carbon market if the species already planted by the farmers were considered in the catalogue for certification (especially fruits trees).

8.2 Socio-economic resilience and transformability

There is a vast literature on the concept of socio-economic resilience. For the purposes of our study, and based on the data collected, we analyse the economic resilience of these farming systems according to three criteria:

- annual income, which influences the standard of living by meeting at least basic expenses such as schooling, health care or the purchase of manufactured goods
- standing savings, which allow for rapid mobilisation of resources to deal with external economic shocks
- diversification of sources of income and/or savings, which helps to spread the risk of sudden failure of a source of income or a means of saving

In these Timorese districts, it is not enough to aim for a resilient rural economy when a significant proportion of the population lives below (or not far from) the poverty line. Farming systems need to raise the level of these indicators, and facilitate the transformability of this rural economy, to use a term often associated with the concept of resilience (Walker *et al.,* 2004). AFS should not only be seen to improve the resilience of farming systems by removing technical, institutional or economic constraints, but also as opportunities to improve their performance.

Beyond the environmental, socio-economic and institutional specificities of each of the four districts, the concept of farming systems seems more appropriate for analysing the resilience of rural households in Timor-Leste. Even if the implementation of a farming system may vary from one district to another, for example when the cash crop is different, this concept brings together the main variables that will explain the socio-economic situation of rural households, and highlight the possible evolution of their livelihoods. Based on the detailed descriptions of the farming systems in each of the four districts (Chapters 3 to 6) and a comparison of their performance (Chapter 7), Figure 28 positions each of the six farming systems according to its dependence on SFM and its potential for developing agroforestry.



Figure 28: Farming systems' dependence on and potential to develop agroforestry

The information collected during this mission also makes it possible to estimate the current socio-economic resilience of the farming systems, based on the three criteria selected (Table 53). AFS play a more or less important role in modifying the levels of resilience associated with these farming systems, either by removing constraints that hinder their development or by offering new opportunities. Various actions to support or develop AFS are proposed, which are based on the specific characteristics of each farming system. There is therefore a wide range of interventions to promote agroforestry in Timor-Leste, depending on the objectives sought. In all cases, a prior understanding of farming systems allows the development of actions that are better adapted to the actors' expectations and to local specificities, significantly increasing the chances of success.

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Farming	Annual	Sovingo	Diversification	Constraints	AFS's potential	Opportunition	AFS's potential
strategies	US\$)	Savings	of revenues	Constraints	constraints	Opportunities	opportunities
Specialization in intensive cropping	1.100 - 6.000	cattle: + trees: +	+	They have a small/medium access to land	Interested in planting a few fruit trees to enrich their home gardens (for self-consumption purpose)	Agroforestry offers complementary revenues, that are not sufficient to meet the family needs or to increase livelihoods, but that remains too significant to give away	Interested in a few high- value trees in or around their crop fields to complement their revenue
Specialization in agroforests' harvesting	1.000 - 4.500	cattle: + trees: +++	+	This farming system is suitable with a low pressure on land at the aldea level		Easy access to land allows to produce important volumes of agroforestry products (coconut, betelnut, candlenut, teak) that is sufficient to make a living and to support investment	Tree plantations over large surface in old and young agroforests are the main way to accumulate capital to pass on to children
Specialization in livestock breeding	4.200 - 15.000	cattle: +++ trees: 0	+	Because of their breeding activity, they do not invest in tree plantation and rely more on collective pasture land		Interested in trees species that provide fodder for animals	Enrich sylvo-pastoral lands in fodder- specialised tree species
Abandonment	2.500 -	cattle: +	++	No reliance on trees for food or revenues		Potential interest to plant a few trees to mark land in crop fields and forest gardens	Slow-growing tree species in fallows and in old little-used agroforests
or lanning	10.000	иссэ. т				Interested in enriching home gardens with a few fruit-trees	Fruit trees in home gardens

Table 53 : Potential contributions of AFS to socio-economic resilience

Diversification of agriculture and of income	1.100 - 5.000	cattle: ++ trees: ++	+++	Access to land and/or water and/or techniques is a pre-condition to invest in agroforestry	Develop agroforestry support schemes that are built on a comprehensive understanding of the household economy: tree plantations are to be combined with some form of crop farming or silvo- pastoralism	Combination of various AFSs to reduce the risk of pest attacks or to mitigate environmental and economic shocks	Payment for environmental services based on carbon stock may constitute an attractive option for this type of household as their farming system is flexible and adaptable to new activity
	400 - 1.700	cattle: + trees: +		Limited access to land for shifting cultivation and to natural resources to feed animals, build a house, etc.		Tree products are their main sources of income	Intensify tree plantations in the small surfaces of their home garden and yound agroforest
Survival agriculture			++	Low revenue make them be very exposed to prices decrease	Invest in tree products with a secure market	More intensive use of agricultural land	Plant trees that facilitate or maintain these intensive agricultural uses
				In the absence of savings, there is a requirement to ensure a regular minimum income flow	Investing in income- generating agroforestry at short term		

9 Conclusion

The studies conducted to characterise the AFS in Baucau district provide a good understanding of the place and role played by agroforestry in the other three districts of the PSAF. The five AFS studied in Baucau are found in the other districts, although their relative importance and content may vary.

These AFS are used in six farming systems that are implemented in various ways in the four districts. Rather than a geographical approach to supporting agroforestry, which is built on an analysis of local specificities and dynamics, we suggest using the notion of farming system to decipher the production strategies of rural households and understand how these strategies rely on AFS. Of the six farming systems we have highlighted in the four districts, five are active in Baucau district, but there is no 'Specialisation in agroforests' harvesting'. This sixth type of farming cannot therefore be analysed on the basis of the studies previously conducted in Baucau.

The prior description of farming systems improves the definition and application of agroforestry-support mechanisms, for two reasons. Firstly, it requires clarifying the objectives of promoting agroforestry, and the trade-offs between these objectives. For example, making agroforestry a means of reducing poverty in rural areas implies actions that are different from those that would be implemented if one wanted to promote carbon sequestration. On the other hand, the identification of farming systems makes it possible to refine the practical modalities of intervention in terms of types of AFS (home garden versus old agroforest for example), woody and non-woody species, beneficiaries, and operators (NGOs, private sector, or administration).

These localised analyses of AFS and farming systems need to be complemented by cross-sectional studies of the value chains of the products, in order to identify promising markets. Rural communities do not currently have the means to know or anticipate the evolution of agroforestry product markets, which weakens their interest in extending AFS.

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11 Appendix





Figure 29: Climatic diagram of Los Palos, Lautem district (next to Soru Suco)



Figure 30: Climatic diagram of Dilor, Viqueque district (next to Umatolu Suco)

11.2 Appendix 2: Survey guide for the characterization of agrarian dynamics

INTERVIEW GUIDE - DESCRIPTION OF PRODUCTION SYSTEMS

Number of the survey form:							
Aldea: Type of productor:							
0) Household presentation and identification of "social capital"							
Name of the farm manager:							
Age of the head of the farm:							
Lineage (knua/clan/uma lisan):							
Specific family/work link to the aldea/suku (ex: kabu, lianain)?							
Number of brothers and position in the siblings:							
Marital status:							
Family composition:							
Age of eldest son:							
Education, if any:							
Non-farming activities:							
Main source of income: Farming / Non-Farming							
Membership of a farming group?							
1) Historical path							
How many generations have been living here:							
Description of the family displacement and the type of agriculture associated:							
- Since the ancesters era							
- Since the portuguese era							
- Since the Indonesian era							
- Since Independence							
Age of first independent cultivation:							
Year of the marriage:							
Method of obtaining the land/animals (inheritance, displacement, rent, etc.):							

What difference in access to land compared to brothers, neighbors, etc.: Were the land/animals obtained gradually or all at once: What has changed on his farm (land, crops, animals, capital, etc.) since he first started farming individually? Why? Did the farmer receive animals, seedlings or formation training from NGOs or the state? (If yes, which year, which type, where did the plant the seedlings, for which use?) Has the farmer ever passed on land to his heirs? Why or why not? 2) Production factors 2-1) Land Number of parcels currently in cultivation. Types of parcels: Local name Localization Irrigation? Type of soil: Year of first cultivation: Number of parcels in fallow? Since when? Recourse to renting in the last 5 years? if yes, identify the parcels and the years of cultivation for each parcel: - Distance to village: - Surface area: - Year of last cultivation (Which crops): 2-2) Labor force Family workers: - Number of people in the household working on the farm: - What operations do they do and when: - If ves, position in rotation: Labor force outside the household and paid: If payed workers: - Who and how many people: - For which operation(s)? - What period and duration? - Last paid activities: 2-3) Capital List all agricultural tools (purchase price, age, duration of use): Owned/leased/shared: 3) Cropping systems For each cropping system, characterize the following elements: Area involved: Type of plots concerned Technical itinerary (what actions, at what period, with what type of labor, what equipment, mechanized or not, what intermediate consumption, at what cost): Products (type, average/expected yields, place and price of sale/self-consumption Mention of cropping problems these last year (pest, access to water, soil..)

4) Livestock rearing systems

List all livestock rearing systems.

For each livestock rearing system, characterize the following elements:

- Type of animals
- Number of animals (males, females, calves)

- Herd management (what actions, at what period, with what type of labor, what

equipment, what intermediate consumption, at what cost)

- Renewal of the herd

- Products (type, average/expected yields, place and price of sale/self-consumption)

Mention of livestock problems these last year (disease, access to water, fodder..)

What is their perspective/strategy for the future? Any final question or comment?

	INVENTAIRE ARBRES							
N°	0-7 m	7-15 m	Espèce					
	>33cm	>100cm						

11.3 Appendix 3: Inventory form for biomass and soil inventories

	CARACTÉRIS	SATION DU SOL					
Numero d'enc	quête						
			Type de				
Localisation			producteur				
	Caractérisati	Caractérisation générale		0-10 cm	10-30 cm	> 30 cm	
			Couleur				
	Торо		(tétoum)				
			Elements				
			grossiers (0-				
	Nom local		3 cm)				
	Couleur						
	locale		Texture				
			Profondeur				
			du sol				
	. (
	Presence						
	reservoir eau						
	Pente		Profil de sol	0-10 cm	10-30 cm	> 30 cm	
			Couleur				
			(tétoum)				
			Elements				
			grossiers (0-				
			3 cm)				
			Texture				
			Profondeur				
			du sol				
11.4 Appendix 4.1: Focus group discussion to identify the village history and main cropping systems

1. HISTORY OF THE VILLAGE

CREATION AND MOVEMENT - Portuguese era:

- When did the village was first created and where?
- Where did the first inhabitants came from?
- How many families/households lived in the village at its creation?
- What were the main crops and livestock at this time?

DISPLACEMENT - Indonesian era:

- Dates and places of population displacement during the occupation?
- When the village was displaced what did you cultivate? How did you share the land when you settled in the new place?
- Did the Indonesian army provide animals? Seedlings? Equipment? practical training?
 - o How many?
 - To whom?

EVOLUTION – Since independence:

- Did NGO's or MAF provide animals? Seedlings? Equipment? practical training?
 - How many?
 - o To whom?
- How many families/households live here now?
- How many clans/uma lisan/knuas and their names?
- Are there still new families arriving in the village?

INFRASTRUCTURES:

- Dates of construction/establishment of different infrastructures and public services as:
 - o Road
 - o Electricity
 - Church (land given to church?)
 - School (type of school)
- Were there any disease or pest or special events since Independence?

2. IDENTIFICATION AND LOCATION OF CROPPING SYSTEMS

- What are the main crops grown in the village? (Let people telling by spontaneous order).
- Which are grown together in the same field?
- What is the local name of each different field mentioned?
- Where are located these different fields in the landscape? (Drawing a rapid map with structuring elements of the village as the road, the school or church, the river)

3. BASIC NECESITIES

11.5 Appendix 4.2: Focus group discussion to identify basic necessities

1. Introduction

- The purpose of our work is to understand how crops, animals, tree products can contribute to improve the living conditions in this village.
- Therefore, we need to know what you consider your basic living conditions, which means the goods or services that one household must get to live in this village. These are what we call the "basic necessities". A basic necessity is "something that all household should have and none should do without".
- We want to establish with you the list of the basic necessities in your village. This is not a "wish list", i.e. a list of the goods and services that you would like to possess, and this is not a list of important goods/services. This is the list of the basic goods and services that a household must get to accept to live in this village.

2. First list of basic necessities

- Ask the participants to think about a list of 5 basic necessities.
- Select randomly a few participants and ask her/him to say what her/his basic necessities are. Write them on the board paper.
- After asking 5-6 participants, ask all attendants to complete the list with their basic necessities. Write them down on the paper.

3. Check if all usual basic necessities are covered

- Basic necessities usually include: health, education, agricultural equipment, lodging, energy, water, land, social environment.
- Verify that all these concerns were mentioned one way or another in your list; otherwise, ask the respondents if they have not forgotten any of them.

4. Define an indicator for each basic necessity

• For each basic necessity, define at least one concrete indicator that can be verified on the field.

For instance "health" is considered a basic necessity, then ask "what is the maximal distance you can accept to reach an operational hospital"?

Another example with cash: you can ask "what is the minimum cash amount that one household needs every week to live decently on the village"?

Conclusion: what's next?

The final deliverable is the list of indicators for all basic necessities. To conclude, explain that we will check this list during the interviews with households to understand how people cope to get these basic necessities.

11.6 Appendix 5: Individual survey form on rural economics

Introduction of this work, connection with GIZ and GOPA. Anonymity and confidentiality. Duration: about 30 minutes. Request of acceptation

Household presentation

Surname and name of the household head (HH):

Knua: Ties with the knua chief: Age of the HH: Residence time in the aldea: Family composition (number of adults and children):

Education:

Participation in formal and informal associations and groups:

Crops production in 2021

What were your main crops (in volume) in 2021 for the household?

Overall estimation			
Quantity in 2021			
Ecological zone(s) ²			
Land status ³			
Purposes (in quantity)			
Self-consumption			
Food for animals			
Trade (and unit price)			
Gifts, barter			

Breeding production in 2021

What were your main livestock in 2021?

Overall estimation			
Herd size in 2021			
Ecological zone(s)			
Land status			
Purposes (in quantity)			
Self-consumption			
Trade (and unit price)			

² Home garden (toos uma hun), abattis-brûlis (toos kuda no husik), young agroforest (toos joven), sylvopastoral (fatin pastagen), old agroforest (abat laran).

³ his/her own, family ownership, collective, rent.

Gifts, barter			

Forestry production in 2021

What were the main products you extracted from trees in 2021?

Overall estimation			
Quantity of products			
exploited in 2021			
Ecological zone(s)			
Land status			
Purposes (in quantity)			
Self-consumption			
Food for animals			
Trade (and unit price)			
Gifts, barter			

Other sources of incomes

Order your 4 other main sources of income in 2021

	Income	Amount	Income	Amount
1.			3.	
2.			4.	

Basic necessities

Necessity	Met by the HH ?	Plan to increase?	Means and resources mobilised for improvement
Field and plantations			
Animal:			
2 plantations			
Money:			
Agric. eqpmt:			
Cloths			

Any final question or comment?

11.7 Appendix 6: Species inventories

Nuu Ahuk aldea, Manehat Suco, Manatuto district :

	ak alaca, marieriat c		
SPECIE N°	LATIN NAME	TETUM NAME	FUNCTION
S1	Albisia sp	AI SAMTUKU TIMOR	SHADOW / FERTILISATION
S2	Albsia sp	AI MATAN DUKUR	SOIL EROSION/FERTILISATION
S3	Aleurites moluccana	KAMII	SELL/CARPENTRY
S4	Alstonia sp	AI DOTI	MEDICINE
S5	Amorphophallus paeoniifolius	MAEK	SELL
S6	Areca catechu	BUA	SELL/CARPENTRY/FODDER
S7	Arenga pinata	TUA METAN (MATE)	PALM WINE/ROOF/ROPE/FOOD
S8	Artocarpus heterophyllus	KULU JAKA	CONSUMPTION
S9	Averhoa carambola	CARAMBOLA	CONSUMPTION
S10	Averrhoa bilimbi	BILIMBI	CONSUMPTION
S11	Bambusa sp	AU BETUN	CARPENTRY
S12	Bougainvillea sp	TREPADELHA	DECORATIVE/CIMENTRY
S13	Cajanus cajan	TUNIS	CONSUMPTION
S14	Capsicum sp	AI MANAS	CONSUMPTION
S15	Carica papaya	AI DILA	CONSUMPTION/SELL/MEDICINA/ANIMAL FOOD
S16	Citrus grandis	JAMBUA	CONSUMPTION
S17	Citrus limon	DEROK	CONSUMPTION/MEDICINE
S18	Citrus sp	SABRAKA	CONSUMPTION/SELL
S19	Cocos nucifera	NUU	CONSUMPTION/ANIMAL FOOD/SELL/CARPENTRY/HANDCRAFT
S20	Coffea sp	KAFE ROBUSTA	CONSUMPTION
S21	Colocasia esculenta	TALAS	CONSUMPTION
S22	Eugenia malaccensis	JAMBU AIR	CONSUMPTION/SELL
S23	Gliricidia sepium	AI GAMAL	FERTILISATION / FENCE
S24	Ipomea batata	FEHUK	CONSUMPTION/SELL
S25	Mangifera sp	HAS	CONSUMPTION
S26	Manihot esculenta	AI FARINA	CONSUMPTION/ANIMAL FOOD
S27	Musa sp	HUDI	CONSUMPTION
S28	Nephelium lappaceum	RAMBUTAN	CONSUMPTION/SELL
S29	Persea americana	Ανοκατι	CONSUMPTION/SELL
\$30	Psidium guavaia	GOAVA	CONSUMPTION/MEDICINE
S31	Spondias dulcis	AMARE	CONSUMPTION
\$32	Tectona grandis	ТЕКА	CARPENTRY
\$33	Zea mays	BATAR	CONSUMPTION
\$34		AI BATAR	EIREWOOD
\$35		AI FUNAN	DECORATIVE/CIMENTRY
\$36		AI MARAS MUTIN	CABPENTRY
\$37		AI MATA BIDA	FERTILISATION (BURN)
\$38		AI MEDA	EROSION PROTECT
539		AI NANAN	
S40		AI SAKA METAN	FERTILISATION
S41		AI-KFUIR	
S42		BANDERA	DECORATIVE/CIMENTRY
543		KORNETA	DECORATIVE/CIMENTRY
544		LFBO	
\$45	1	MIRO	
\$46			
547			FERTILISATION
548		ΜΑΚΠΑΠΙ	MEDICINAL
\$10	1		
3+3		TIDADALUK	

	Dambua	hun	aldea,	Manehat	Suco.	Manatuto	district:
--	--------	-----	--------	---------	-------	----------	-----------

CDECIES Nº				
SPECIES IN				
51				15
52				
53	Area raba a ballua ana ana iifa li			10, 17, 18, 19, 110, 10
54	Amorphophalius paeoniifoii	MAEK		17, 18, 110
55	Anacardium occidentale		SELL/FOOD	17, 19
S6	Anona sp	AI ATA FUIK		110
S7	Areca catechu	BUA	FOOD/SELL/ANIMAL FOOD/ FERTILITY/CARPENTRY	16, 18, 19, 110
58	Arenga pinata	TUA METAN	PALM WINE/SACRED HOUSE/BETEL STICK	110
<u>\$9</u>	Artocarpus altilis	KULU GUISA	FOOD	111
S10	Artocarpus heterophyllus	KULU JAKA	FOOD/SELL	110
S11	Bambusa sp	AU	CARPENTRY	18, 110
S12	Bougainvillea sp	TREPADELHA	CIMENTRY	111
S13	Carica papaya	AI DILA	FOOD/SELL/MEDICINE/ANIMAL FOOD	17, 111
S14	Cinnamomum sp	CANELA	FOOD	18, 19
S15	Citrus grandis	JAMBUA	FOOD/SELL	19
S16	Citrus limon	DEROK	FOOD	19
S17	Citrus sp	SABRAKA	CONSUMTION/SELL	19
S18	Cocos nucifera	NUU	FOOD/SELL/CARPENTRY/HANDCRAFT	111
S19	Colocasia esculenta	TALAS	FOOD/ANIMAL FOOD	17, 111
S20	Corypha sp	TALI TAHAN	CARPENTRY	17, 19
S21	Diascorea sp	KOMBILI	FOOD/SELL	17
S22	Ficus sp	HALE PORTUGAL	SHADOW	111
S23	Gliricidia sepium	GAMAL	FERTILISATION/FENCE/ANIMAL FOOD	18, 19, 111
S24	Gmelina sp	TEKA FILIPINA	CARPENTRY	19
S25	Gossampium arboreum	KABAS FUIK	TAIS/LAMP WITH CANDLENUT	17
S26	Hibiscus sp	FAU	FERTILISATION/CARPENTRY/ANIMAL FOOD	19, 110
S27	Imperata cylindrica	DUUT MANLAI	SACRED HOUSE	18
S28	Ipomea batata	FEHUK	FOOD	17, 16
S29	Leuceana leucocephalla	AI-LAMTORO	FERTILISATION/COW FOOD	18, 19,
S30	Mangifera sp	HAS	FOOD	19, 110, 16
S31	Manihot esculenta	AI FARINA	FOOD/ANIMAL FOOD/ SELL	17.16
S32	Moringa sp	MORINGA	FOOD	111
\$33	Musa sp	HUDI	SELL/FOOD/COW FOOD	17, 18, 19, 16
\$34	Nephelium Jappaceum	RAMBUTAN OAN	FOOD/SELL	19.16
\$35	Psidium guavaia	GOAVAS	FOOD/MEDICINE	19
S36	Pterocarnus indicus			19
\$37	Schleichera oleosa			110
\$38	Solanum sn	BRINGELA FLUK	FOOD	18
530	Spondias dulcis		FOOD	19 16
S40	Swietnia mahagoni	MAHONI		19,110
541	Tectona grandic	ТЕКА	CARPENTRY SELL	17 18 19
542	Theobroma cacao		FOOD	111
542				
545	Timonius sp Zizinhus sn			10, 10, 110, 10
544				17
545				19,10
540				
547			FERTILISATION	18
548		BABUNUK		110
549				
550				
551		KAIN		16
S52		KALA	FERTILISATION/ANIMAL FOOD	16
\$53		KRAME	PALM WINE	17
S54		LAKDUNU	FIREWOOD/COW FOOD	17
S55		MIROK	FERTILISATION	17
S56		SERESAS	FIREWOOD/COW FOOD	17

	Caivaca	aldea,	Soru	Suco,	Lautem	district	:
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SPECIES N°	LATIN NAME	TETUM NAME	FUNCTION	INV ID
S1	Alpinia galanga	LANGKUAS	FOOD/MEDICINE	12, 14
S2	Amorphophallus paeoniifoliu	MAEK	ANIMAL FOOD	114
S3	Anacardium occidentale	CAJU	FOOD/SELL	112
S4	Ananas comosus	AI NANAS	FOOD/SELL	112
S5	Anona muricata	AI ATA MALAI	FOOD/SELL	114
S6	Areca catechu	BUA OAN	FOOD/SELL	12, 13
S7	Arenga pinata	TUA METAN	PALM WINE/SUGAR/ROOF SACRED HOUSE/ROPE	l15
S8	Artocarpus altilis	KULU GUISA	FOOD/SELL	12, 16
S9	Artocarpus camansi	KULU MODO	FOOD	114
S10	Artocarpus heterophyllus	KULU JAKA	FOOD/SELL	12, 13, 14
S11	Bambusa sp	AU	FENCE/CARPENTRY/SELL	14, 15
S12	Canna edules	KONTAS	FOOD/SELL	113
S13	Carica papaya	AI DILA	FOOD/SELL/MEDICINE/ANIMAL FOOD	114
S14	Citrus limon	DEROK	FOOD/MEDICINE/SELL	113
			FOOD/ANIMAL	
S15	Cocos nucifera	NUU	FOOD/SELL/CARPENTRY/HANDCRAFT	12, 13, 14, 15
S16	Colocasia esculenta	TALAS	FOOD/ANIMAL FOOD/SELL	12, 13, 14
S17	Curcuma longa	KINUR MUTIN	FOOD/MEDICINE/SELL	113
S18	Cymbopogon citratus	DUUT MORIN	FOOD/MEDICINE/SELL	114
S19	Gliricidia sepium	AI GAMAL	FENCE/FERTILISATION	12, 13, 14
S20	Gmelina sp	TEKA FILIPINA	SELL/CARPENTRY	I13
S21	Imperata cylindrica	DUUT MANLAI	ROOF	112
S22	Ipomea batata	FEHUK	FOOD/SELL	12, 14
S23	Mangifera sp	HAS	FOOD/SELL	12, 13, 15
S24	Manihot esculenta	AI FARINA	FOOD/ANIMAL FOOD/SELL	12, 14
S25	Musa sp	HUDI	FOOD/SELL/ANIMAL FOOD	12, 13, 14
S27	Persea americana	AVOKATI	FOOD/SELL	12, 13, 14
S28	Piper betle	MALUS	FOOD/MEDICINE/SELL	114
S29	Prunus sp	PRUNUS	FOOD/SELL	I12
S30	Psidium guavaja	GOAVAS	FOOD/MEDICINE	12, 13, 14
S31	Swietnia mahagoni	MAHONI	SELL/CARPENTRY	13, 16
S32	Tectona grandis	ТЕКА	SELL/CARPENTRY	13, 14, 15, 16
S33	Theobroma cacao	CACAO	FOOD	I13
S34	Vigna sp	FORE	FOOD/SELL	I13
S35	Zea mays	BATAR	FOOD/SELL/ANIMAL FOOD	12, 13, 14
			WINE FERMENTATION/CATERPILLAR	
			TRAP/CARPENTRY FOR TRADITIONAL HOUSE AND	
S36		LAIK HURUHUA	TRADITIONAL CRAFT	115
S37		PIQPEA	CARPENTRY	115
S38		AJAN	FOOD	115

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SPECIES Nº			FUNCTION	
S1	Aleurites moluccana	KAMII		118 121
52	Alstonia sp			119
52	Amorphophallus paeoniifolius	MAFK		119 120
54	Ananas comosus	ΔΙΝΔΝΔ	FOOD/SELL	119
55	Anona muricata		FOOD/SELL	119
55	Anona sp	RUFA	FOOD	119
57	Areca catechu	BUA	FOOD/SELL/CARPENTRY	118 121
58	Arenga pinata	TUA METAN	PALM WINE/SUGAR/ROOF SACRED HOUSE/ROPE	120, 121
59	Bambusa sp	AU	EENCE/CARPENTRY/SELL	118, 119, 120
S10	Carica papava	AI DILA	FOOD/SELL/MEDICINE/ANIMAL FOOD	118.119
S11	Ceiba pentandra	AI LELE FUIK	PILLOW/CARPENTRY	118
S12	Citrus grandis	DJAMBUA	FOOD	119
S13	Cnidoscolus aconitifolius	AI DILA FILIPINA	FOOD	118
S14	Cocos nucifera	NUU	FOOD/ANIMAL FOOD/SELL/CARPENTRY/HANDCRAFT	117. 118. 119. 120. 121
S15	Colocasia esculenta	TALAS	FOOD/ANIMAL FOOD	119
S16	Curcurbita sp	LAKERU	FOOD/SELL/ANIMAL FOOD	117, 119
S17	Delonix regia	AI-KASI	FERTILISATION/FENCE	118
S18	Gliricidia sepium	AI GAMAL	FERTILISATION/FENCE	117, 118, 119, 120
S19	Gmelina sp	TEKA FILIPINA	CARPENTRY/SELL	119
S20	Leucaena leucocephala	AI KAFE	FERTILISATION/ANIMAL FOOD/FOOD	118, 120
S21	Mangifera sp	HAS	FOOD/SELL	118, 119, 121
S22	Manihot esculenta	AI FARINA	FOOD/ANIMAL FOOD/SELL	118, 119
S23	Musa sp	HUDI	FOOD/SELL	118, 119, 120
S24	Pennisetum purpuroides	DUUT LIURAI	ANIMAL FOOD	118
S25	Phaleria macrocarpa	MAKOTA DEWA	ANIMAL FOOD	118
S26	Phaseolus sp	FORE	FOOD/SELL	117
S27	Phaseolus vulgaris	КОТО	FOOD/SELL	119
S28	Piper nigrum	PIMENTA	FOOD/SELL	118
S29	Psidium guajava	GOAVA	FOOD/MEDICINE	17, 18, 19
S30	Salacca edulis	SALAK	SELL/CARPENTRY	117
S31	Santalum album	AI KAMELI OAN	SELL/CARPENTRY	119
S32	Schleichera oleosa	AI DAK	FOOD/FIREWOOD/FERMENTATION PALM WINE	117
S33	Sesbania grandiflora	AI TURI	FERTILISATION/ANIMAL FOOD	118
S34	Swietnia mahagoni	MAHONI	SELL/CARPENTRY	118
S35	Syzygium aromaticum	CENGKEH	SELL	118
S36	Tamarindus indica	SUKAER	FOOD/ANIMAL FOOD/FERTILISATION	118, 119
S37	Tectona grandis	TEKA	SELL/CARPENTRY	17, 18, 19, 20
S38	Theobroma cacao	CACAO	FOOD	118
S39	Timonius sp	AI KATIMUN	CARPENTRY/FIREWOOD/MEDICINE	17, 18, 19, 21
S40	Vigna sp	FORE TALI	FOOD/SELL	120
S41	Vigna sp	FORE MASIN	FOOD/SELL	120
S42	Zea mays	BATAR	FOOD/SELL/ANIMAL FOOD	17, 18, 19, 20
S43		SAVELE	MEDICINE	119
S44		AI MALAHU	SELL/CARPENTRY	121
S45		AJAN	FOOD	121
S46		DALAR	CARPENTRY	121
S47		PAHARU	FIREWOOD	121
S48		AI FOROK	FIREWOOD	121

Crarec maruc Aldea, Uma Tolu Suco, Viqueque district :

SPECIES N°	Latin name	Tetum name	Function	INVID
S1	Albizia saman	AI MATAN DUKUR	FERTILISATION/SHADOW	124
S2	Aleurites moluccana	KAMII	SELL/CARPENTRY	123, 124
S3	Amorphophallus paeoniifoliu	MAEK	ANIMAL FOOD	124
S4	Ananas comosus	AI NANAS	FOOD/SELL	123, 126
S5	Areca catechu	BUA	FOOD/SELL	123, 124
S6	Artocarpus camansi	KULU MODO	FOOD	126
S7	Artocarpus heterophyllus	KULU JAKA	FOOD/SELL	123
S8	Bambusa sp	AU BETUN	FENCE/CARPENTRY/SELL	124
S9	Citrus limon	DEROK	FOOD/MEDICINE/SELL	125
S10	Citrus sinensis	SABRAKA OAN	FOOD/SELL	125
S11	Cocos nucifera	NUU	FOOD/ANIMAL FOOD/SELL/CARPENTRY/HANDCRAFT	123, 125, 126, 127
S12	Coffea sp	KAFE	FOOD/SELL	123, 126
S13	Colocasia esculenta	TALAS	FOOD/ANIMAL FOOD	122, 123, 125, 127
S14	Corypha sp	TALI TAHAN	ANIMAL FOOD/HANDCRAFT/FENCE	124, 126
S15	Gliricidia sepium	AI GAMAL	FENCE/FERTILISATION	122, 123, 124, 125, 126, 127
S16	Gmelina sp	TEKA FILIPINA	CARPENTRY	122, 126
S17	Ipomea batata	FEHUK	FOOD/SELL	123, 126
S18	Leucaena leucocephala	AI KAFE	FERTILISATION/FODDER	123, 124
S19	Mangifera sp	HAS	FOOD/SELL	123, 124, 125
S20	Manihot esculenta	AI FARINA	FOOD/ANIMAL FOOD/SELL	123, 126, 127
S21	Musa sp	HUDI	SELL/FOOD	122, 123, 125, 126, 127
S22	Phaseolus sp	КОТО	FOOD	123, 126
S23	Phyllanthus acidus	SARMALEN	FOOD	125
S24	Piper betle	MALUS	FOOD/MEDICINE/SELL	123
S25	Psidium guavaja	GOAVAS	FOOD/MEDICINE	125
S26	Sesbania grandiflora	AI TURI	FERTILISATION/FODDER	123
S27	Sterculia foetida	AI NITAS		124
S28	Syzygium cumini	BECO	CARPENTRY/MEDICINE	125
S29	Tamarindus indica	SUKAER	FOOD/ANIMAL FOOD/FERTILISATION	125
S30	Tectona grandis	TEKA TIMOR	CARPENTRY	122, 123, 124, 125, 126
S31	Theobroma cacao	CACAO	FOOD	123, 126
S32	Timonius sp	AI KATIMUN	FIREWOOD/CARPENTRY/MEDICINE	123
S33	Vigna sp	FORE	FOOD	123, 126
S34	Zea mays	BATAR	FOOD/ANIMAL FOOD/SELL	123, 126
S35	Zingiber officinale	AI LIA	SELL/FOOD	122, 127
S36		AI MAHAR	CARPENTRY	124